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China's Economic Transition, Integration and External Position

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Abstract:

This paper analyses the link between China's economic transition and global integration and the country's external surplus and large international creditor position. It uses an extended multi-country version of the QUEST III model (Ratto et al., 2009). The extensions are (1) a portfolio model that distinguishes gross/net and private/government foreign asset holdings and (2) the modelling of exchange rate management in the form of (sterilised) foreign exchange interventions. The paper selects a set of shocks that characterise China's recent economic development (TFP, labour supply, labour reallocation, investment incentives, household savings, trade integration, foreign savings demand) and analyses their individual and combined ability to match key stylised facts: (1) High GDP growth; (2) declining consumption and increasing investment shares in GDP; (3) large current account surpluses; (4) the build-up of a large aggregate NFA position, combining even larger foreign reserves of the central bank and negative net foreign asset holdings of the private sector. None of the shocks is sufficient to individually match the domestic and external dynamics, but the combination of domestic and "globalisation" shocks replicates them at least in qualitative terms. Domestic supply shocks replicate high GDP growth and the shift in demand composition, while "globalisation" shocks are essential to generate persistent external surpluses. The simulation results suggest foreign savings demand to be an important driver of the external surplus and NFA accumulation.

JEL classification: E52, F41, F43

Keywords: DSGE modelling, China, capital controls, exchange rate policy, net foreign assets

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1. INTRODUCTION

The Chinese economy has undergone remarkable transition and development over the past 20 years. Output has grown at two-digit annualised rates; per capita income has risen from 5% to 20% of EU-15 levels. Another characteristic has been the development of large external surpluses which have made China the world's largest international creditor.

The primary purpose of this paper is to analyse the link between economic catch-up and global integration and China's development towards becoming the world's largest net capital exporter. The standard neoclassical model with perfect international capital mobility does not explain the coincidence of economic catch-up and income convergence, on the one side, and of large external surpluses and net foreign asset accumulation, on the other side.

The paper uses an extended version of the QUEST III model, a multi-country Dynamic Stochastic General Equilibrium (DSGE) model (Ratto et al., 2009). The extensions are (1) a portfolio model that distinguishes between gross versus net and private versus government foreign asset positions and (2) the inclusion of exchange rate management in the form of (sterilised) foreign exchange intervention. The extensions capture two important elements of macroeconomic policy in China, which are the restriction of cross-border capital flows (captured by low elasticities of cross-border capital flows with respect to expected return differentials) and active exchange rate management. The multi-country model includes four regions: China, the US, the euro area and the rest of the world.

The work is closely related to research that analyses determinants of global imbalances especially from the perspective of surplus countries and to simulations in multi-region DSGE models of the world economy (e.g., Cova et al., 2009; Faruquee et al., 2007; Straub and Thimann, 2009). However, the models usually assume perfect international capital mobility and do not explicitly model foreign exchange interventions; the standard fix is the addition of exchange rate targets to the interest rate rule, which does not allow distinguishing between private and central bank foreign asset positions and for sterilised interventions, however.

The paper selects domestic and "globalisation" shocks to characterise China's recent economic development (TFP, labour supply, labour reallocation, investment incentives, household savings, trade integration, US savings gap) and investigates their individual and combined impact on output, demand composition and external balances, i.e. their ability to match key stylised facts: (1) High GDP growth; (2) declining consumption and increasing investment shares in GDP; (3) large current account surpluses; (4) the build-up of large aggregate NFA holdings, combining an even stronger foreign reserve position of the central bank and negative foreign asset holdings of the private sector.

The results suggest that while none of the domestic and "globalisation" shocks is sufficient to individually replicate the domestic and external characteristics of China's macroeconomic transition, the combination of domestic and "globalisation" shocks matches the stylised facts at least qualitatively. The simulations also suggest a major role of foreign savings demand instead of a "savings glut" for China's external surplus and NFA accumulation.

The structure of the paper is as follows. Section 2 provides a short literature review to place the analysis in context. Section 3 sketches stylised facts on China's economic development that model simulations should be able to replicate. Section 4 introduces the portfolio model with limited capital mobility and the structure of foreign exchange intervention. Section 5 discusses the calibration of model parameters. Section 6 presents simulation results for individual and combined shocks and alternative parameter settings. Section 7 summarises the main results and concludes.

2. REVIEW OF THE LITERATURE

The emergence and persistence of large global current account imbalances has attracted a lot of economic research and policy discussion (see Gruber and Kamin, 2007). Part of the work focuses on net debtor countries as the pull side of global imbalances (e.g. Bems et al., 2007; Blanchard, 2007; Bussiere et al., 2005; Chinn and Prasad, 2003; Chinn and Ito, 2008; Corsetti and Mueller, 2006); another part deals with net creditors as the push side (e.g. Blanchard and Giavazzi, 2005; Bracke and Fidora, 2008; Lee and McKibbin, 2006; Mendoza et al., 2007; Yu, 2007). Work based on simulations in multi-country models (e.g. Choi et al., 2008; Choi and Mark, 2009; Faruquee et al., 2007) combines and compares the impact of shocks that pull in foreign savings on the debtor and push external surpluses on the creditor side.

China is currently the largest single net creditor in international capital markets. Economic research has suggested multiple explanations for the current account surplus of the Chinese economy, which are not mutually exclusive. A first line of arguments sees high precautionary saving in the context of population ageing, the decline of traditional families as old-age support, the lack of encompassing social security systems or even the unbalanced gender ratio as drivers of excess savings in the private sector (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). Regarding the implementation in DSGE models, Choi et al. (2008) and Choi and Mark (2009) rely on state-dependent cross-country heterogeneity of discount rates to generate country differences in savings behaviour: countries with patient households lend to the rest of the world, countries with impatient households borrow from abroad. Gertler (1999) and Roeger (2003) obtain cross-country heterogeneity of aggregate savings from a life-cycle model 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.

Government policies of export promotion and limiting external financial vulnerability constitute a second set of explanations. In this context, exchange rate management and capital controls have received particular attention. The restrictions on Renminbi (RMB) appreciation have been interpreted as measures to keep the country competitive in the world market and to promote export growth (e.g. Dooley et al., 2007; Faruquee et al., 2007). The accumulation of foreign exchange reserves also provides the government with a "war chest" to defend the domestic currency in case of attack (e.g. Cova et al., 2009; Prasad and Rajan, 2008). The undervaluation of the RMB and its impact on the current account remain disputed, however. While Korhonen and Ritola (2009) illustrate that most empirical studies (e.g. Cline and Williamson, 2009) consider the RMB (heavily) undervalued, Cheung et al. (2007a, 2007b) conclude the evidence not to allow a strong verdict. Global rebalancing ultimately depends on real effective exchange rate adjustment, which is also a function of price and wage dynamics. Chin and Wei (2009) do not find strong, robust and monotonic links between nominal exchange rate flexibility and real exchange rate adjustment. Dooley et al. (2007) and Xiao (2008) add that if it is a credible policy objective, real appreciation should be compatible with both flexible and managed nominal exchange rates as price levels can adjust appropriately.

A third strand of the literature addresses imbalances between savings and investment from the perspective of heterogeneity in financial market development. Caballero et al. (2008) illustrate that global imbalances can be an equilibrium outcome if different world regions differ in their capacity to generate financial assets for real investment. Mendoza et al. (2007) consider the impact of differences in financial market development on savings behaviour and the demand for various assets. While both papers focus on the US current account deficit, the explanatory value for why China is such a big creditor remains limited. Domestic investment in China is high by international standards and has grown during the years of net foreign asset (NFA) accumulation, giving little plausibility to a shortage of investment opportunities compared to other world regions as key driver of capital outflows. Song et al. (2009) consider financial imperfections in the form of unequal access to credit. Highly productive firms have poor access to capital markets and must finance investment out of internal savings; the decline of low productivity firms with good access to capital markets forces a growing share of domestic savings to be invested in foreign assets.

However, this approach does not yet explain the central role of the Chinese state as holder of foreign assets; the positive NFA position of the government coincides with a negative one of the private sector.

Although high domestic savings can explain the external surplus, NFA accumulation of an emerging economy with technology catch-up, growing labour supply and rising per capita income are difficult to reconcile with the standard neoclassical model (e.g., Dollar and Kraay, 2006; Ma and Haiwen, 2009; Straub and Thimann, 2009). Permanent positive shifts of technology and labour supply increase the marginal productivity of capital, which should lead to net capital inflows.

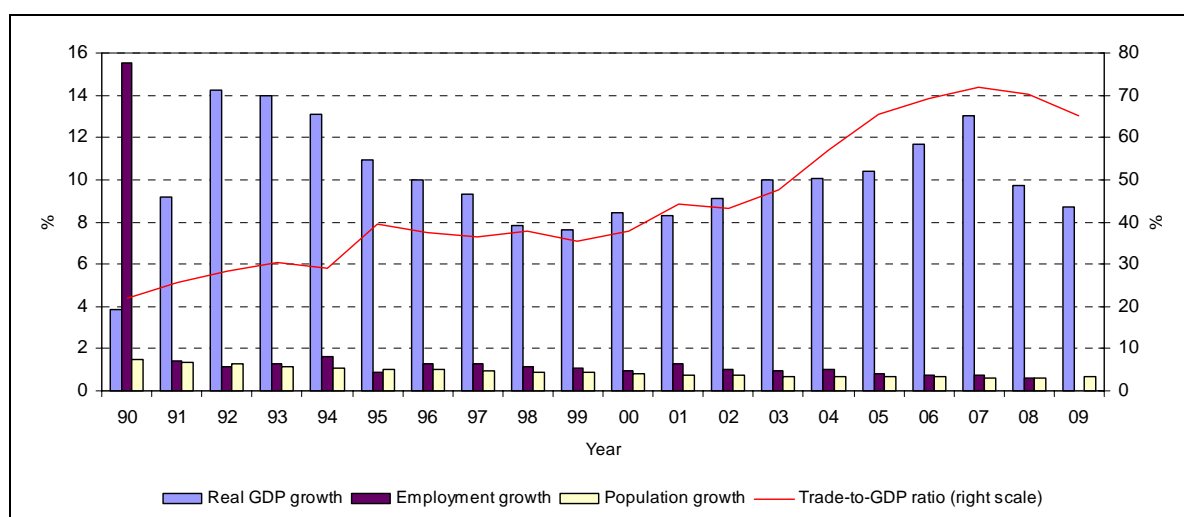
Straub and Thimann (2009) find that weak responses of domestic demand to permanent income shifts are able to generate a positive correlation between output and the balance of trade in reaction to positive technology and labour supply shocks. However, the time-varying costs of money holding and the time-varying consumption taxes used by Straub and Thimann (2009) to specify inefficiencies in the domestic demand adjustment are not overly intuitive from the empirical point.

The present paper looks at the potential of cross-border capital flow restrictions as an alternative friction in financial markets and exchange rate management to explain current account and NFA dynamics and the positive correlation with output in a catching-up economy. Restricting cross-boarder capital flows weakens the arbitrage between domestic and foreign assets and can leave domestic monetary policy with substantial autonomy even in a system of managed exchange rates. The approach proxies the Chinese policy of exchange rate management and binding cross-border capital controls (e.g., Koivu et al., 2008; Ma and McCauley, 2008). Regression analysis in Dollar and Kraay (2006) finds a positive relationship between capital controls and a country's NFA position.

3. CHINA'S RECENT ECONOMIC DEVELOPMENT

This section highlights some key aspects of China's macroeconomic development during the past two decades. The occurrence of a large positive NFA position is a puzzle for standard open-economy models with international capital mobility that predict net capital inflows to a catching-up economy. The paper's focus on China derives from the country's role as the most important net lender among developing countries.

Figure 3.1: Growth and trade openness

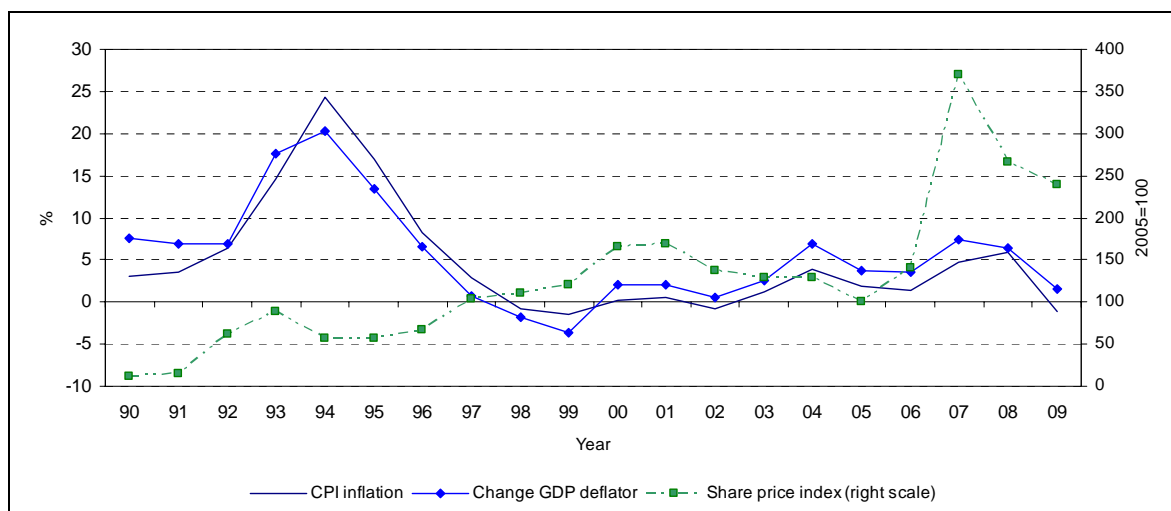


Source: Commission services, National Bureau of Statistics of China

Figure 3.1 shows the rapid development of the Chinese economy during the past two decades. China's real GDP has grown at annual rates of around 10% despite only moderate employment growth¹ and combined with the rapid integration in world markets as indicated by the sharp increase of its trade-to-GDP ratio.

Inflation has remained modest after a period of higher inflation in the early 1990s, while share prices have risen considerably (Figure 3.2). The modest inflation implies very limited real appreciation relative to the US given the stability of the RMB-USD exchange rate.

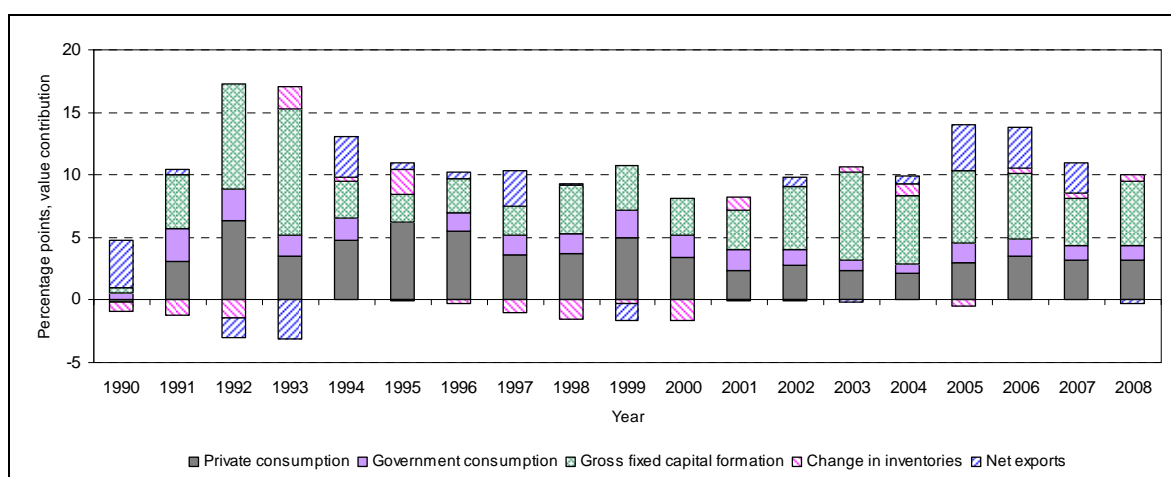
Figure 3.2: Price indices



Source: Commission services, IMF International Financial Statistics

Increasing investment has been the main drivers of China's GDP growth on the demand side. The contribution of private and government consumption has been weaker, but constantly positive, whereas net exports have made a positive contribution especially in recent years (Figure 3.3).

Figure 3.3: Contribution to demand growth

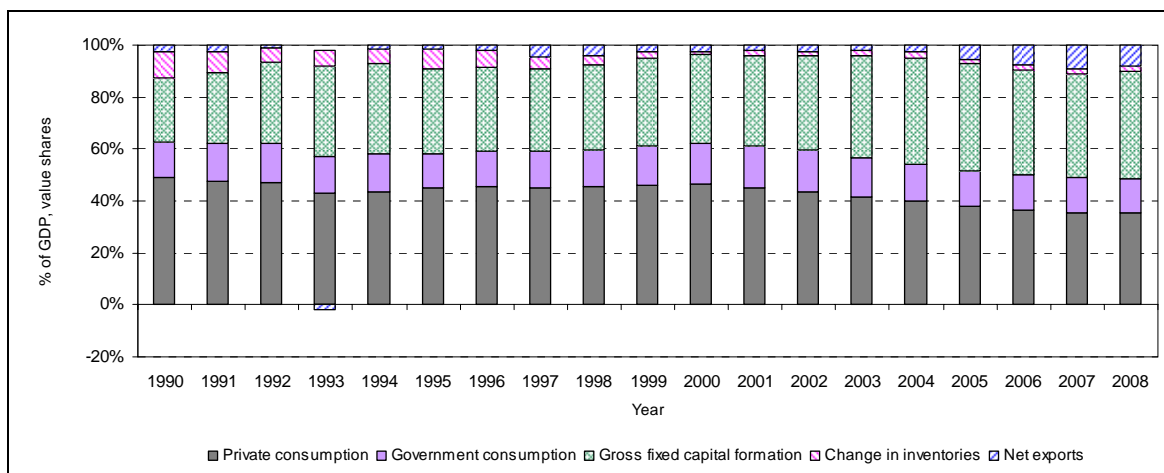


Source: IMF International Financial Statistics

¹ The rate of employment growth in 1990 is generally considered a statistical artefact that is related to methodological changes in the labour force survey.

The disparate growth performance has shifted the shares of the different components of total demand: The share of private consumption in total demand has fallen over the past 20 years, while investment has risen in similar proportion; government consumption remained fairly stable, net exports have increased in relative terms (Figure 3.4).

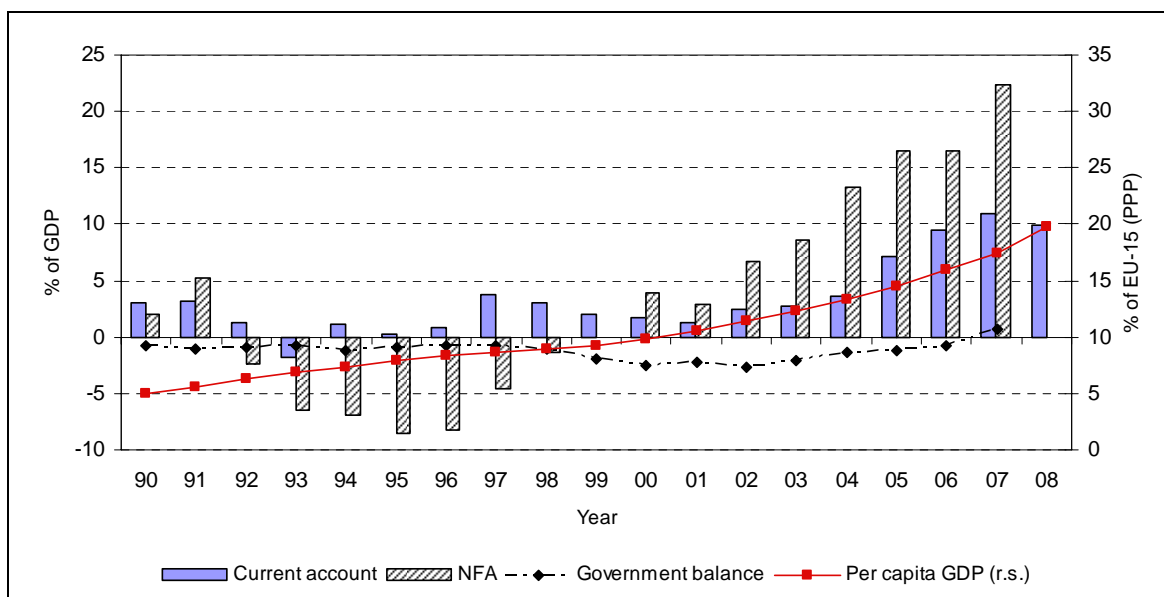
Figure 3.4: Composition of final demand



Source: IMF International Financial Statistics

Despite the steady income convergence towards Western countries, China has run current account surpluses for much of the past two decades and started continuously accumulating NFA since the year 2000. Excess savings stemmed from the private sector and cannot be attributed to the government sector that has run modest deficits over the past 20 years (Figure 3.5).

Figure 3.5: Foreign position and income convergence

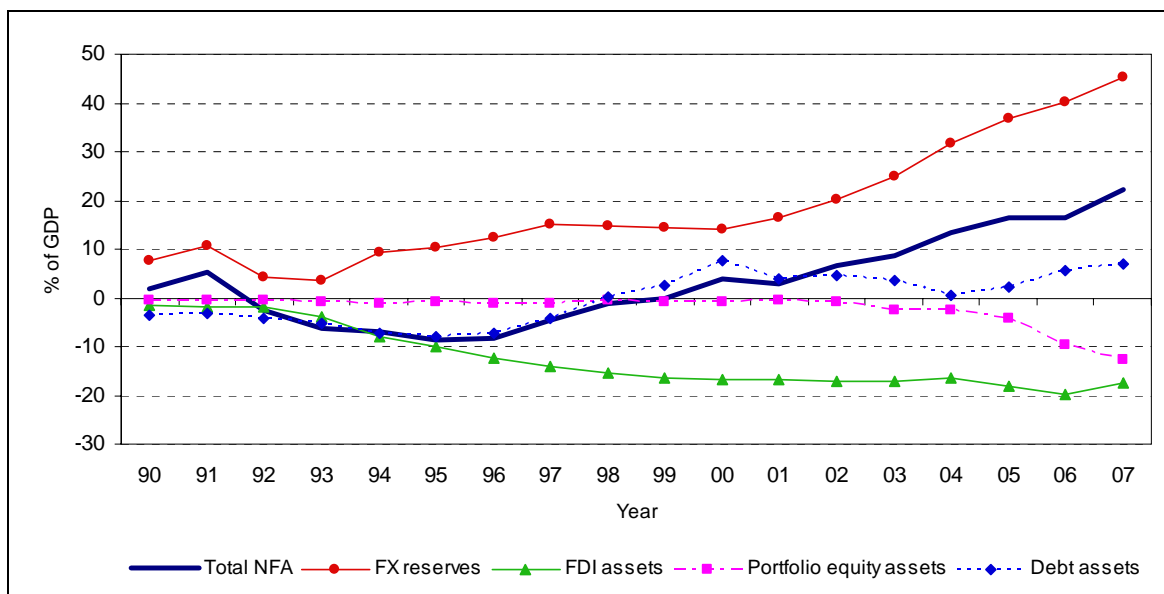


Source: Commission services, Lane and Milesi-Ferretti (2007)

On the side of origination, Prasad (2009) explains the rapid rise in China's NFA position since 2000 with the inflow of speculative capital in the context of expected RMB appreciation in the years 2001-2004 and the steep rise in the trade surplus since 2005. On the expenditure side, total net foreign assets can be decomposed into the private and public sector positions. Figure 3.6 shows China's NFA surplus to consist

primarily of foreign reserve holdings of the monetary authority, while the private sector has a negative net position. China is thus “normal” at least in the sense of net FDI inflows, which are prototypical for an economy that is catching up in productivity terms. China has successfully tilted capital inflows towards FDI and has limited portfolio investment (Prasad and Wei, 2005; Prasad and Rajan, 2008).

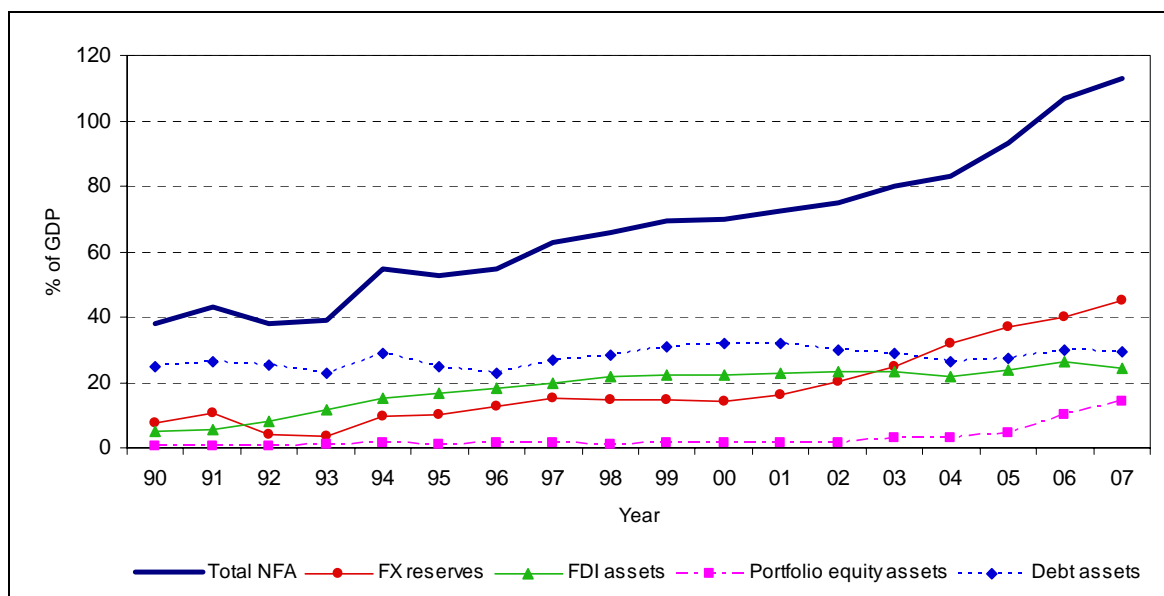
Figure 3.6: Decomposition of net foreign assets



Source: Calculations based on Lane and Milesi-Ferretti (2007)

Looking at gross foreign asset positions illustrates China’s increasing integration in international capital markets despite remaining restrictions on cross-border capital flows (Figure 3.7).

Figure 3.7: Sum of foreign assets and liabilities

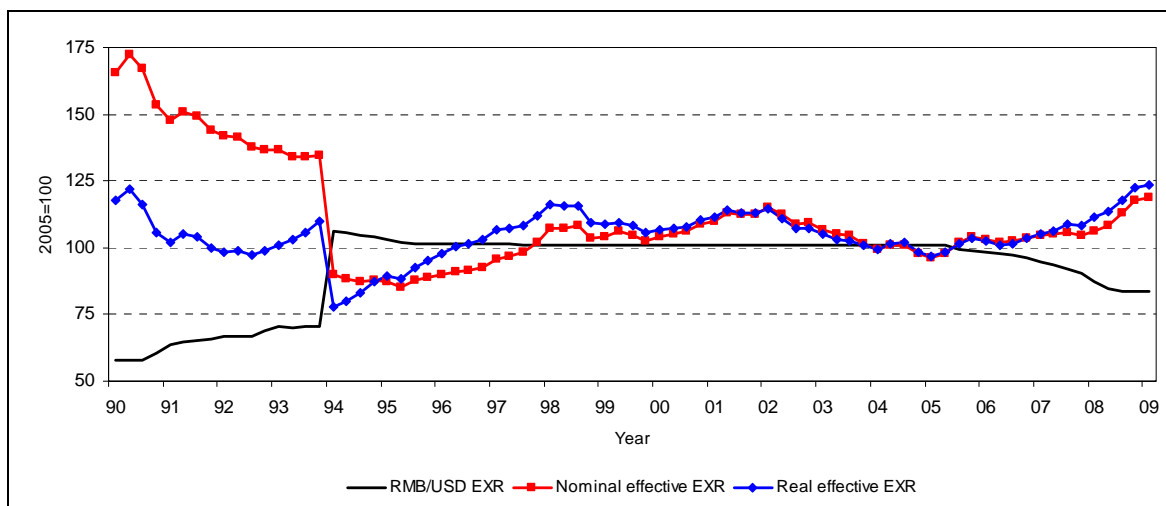


Source: Calculations based on Lane and Milesi-Ferretti (2007)

Legal and factual restrictions on cross-border capital inflows and outflows have been reduced over the past two decades. Given its attempt to stabilise the RMB exchange rate (Figure 3.8), the central bank has accumulated large foreign exchange reserves as a consequence of increased capital inflows and the pressure towards

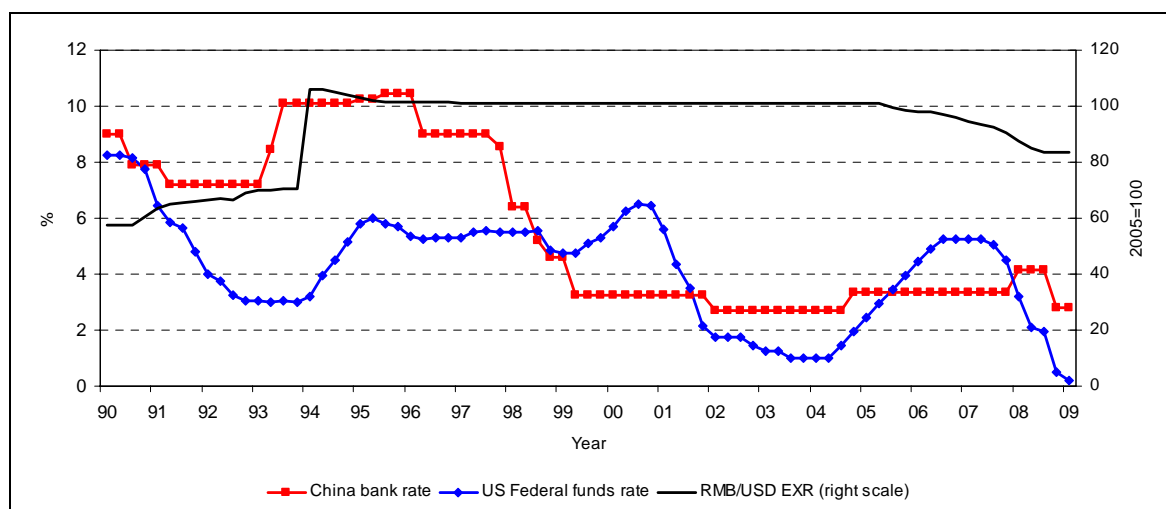
RMB appreciation. The subsequent relaxation of capital outflow restrictions has helped reducing the pressure towards appreciation (Prasad and Wei, 2005; Prasad and Rajan, 2008). The central bank sterilises foreign exchange interventions by selling or buying domestic bonds in line with domestic objectives of price level and output stabilisation (e.g., Glick and Hutchinson, 2008; Ouyang et al., 2008).

Figure 3.8: Renminbi exchange rates



Source: IMF International Financial Statistics

Figure 3.9: Interest and exchange rates



Source: IMF International Financial Statistics

Those restrictions on cross-border capital flows that are still in place after a period of capital account liberalisation remain effectively binding. Figure 3.9 shows short-term interest rate differentials in the context of exchange rate stability, i.e. deviations from uncovered interest parity, as simple illustration for remaining frictions and domestic monetary autonomy. Ma and McCauley (2008) provide more extensive and sophisticated analysis of the effectiveness of China's capital controls. Depending on the selected Chinese and US interest rates, they find deviations from uncovered interest rate parity of a magnitude of 200 basis points over the period 1997-2005 (150-300 basis points in 97-01, 50-100 basis points in 01-05). Ma and McCauley (2008) also show evidence for geographical yield differentials for identical assets, indicating limited arbitrage opportunities. The yield differentials between Chinese government bonds traded inside and outside China have reached magnitudes of 500 basis points and above in the past decade.

4. CAPITAL RESTRICTIONS AND EXCHANGE RATE MANAGEMENT

The analysis builds on DG ECFIN's QUEST III DSGE model.² The model economy is populated by representative households and firms and has monetary and fiscal authorities committed to rules-based stabilisation policies. The firms in each region produce a continuum of differentiated goods. Each region has tradable and non-tradable goods sectors. The goods produced in one region are imperfect substitutes for the goods produced in other regions.

The model features liquidity-constrained households that in each period consume their disposable wage and transfer income and unconstrained households that have full access to financial markets. The unconstrained households decide on financial and real capital investments and allocate their wealth over domestic and foreign assets. The paper uses a model version with finite lifetime of unconstrained households.

The paper departs from the standard assumption of perfect substitutability between domestic and foreign assets; it introduces imperfect substitutability between domestic and foreign assets that may result from legal and factual restrictions on cross-border capital flows. The modelling of the portfolio decision and imperfect substitutability follows Blanchard et al. (2005) and Breuss et al. (2009).

This section extends the QUEST III model to include (1) the international portfolio decision and (2) foreign exchange interventions as the central bank's instrument for exchange rate management; interventions are sterilised in line with objectives of domestic macroeconomic stability. In the context of section 3, we consider the extensions as proxies for the limited cross-border capital mobility and the exchange rate management in China.

The portfolio approach with imperfect substitutability between domestic and foreign assets replaces the standard uncovered interest parity (UIP) condition that assumes the perfect substitutability between domestic and foreign currency assets of identical risk. Imperfect substitutability reduces the elasticity of cross-border capital flows to interest rate differentials and facilitates foreign exchange intervention for the purpose of exchange rate stabilisation.

The portfolio approach and the mechanics of foreign exchange intervention are described in a two-country setting with domestic and foreign economies indexed by d and f . The multi-region model treats China as the domestic and the US as the foreign economy. Portfolio decisions therefore refer to the choice between RMB and US dollar (USD) assets; exchange rate targets for the RMB are formulated relative to the USD.

4.1. PRIVATE SECTOR PORTFOLIO DECISIONS

The "real" production and demand blocks (goods market, labour market, production technology) of the model correspond to the standard settings in QUEST III. The equations for consumption, export and import demand, investment, physical capital accumulation and labour supply remain therefore unchanged.

The ownership of productive assets differs from the standard QUEST III framework in that domestic and foreign households own part of the domestic and foreign firms:

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

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

² Ratto et al. (2009) provide a detailed model description.

The variables V^d , V^{dd} and V^{df} denote respectively the total value of firms in the domestic economy, the value of domestic firms in domestic ownership and the value of domestic firms in foreign ownership. The variables are expressed in real terms and in units of the firm's country of location.

The demand by domestic households for domestic and foreign productive assets depends on investment home bias, b^d , the elasticity of demand with respect to expected return differentials, σ^d , and household wealth, F^d :

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

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

The portfolio decision of foreign households follows analogously from the demand equations:

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

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

Binding capital controls should imply (1) strong home bias of investors, b^d and b^f , and (2) low substitution elasticities, σ^d and σ^f .

Household wealth in real terms is the sum of the real value of government debt, B/P, and firm ownership:

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

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

For simplicity, private households assumingly hold only government bonds of their own country, but no foreign government debt, so that $B^{fd}=0$ and $B^{df}=0$.

Combining the equilibrium condition that at the aggregate level the relative supply of domestic and foreign assets must equal the relative asset demand:

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

and the demand functions (3) to (6) yields the equation:

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

which can be interpreted as generalised interest parity condition.

Equation (10) has important implications for economic policy. Lower values of the elasticity of substitution between domestic and foreign assets reduce the pressure from international interest rate differentials on exchange rates. Capital controls that are sufficiently effective in limiting the cross-border arbitrage allow the combination of exchange rate targets with domestic monetary autonomy.

4.2. FOREIGN EXCHANGE INTERVENTIONS

The government debt B^d is the sum of the outstanding government debt stock, the debt service and the primary surplus, which is determined by government consumption, G , government investment, IG , transfers and subsidies, TR , tax revenues, T , and the profit generated by the central bank, $profit^{CBd}$:

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

The government debt is owned by domestic households and by domestic and foreign central banks:

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

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

As the paper focuses on China's NFA accumulation and considers China as the domestic economy, the amount of domestic public debt hold by foreign central banks, B^{dCBf} , is set to zero in the remaining derivation.

The domestic central bank's balance sheet identity requires that the net holding of domestic and foreign currency bonds equals the outstanding stock of money:

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

Profits of the central bank are the net return on the asset portfolio:

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

The central bank transfers these profits to the government as specified in the government budget constraint (11).

The structure of the central bank's portfolio depends on its macroeconomic objectives. The portfolio decision is a two-stage process: First, foreign exchange interventions by the central bank stabilise the exchange rate at the target ($\gamma_e > 0$) or historical ($\gamma_{\Delta e} > 0$) level:

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

and determine the central bank's net foreign asset holdings.

Second, the central bank sells or buys domestic bonds to sterilise the impact of the foreign exchange intervention on domestic money supply to maintain a level of domestic interest rates that is compatible with the domestic inflation and output targets:

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

The monetary policy rate resulting from rule (17) and the balance sheet identity (14) determine the domestic money supply and the central bank's net position in domestic currency bonds.³

The explicit modelling of foreign exchange intervention departs from Faruqee et al. (2007) and Straub and Thimann (2009), who include exchange rate targets in the interest rate rule. The two-stage approach approximates the practice of foreign exchange interventions (e.g., Obstfeld and Rogoff, 1996). In addition, the analysis of foreign exchange reserves as the main component of China's positive NFA position requires the explicit modelling of the central bank's balance sheet.

4.3. NET FOREIGN ASSET POSITION

The real net foreign asset position is the difference in real terms between the domestic ownership of foreign assets and the foreign ownership of domestic assets:

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

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

The first term on the right side of equation (18) is the foreign asset position of the central bank and the term in brackets is the net private ownership of foreign assets.

The NFA position of the economy is the sum of the outstanding NFA position, the net return on these assets and the county's trade balance:

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

A trade surplus ($P^{xd}X^d > P^{md}IM^d$) increases and a trade deficit ($P^{xd}X^d < P^{md}IM^d$) reduces the economy's NFA position for given initial NFA stocks and interest payments.

5. MODEL CALIBRATION

The analysis uses an annualised multi-region version of QUEST III; the regions are: China, the United States, the euro area and the rest of the world. The calibration of the model parameters for China is challenging as empirical evidence on many parameters remains very limited. In line with other DSGE models

³ Alternatively, a money supply rule could be used to adjust domestic monetary conditions in response to the central bank's stabilisation objectives. Money supply rules that are equivalent to the Taylor rule (17) should create equivalent monetary conditions.

(Cova et al., 2009; Faruquee et al., 2007; Straub and Thimann, 2009) we limit deviations from the baseline QUEST III calibration to a number of important parameters for which supportive evidence exists and to the portfolio extension. The Table 5.1 summarises the calibration of the China block of the model.

Table 5.1: Calibration of China model block

Parameter	Symbol	Value	Source
Domestic ownership share of domestic capital	b^d	0.85	Li (2009)
Elasticity of portfolio decisions	σ^d, σ^f	1.00	Blanchard et al. (2005), Breuss et al. (2009)
Reaction to deviation from target exchange rate	γ_e	1.00	-
Reaction to changes in exchange rate	$\gamma_{\Delta e}$	0.00	-
Share of liquidity-constrained consumers	slc	0.40	Zhang and Wan (2004)
Habit persistence	h	0.24	QUEST III
Inverse of elasticity of labour supply	κ	5.00	QUEST III, Herd et al. (2010)
Price elasticity of trade	$\sigma^x = \sigma^m$	1.50	Ahmed (2009), Cheung et al. (2009)
Persistence of nominal interest rate in Taylor rule	ρ	0.45	QUEST III
Coefficient on CPI inflation in Taylor rule	τ_π	1.50	QUEST III
Coefficient on output gap in Taylor rule	τ_y	0.05	QUEST III
Strength of foreign exchange intervention	τ_e	1.00	QUEST III
Capital adjustment cost	γ_k	15.00	QUEST III, Woelfl et al. (2009)
Investment adjustment cost	γ_i	10.00	QUEST III, Woelfl et al. (2009)
Labour adjustment cost	γ_l	6.25	QUEST III, Herd et al. (2010)
Price adjustment cost for final tradable goods	γ_p	10.00	QUEST III, Woelfl et al. (2009)
Price adjustment cost for final non-tradable goods	γ_{ph}	15.00	QUEST III, Woelfl et al. (2009)
Exports goods price adjustment cost	γ_{px}	0.00	QUEST III
Nominal wage adjustment cost	γ_w	6.25	QUEST III, Herd et al. (2010)
Degree of forward-looking in domestic pricing	$sfp, sfph$	0.90	QUEST III
Degree of forward-looking in export pricing	$sfpx$	0.80	QUEST III
Degree of forward-looking in wage setting	sfw	0.90	QUEST III
Steady-state trade openness	X/GDP	0.42	GTAP

China's trade openness, the bilateral trade linkages between the model regions and the input-output structure are taken from the GTAP database for 2004. An important trade-related parameter is the price elasticity of export and import demand. Although one may conjecture the price elasticity to be low on the import side (commodities, investment goods) and higher on the export side (low product differentiation), empirical research lends little support and is often sensitive to particular data and definitions of relevant price deflators. Cheung et al. (2009) estimate (93q3-06q2) China's total imports to fall by 0.4-1.5% per 1% rise of import prices and total exports to fall with below-unit elasticity, or even to rise, when export prices increase. The estimated elasticities for bilateral China-US trade are 1.0-1.3 for Chinese imports (US data; insignificant with Chinese data) and 0.8-1.3 for exports (US data; 1.6-2.0 for Chinese data). The recent econometric work by Ahmed (2009) finds price elasticities for Chinese exports (96q1-09q2) of circa 1.5. In the light of this (limited) evidence we use a price elasticity of 1.5 for China.⁴

The simulations start from a baseline scenario with balanced trade and zero net foreign asset positions and investigate the current account and NFA dynamics in response to shocks and policy settings. The zero cur-

⁴ It is plausible to conjecture that export and import price elasticities may have increased over time, especially in the aftermath of China's WTO accession in 2001. The simulations do not investigate such parameter shift, however, but contain a scenario for growing access to international markets instead.

rent account and NFA baseline seems an admissible approximation to the external position of the Chinese economy in the early 1990s (Figures 3.5).

The GDP share of public sector final demand is kept constant, so that public demand evolves proportional to total output. This is in line with Figure 3.4 and the evidence in Prasad (2009) to the extent that investment in state-owned companies is considered to be part of business investment.⁵ Faruqee et al. (2007) and Straub and Thimann (2009) set the share of liquidity-constrained households in the China block higher than in Europe and the US, but strong empirical support for tighter constraints is missing (e.g., Modigliani and Cao, 2004). As econometric estimates of Zhang and Wan (2004) for the period 61-98 suggests a share of 37% for liquidity-constrained consumption, the calibration in Table 5.1 uses a share of 40% as for the other regions.

In light of scant comparable evidence on nominal and real rigidities in emerging Asia, Cova et al. (2009), Faruqee et al. (2007) and Straub and Thimann (2009) calibrate price, wage, employment and capital adjustment costs uniformly across all model regions. The calibration here departs from this practice; comparable evidence on international differences is scarce, but some indication exists, e.g. in form of the OECD indicators of product market regulation (PMR) and employment protection legislation (EPL).

Product market regulation in China is still restrictive. China's overall PMR score is 3.3 (euro area: 1.3; US: 0.8) on a 0-6 scale, with a score of 3.9 (euro area: 1.3, US: 0.9) for the sub-indicator "state involvement in business operations" and 2.9 (euro area: 1.3, US: 1.2) for the sub-indicator "barriers to entrepreneurship"; price controls, the use of command and control regulation and the administrative burden on start-ups appear particularly pronounced (see Woelfl et al., 2009). China's score for employment protection legislation (EPL) of 2.8 on the 0-6 scale is close to euro area countries and above the US score (0.9); *de facto* protection may be substantially below the EPL score due to the limited enforcement of labour laws and minimum wage requirements (see Herd et al., 2010). Based on this evidence from OECD indicators we set the parameter values for product market rigidities (price, investment and capital stock adjustment costs) above and those of labour market rigidities (wage and employment adjustment costs) equal to euro area levels. This selection of values is very informal though, because the PMR and EPL indicators are not identical to the concept of adjustment costs in the QUEST III model. Against the same background, the elasticity of labour supply is set to 0.20 in China, Europe and the rest of the world and to 0.33 for the US labour market; the value for China may risk underestimating the *de facto* responsiveness of migration flows.

Mehrotra et al. (2007) estimate New Keynesian Phillips curves for China and find sizable inflation inertia in the form of approximately equal weights for the lag and lead components of inflation expectations. Liu and Zhang (2007) find lagged output and inflation terms to dominate lead ones in the output and inflation equations of a four-equation New Keynesian model of the Chinese economy. However, the estimates from these reduced-form equations are of limited use for calibration, because the persistence may capture inertia in underlying demand and supply factors rather than persistence in expectation formation itself. Given the persistence embodied in the calibration of adjustment costs for China and the lack of further evidence, the weight of forward-looking behaviour is kept as in the other regions.

The calibration of the portfolio structure requires an estimate for the equilibrium foreign-ownership share of the domestic capital stock. Li (2009) breaks down China's capital stock by sources and ownership of funds: 7% (8%) of the capital stock has been owned by foreign funds in 2006 (1993). The investment from Hong Kong, Macau and Taiwan covered another 12% (3%) in 2006 (1993); the latter may partly reflect reflows of funds from mainland China though. In between these magnitudes we set the gross foreign-ownership share of Chinese assets to 15%; this implies that in the zero-NFA baseline Chinese households own 2% of the foreign capital stock.

⁵ The public investment in the QUEST III model is infrastructure investment that augments the productivity of private capital and labour; the model does not include a sector of state-owned producers.

Restrictions on cross-border capital flows have been relaxed and have become less efficient over time, but they are still binding (Ma and McCauley, 2008; Prasad, 2009). Consequently, while the elasticity of cross-border flows to expected return differentials should have increased, it remains limited. Unfortunately, there is little empirical information about the value of σ , which is the decisive parameter to pin down the real effects of portfolio choices. In line with Blanchard et al. (2005) and Breuss et al. (2009) the simulations focus on $\sigma=1$ and check the robustness of the results for alternative parameter values. The value $\sigma=1$ implies that each 100 basis-point increase in the expected rate of return on foreign assets raises the desired share of foreign assets in total wealth by one percentage point. Despite potential asymmetries in the extent or timing of capital account liberalisation, we assume symmetry in the elasticity of cross-border investment with respect to expected returns, i.e. $\sigma^d=\sigma^f$.

6. SIMULATIONS

This section presents model simulations for a series of shocks that are part of China's economic development in recent decades and have received attention as potential determinants of the country's external position.

6.1 TOTAL FACTOR PRODUCTIVITY GROWTH

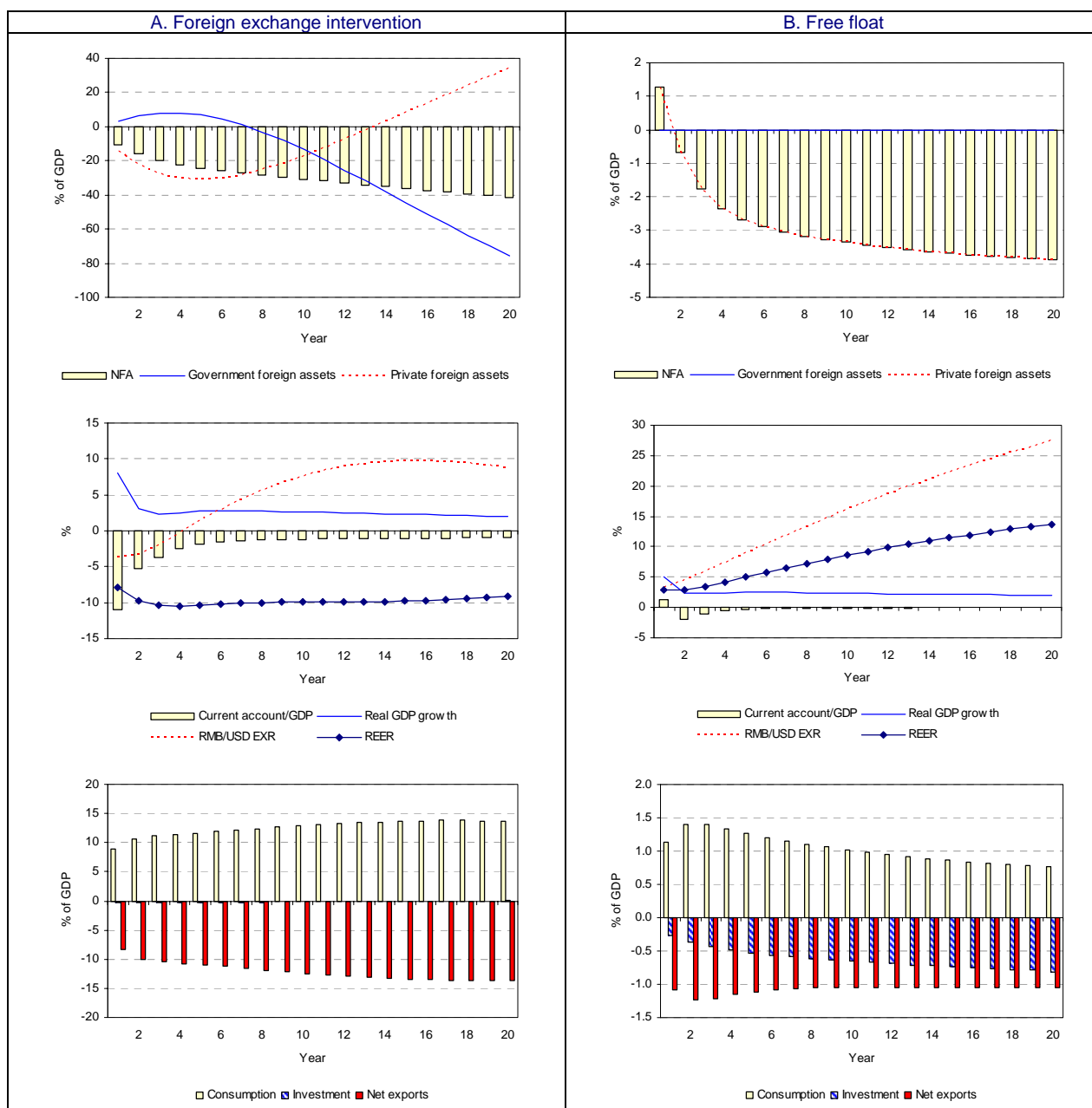
The first scenario shows the impact of growing total factor productivity (TFP) on output growth, demand composition and external balances. Estimates of TFP growth in China and productivity catch-up towards Western economies vary substantially. Li (2009) estimates annual TFP growth of 4.3% during the period 84-06, accounting for half of the annualised labour productivity growth during those years. Bosworth and Collins (2008) estimate annualised TFP growth of 3.9% (3.6%) for the period 93-04 (78-04).

Based on a critical review of the official statistics, other authors have given more modest accounts of technology growth in China. The growth accounting by Young (2003) finds annual TFP growth of 1.4% for the period 78-98, including a sizable dispersion across sectors⁶, instead of 3.0% based on official statistics. Hu (2010) revises output and factor input data to obtain annual TFP growth of only 1.5% in the period 88-08; together with EU KLEMS estimates for Europe this would imply that TFP relative to the EU-15 has increased by only 20% since the early 1990s, instead of the doubling that an annual TFP growth of 3.9% would imply.

The characterisation of the effects of technological progress that is displayed in Figure 6.1 builds on the Bosworth and Collins (2008) estimate of 3.9% annual TFP growth, which is at the higher end of available estimates. As the model incorporates annual trend TFP growth of 1.5% for all regions, China's TFP growth is decomposed into 1.5% world trend TFP growth and 2.4% TFP catch-up growth. In addition, the scenario assumes catch-up growth to be tilted towards the tradable sector; $\frac{3}{4}$ of the 2.4% is attributed to tradable and $\frac{1}{4}$ to non-tradable goods. TFP catch-up at the same annual rate is supposed to continue for another decade to avoid an imposed hypothetical slowdown of catch-up after 20 years to affect the dynamics during the 20 year horizon displayed in Figure 6.1.

⁶ Research by Dollar and Wei (2007) and Hsieh and Klenow (2009) finds large misallocation of production factors across firms and industries in China. Hsieh and Klenow (2009) estimate that factor reallocation within industries alone could enhance China's TFP by 30-50%.

Figure 6.1: Macroeconomic effects of TFP growth



TFP growth in the model increases the productivity of domestic firms and the supply of domestically produced goods. Since domestic and foreign tradable goods are imperfect substitutes, higher supply of the former should reduce their price in export markets. In panel B this happens through a steep fall of the external value of the RMB that translates into real effective (REER) depreciation. Exchange rate stabilisation in panel A prevents the RMB value from falling at comparable speed. Instead, domestic consumption rises sharply as a consequence of higher real wages, amplified by the positive impact of non-depreciation on household wealth. The sharp rise in domestic demand increases domestic and export prices. The currency even appreciates in real effective terms. The implications for demand and external balances in managed versus floating exchange rate settings contradict key stylised facts from section 3:

(1) Technological progress makes a big contribution to GDP growth. Private consumption grows at an even faster rate than output in the setting with (loose) exchange rate pegging in panel A, whereas gross and

net exports fall in conjunction with rising export prices and higher import demand. Employment and the capital stock increase very modestly. The implied rise in the consumption-to-GDP ratio, the fall of the trade balance and the stable investment-to-GDP ratio contradicts China's experience during the past 20 years (see Figure 3.4).

(2) The trend RMB depreciation in panel B implies that foreign exchange intervention of the monetary authority to stabilise the RMB-USD exchange rate at target value requires a *sale* of USD assets to avoid RMB depreciation, i.e. the opposite of the observed *purchase* of USD assets to prevent RMB appreciation. On the other hand, the real effective exchange rate (REER) appreciates in panel A, whereas Figure 3.8 shows an depreciation since the mid-1990s.

(3) The current account temporarily falls in line with the negative trade balance. The deterioration of the current account balance contradicts the steep rise of China's external surplus in recent years.

(4) The negative trade balance and the foreign exchange intervention deteriorate the economy's net foreign asset (NFA) position. Stabilising the exchange rate in the context of trend RMB depreciation generates a long-run decline in central bank foreign reserves (GFA), while the private sector accumulates foreign assets (PFA) in the long term. The NFA, GFA and PFA dynamics all contradict the evolution of China's external creditor position since the early 1990s.

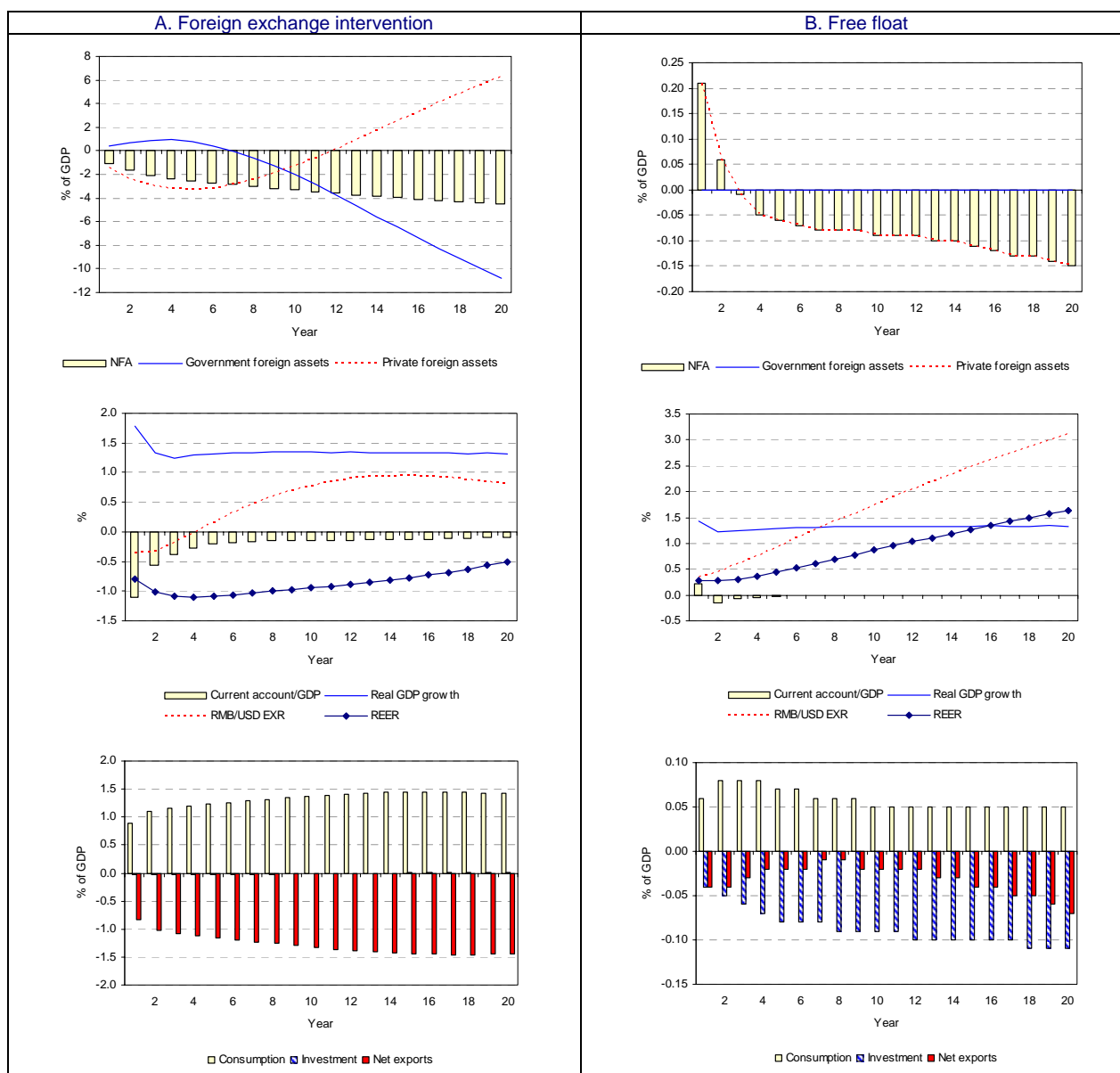
Most results are robust to the use of alternative values for the elasticity of cross-border investment to interest rate differentials. However, the lower value of $\sigma=0.1$ for the elasticity of cross-border capital flows to expected returns leads to immediate RMB depreciation pressure also in the setting with foreign exchange intervention, so that the monetary authority sells foreign currency reserves already during the first year. The private sector limits the deterioration of its net foreign asset position to 9% of GDP in the third year and returns to positive territory after five years already.

Model simulations that are based on lower TFP growth, as suggested e.g. by Young (2003) and Hu (2010), dampen the resulting output growth. Since lower TFP growth also reduces productivity catch-up, the impact on the exchange rate, external balances and the composition of final demand would weaken. However, the qualitative implications of TFP growth for external positions and the demand composition remain counterfactual when confronted with the empirical evidence for China.

6.2 LABOUR FORCE GROWTH

China's National Bureau of Statistics records an average annual labour force growth of 1.2% since 1991, which coincides with the annual average employment growth of 1.2% reported in Bosworth and Collins (2008) for 93-04. Figure 6.2 illustrates the effect of annual 1.2% labour force growth; the growth rate of labour force participation is extrapolated over a third decade to avoid a hypothetical end point after 20 years to affect the short-term and medium-term macroeconomic dynamics in Figure 6.2.

Figure 6.2: Macroeconomic effects of labour force growth



Labour force growth increases employment, output and hence the supply of domestically produced goods. As for the TFP shock in section 6.1, increased supply of domestically produced tradable goods exerts downward pressure on their price. Under freely floating exchange rates (panel B), this would imply a fall in the RMB value that translates into real effective (REER) depreciation. Exchange rate stabilisation in panel A prevents exchange rate adjustment of comparable speed and size and even causes appreciation in real effective terms. Domestic consumption and investment increase more than under the float, together with larger capital inflows and deterioration in the trade balance. The implications for the demand composition and external balances contradict again key stylised facts from section 3:

(1) The growth of the labour force contributes substantially to output growth. Private consumption increases at an even faster rate in both exchange rate policy settings, whereas the trade balance falls as consequence of lower export and higher import demand (panel A) or falling terms of trade (panel B). The investment-to-GDP ratio remains constant (panel A) or slightly declines (panel B). None of these trends matches China's experience during the past two decades (see Figure 3.4).

(2) The trend RMB depreciation in panel B implies that foreign exchange intervention of the monetary authority to stabilise the RMB-USD exchange rate at its target value require a *sale* of USD assets to avoid RMB depreciation, i.e. the opposite of the massive *purchase* of USD assets in recent years. On the other hand, the real effective exchange rate (REER) appreciates in panel A, whereas Figure 3.8 shows an appreciation since the mid-1990s.

(3) The current account temporarily and moderately falls in line with negative net exports, which contradicts the steep rise of China's external surplus in recent years.

(4) The negative trade balance and foreign reserve intervention to defend the RMB exchange rate against depreciation deteriorate the economy's NFA position. Stabilising the exchange rate in the context of trend RMB depreciation generates a long-run decline in central bank foreign reserves (GFA), while the private sector starts holding foreign assets as the supply of domestic bonds declines. The pattern does not match China's external creditor position since the early 1990s.

The results for alternative elasticity values σ are qualitatively robust and quantitatively similar to the results in Figure 6.2. Regarding foreign positions, the lower value $\sigma=0.1$ leads to immediate RMB depreciation pressure also in the model with foreign exchange intervention, so that the monetary authority sells foreign reserves and both PFA and GFA positions deteriorate from the start. A higher value of $\sigma=10$, on the other hand, prolongs the period of positive GFA and negative PFA holdings, while the aggregate NFA position remains almost the same as in panel A.

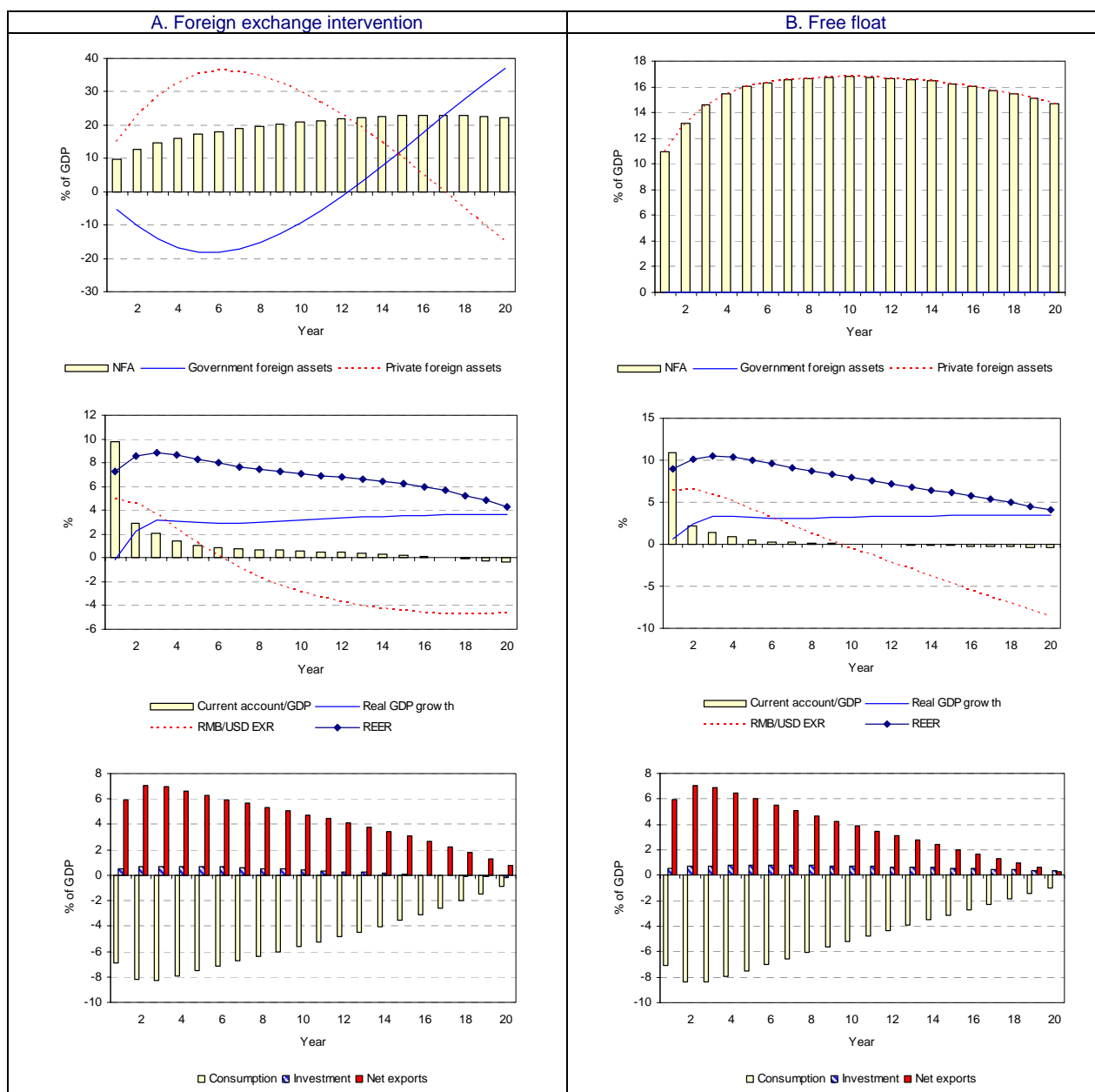
6.3 GROWTH OF NON-AGRICULTURE EMPLOYMENT

The sectoral employment shift from stagnant agriculture and the subsistence economy towards manufacturing and service sectors in the urban centres is another important element of China's economic transition and productivity catch-up and probably more important than aggregate labour force growth as such.

Large changes have occurred in the sector structure of employment during the past two decades. Employment in non-agriculture (agriculture) has risen (fallen) at an average annual rate of 4.5% (1.2%) between 1991 and 2007. The share of non-agriculture employment has risen from 40% (1991) to 58% (2007) of the total active population; the share of agriculture employment has fallen correspondingly. In line with this structural shift, the non-agricultural sector has contributed more than 90% of China's output growth during the past two decades.

Based on this statistics, Figure 6.3 shows the simulation results for annual 1.1 percentage-point increase in the share of non-agriculture in total employment. The labour force reallocation is assumed to occur over a period of 30 years; the pace of reallocation of 1.1 percentage point per year is extrapolated for a third decade after 2010 to avoid a hypothetical end point in 2010 to affect outcomes over the 20-year horizon displayed in Figure 6.3.

Figure 6.3: Macroeconomic effects of labour force reallocation



The reallocation of labour out of low productivity and subsistence activities in rural areas towards industry and service sectors raises labour supply in the most productive part of the official economy. The real wage and production costs fall and tradable and non-tradable output increases. Monetary easing leads to a transitory RMB depreciation that later turns into nominal appreciation. Nevertheless, given the fall in domestic prices, the RMB depreciation lasts in real effective terms and facilitates the absorption of the growing supply of domestically produced tradable goods. This adjustment is similar for both exchange rate policy settings.

The shift of labour from low productivity and subsistence activities in rural areas to higher productivity employment in non-agriculture also eases the liquidity constraints on private households and improves their access to capital markets. Households that newly enter non-agriculture activities in urban areas have zero initial wealth. Therefore, they save substantial parts of their newly acquired income. The savings lead

to an accumulation of foreign assets. The domestic and external adjustment in this scenario matches part of the evidence in section 3:

(1) The change in the sector structure of employment makes a sizable contribution to high GDP growth. The easing of liquidity constraints for households that newly enter the official non-agriculture sector with zero initial wealth also triggers a build-up of private sector wealth. The accumulation of wealth temporarily increases household savings and reduces the average consumption demand of optimising households in the official sector. The negative short-run impact on GDP is offset by the increasing number of households that leave subsistence and low-productivity agriculture production for non-agriculture employment. The real effective RMB depreciation (temporarily) increases export demand, while the consumption-to-GDP ratio falls steeply before reverting gradually back to the baseline value. The return to baseline of relative consumption demand and the nearly constant investment share contradict the gradual decline in the consumption-to-GDP and increase in the investment-to-GDP ratio in Figure 3.4.

(2) Foreign exchange intervention to stabilise the exchange rate around the target level requires the monetary authority to *sell* USD and buy RMB assets during the initial period of RMB depreciation, before the long-term appreciation trend reverses the direction for a lasting accumulation of net foreign reserves. More weight on nominal exchange rate stability as policy target would reinforce the volume of interventions and produce larger shifts in the government's foreign asset position. The real effective RMB depreciation direction-wise coincides with the real depreciation in Figure 3.8. In Figure 3.8, the extent of REER depreciation depends on the reference year (e.g., 45% in 94-09, 4% in 90-09).

(3) The reallocation of labour towards the official non-agriculture sector together with the related easing of liquidity constraints (higher savings) and real RMB depreciation lead to a large temporary improvement in the current account. The size of the initial surplus comes close to China's current account position in recent years. Contrary to the immediately large surplus in Figure 6.3, however, China's position has built up more gradually over a number of years.

(4) The labour reallocation generates positive net foreign asset positions. The gradual build-up of a NFA position of 20% of GDP matches the evolution of China's position in Figure 3.6. The repartition between private and government foreign asset holdings displays some difference, however. The increase in private savings together with the initial tendency for the RMB to depreciate generate a positive net foreign asset position of the private sector in early years, whereas the central bank sells foreign assets to limit RMB depreciation in panel A. The private and government foreign asset positions switch sign only during the second decade of transition, when the monetary authority intervenes to prevent nominal RMB appreciation against the USD in the context of rising domestic interest rates. The initial foreign asset distribution between government and household sectors does not match the Chinese data that show negative net positions of the private sector over the entire past two decades.

In qualitative terms, the results are robust to the use of alternative values for the interest elasticity of cross-border capital flows. Reducing the elasticity to $\sigma=0.1$ would amplify RMB appreciation in the medium and long term, however. The central bank would return to above-baseline foreign asset holdings already after 6 instead of 12 years; private foreign asset holdings reach a maximum of 22% of GDP in year 4, but fall below baseline after 20 years only.⁷

⁷ The impact of labour force reallocation on the consumption share and net foreign asset accumulation results primarily from the weakening of liquidity constraints in the context of the move to official non-agriculture employment. A pure easing of liquidity constraints across the population, e.g. related to financial market development, would constitute an alternative scenario with macroeconomic implications that are similar to Figure 6.3. Based on the estimates of Zhang and Wan (2004) for the period 63-98, the baseline calibration sets the share of liquidity-constrained households to 40%. The evidence remains inconclusive on whether or not recent reforms have reduced the liquidity constraints on officially recorded income and consumption, however. Testing for structural breaks in consumption behaviour, Zhang and Wan (2004) find the elasticity of total consumption with respect to current income to increase

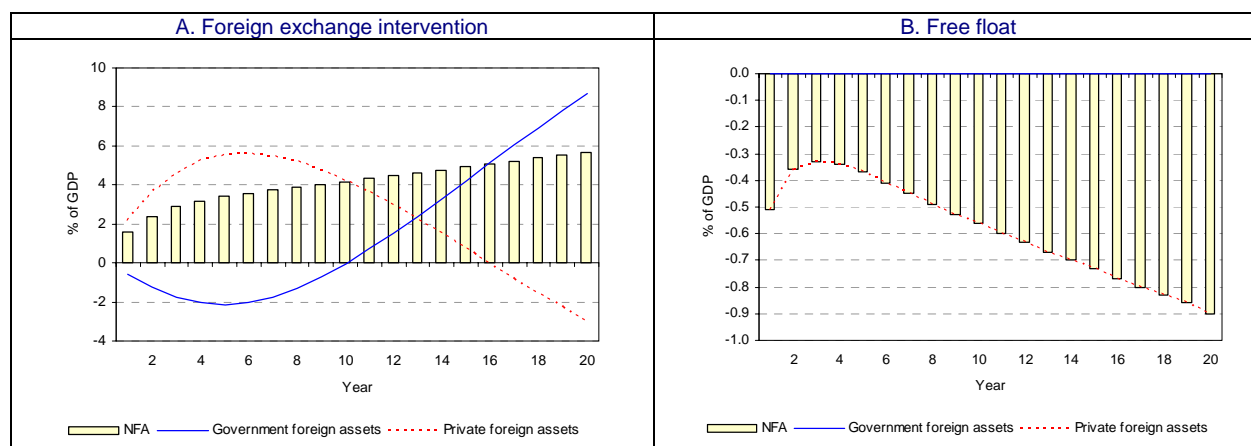
6.4 INVESTMENT INCENTIVES

The previous three scenarios have looked at technological progress, labour force growth and labour reallocation as drivers of output and productivity growth. This section turns to the role of capital formation. Empirical evidence suggests that China's economic development has been strongly driven by and biased towards investment in physical capital. The availability of cheap credit from state-owned banks and of cheap complementary factors, e.g. land and energy, supports investment and capital deepening. The Chinese government has also offered sizable income tax breaks to foreign investors and joint ventures in order to attract investment and related know-how. Low lending rates, soft-budget constraints for state-owned enterprises, tax breaks and complementary investment incentives together can be considered as subsidy to investment and capital (Prasad, 2009 and 2009a), which for investors has a similar effects as a reduction in investment risk.

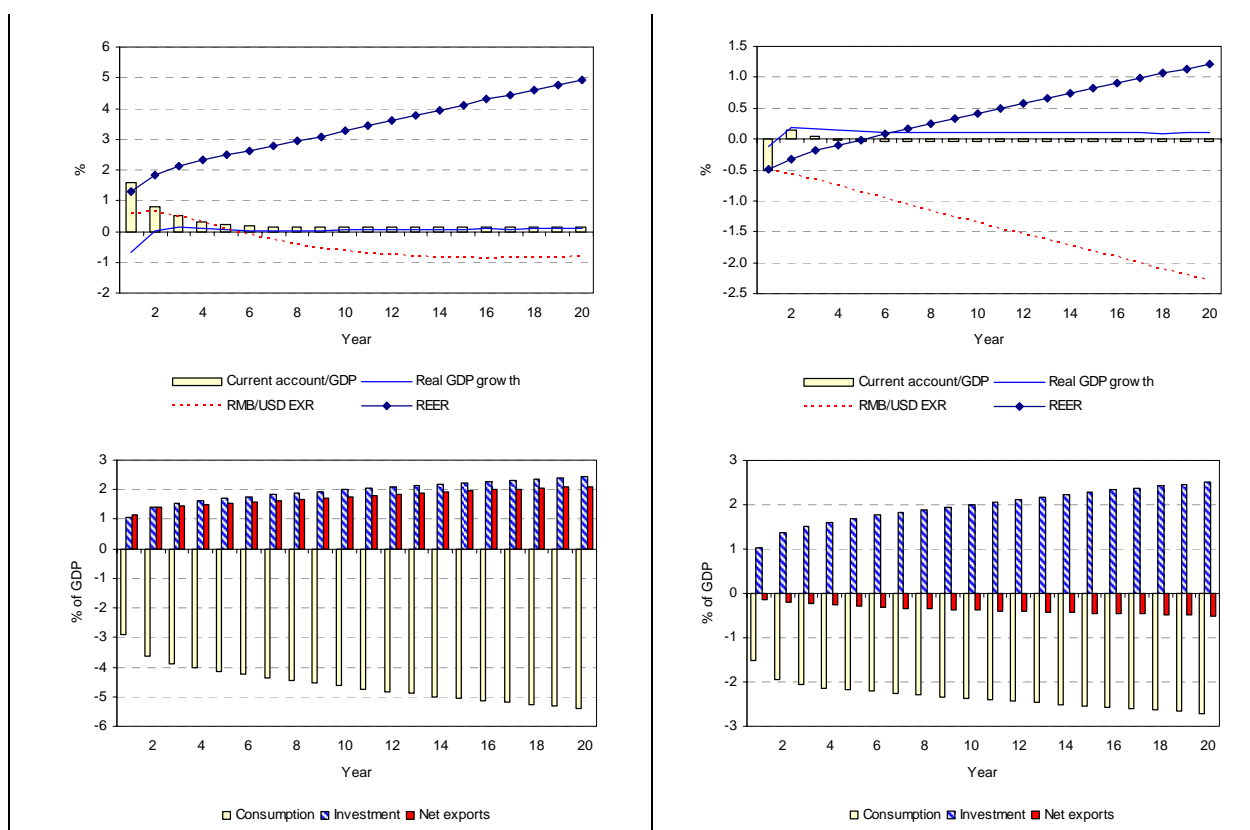
Figure 6.4 illustrates the impact of declining investment risk in the tradable sector to proxy for improved investment conditions. Arguably, the tradable sector has profited the most from the various measures. The graphs show results for a 300 basis-point decline in the investment risk in the tradable sector, which corresponds to a three percentage-point rise in risk-adjusted returns. Contrary to the previous scenarios and due to the lack of comparable data that would suggest stepwise implementation of investment incentives over several years or decades, the risk reduction is not phased in gradually, but fully effective on impact.

Although the size of 300 basis points does not reflect estimated values of the total improvement of investment conditions, the order of magnitude is not implausibly large. Investment incentives have included income tax breaks of 15-30 percentage points for FDI and joint ventures. Under the assumption that FDI earns average returns, a tax break of 15 percentage points for an FDI share of circa 10% of total capital, as estimated by Li (2009), raises the risk-adjusted return to capital in the tradable sector, which accounts for about half of total production, by circa 3 percent.

Figure 6.4: Macroeconomic effects of higher risk-adjusted capital returns



from 0.3 (61-83) to 0.6 (84-98), which suggests a tightening of constraints; but contrary to the parameter estimate of 0.3, the estimated 0.6 is not statistically significant at conventional significance levels. The qualitative implications of lower liquidity constraints on the current account, net foreign assets and exchange rate dynamics correspond to those in Figure 6.3 and result from the initial accumulation of wealth by households with newly attained access to financial markets but zero initial wealth. Differences occur with respect to GDP growth and the dynamics of consumption and net export shares in GDP. Output growth remains close to zero in the absence of growing non-agriculture labour supply; the consumption and net export shares in GDP increase as in Figure 6.3, but the remain stable at the new levels over 20 years instead of decaying as in Figure 6.3.



Higher risk-adjusted returns to capital cause a strong rise in investment and the capital stock; private consumption falls below baseline as households start to save and invest more. Capital inflows lead to nominal appreciation against the USD if the currency is allowed to float, despite a reduction in policy rates, while at the same time a fall in production costs and the terms of trade leads to moderate real effective depreciation.

The adjustment under a managed RMB exchange rate in panel A of Figure 6.4 matches characteristic elements of China's recent economic development:

(1) Higher investment incentives increase investment and the investment share in GDP gradually.⁸ Optimising households save and invest more at the expense of lower current consumption, which gradually lowers the consumption-to-GDP ratio. The share of net exports in GDP also increases due to real effective depreciation and in line with the data. The investment incentives have only a very moderate effect on output growth, however, as employment declines in parallel to the increase in investment.

(2) Foreign exchange interventions stabilise the exchange rate around its target level. The intervention requires the monetary authority to *sell* foreign currency and buy domestic currency assets during an initial period of RMB depreciation. The pattern of intervention reverses after five years as the RMB starts to appreciate and the central bank buys USD assets to contain long-run RMB appreciation. The policy implies the continuous accumulation of foreign currency reserves. The magnitude of the reserve accumulation remains fairly limited for the given shock and compared to the empirical evidence in Figure 3.6, however.

(3) The shock generates a persistent but small current account surplus in panel A. The surplus is biggest in the first year and then gradually decays, contrary to the gradual increase in China's external balance shown

⁸ The gradual profile results from quadratic capital adjustment costs in the model that provide an incentive to smooth capital deepening over time.

in Figure 3.5. In a system of managed exchange rates, domestic savings grow more than investment, leading to capital export and a positive trade balance.

(4) The net foreign asset position deteriorates in a floating regime due to the net inflow of investment. Foreign exchange intervention modifies the pattern. Initially, the government reduces its foreign asset position while the private sector exports surplus savings. The direction reverses as the RMB starts appreciating against the USD after five years. The central bank now buys and private households sell foreign currency assets. In the long run, the monetary authority reaches a positive and the household sector a negative foreign asset position.

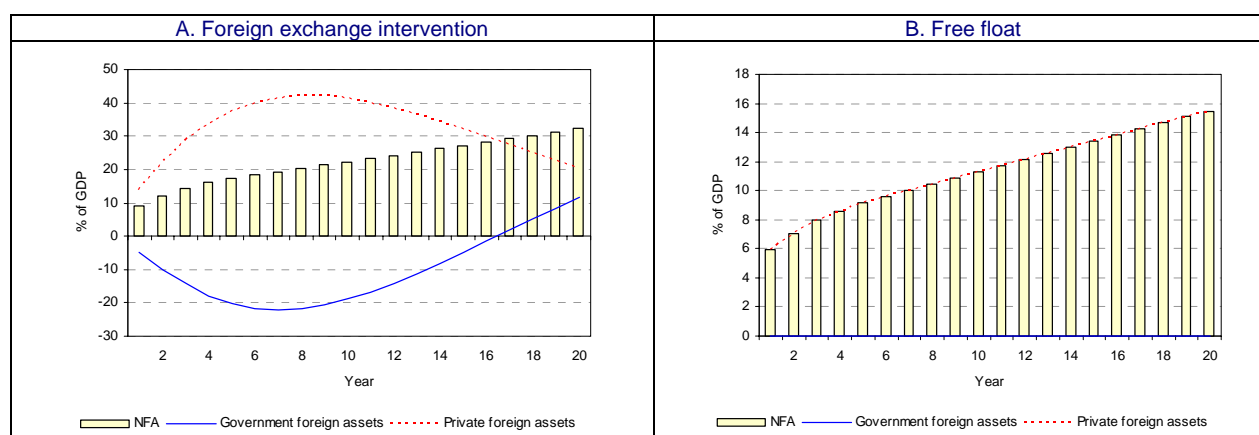
The evolution of demand shares and the aggregate external position fit the empirical evidence at least in qualitative terms; a stronger decline in investment risk would amplify the investment, consumption, current account and foreign asset responses. Reducing the interest elasticity of cross-border capital flows, e.g. to $\sigma=0.1$, would generate *immediate* and larger foreign reserve accumulation by the monetary authority to neutralise the appreciation pressure from capital inflows.

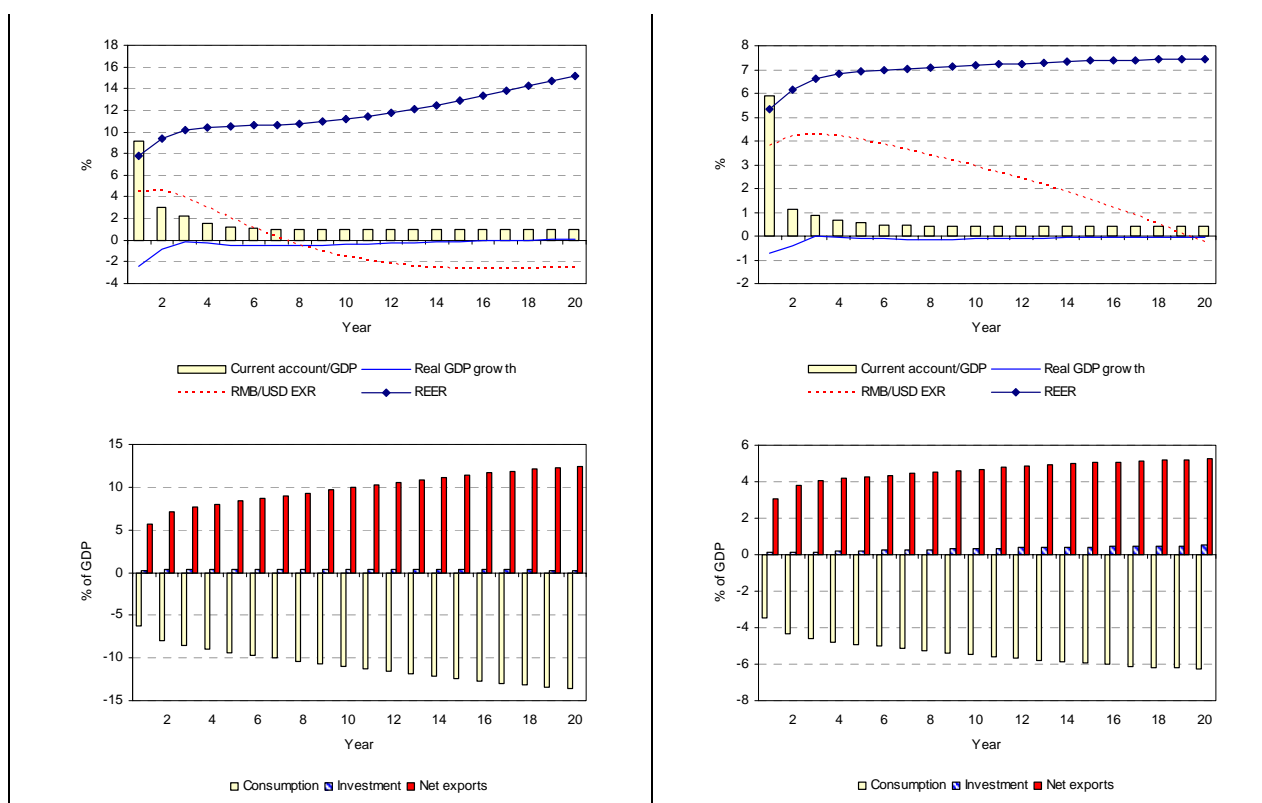
6.5 HIGHER SAVINGS RATES

Rising private savings figure prominently in the literature as (most) important determinant of China's international creditor position. Chamon and Prasad (2010), Feng et al. (2009), Prasad (2009a) and many others link the high private savings rate to precautionary motives in the context of fragmentary social security and pension systems. Although this argument may explain the high level of private savings, it provides no straightforward explanation for why savings rates have *increased* in recent years. Wei and Zhang (2009) establish a correlation between savings rates and regional gender gaps and link the rise in household savings to growing male-female imbalances in China's regions.

The model can incorporate higher household savings rates as a *preference* shift that reduces the rate of time preference, i.e. increases the discount factor, which lowers long-term equilibrium interest rates. The shock to the time preference rate is calibrated so as to generate a rise in the savings rate that comes close to the evidence in Chamon and Prasad (2010). The shock phases in during three decades and raises the savings-to-GDP ratio by about three percentage points per decade; after three decades, the discount factor remains permanently at the lower level. The persistence of the shock appears compatible with econometric evidence in Horioka and Wan (2007) that suggests that the savings rate of Chinese households will stay high over the nearer future. The macroeconomic implications of higher savings in managed versus floating exchange rate regimes are shown in Figure 6.5.

Figure 6.5: Macroeconomic effects of higher savings rates





The rise in household savings implies a massive fall in private consumption; investment and output also decline, whereas the trade balance improves and private households accumulate foreign assets. Higher savings increase the supply of RMB and the demand for USD assets, which leads to RMB depreciation. The RMB exchange rate overshoots as prices adjust slowly; the RMB/USD exchange rate returns to baseline and tends to appreciate in the long run, while the RMB remains depreciated in real effective terms. Real effective depreciation is stronger in panel A because of a more pronounced decline in domestic prices and the containment of long-run RMB appreciation.

The dynamics in Figure 6.5 suggest that the savings shock may contribute to the explanation of China's savings behaviour. As it misses some key characteristics, it does not provide a sufficient explanation, however, but is at best one element of the transition:

- (1) Figure 6.5 replicates the gradual decline in the consumption-to-GDP ratio. At the same time, it displays a strong rise in the output share of net exports, stronger than in Figure 3.4, while failing to generate a sizeable increase of investment. The shock also leads to a counterfactual contraction of real output.
- (2) The exchange rate management in panel A limits deviations of the RMB exchange rate from the target level. However, the intervention requires a *sale* of foreign assets during the first seven years to avoid RMB depreciation as opposed to the sustained accumulation of foreign assets in Figure 3.6; the direction of intervention reverses after seven years.
- (3) Increased savings generate a large initial current account surplus; the surplus quickly reduces to small numbers, however, instead of the gradual increase in the data in Figure 3.5.
- (4) The current account surpluses lead to lasting net foreign asset accumulation. NFA growth is stronger in the case of exchange rate management, in which the central bank intervenes to avoid RMB appreciation after 7 years and which displays larger sustained current account surpluses. The repartition of NFA hold-

ings between the private and public sector in the early years does not match the recent evidence in Figure 3.6, however.

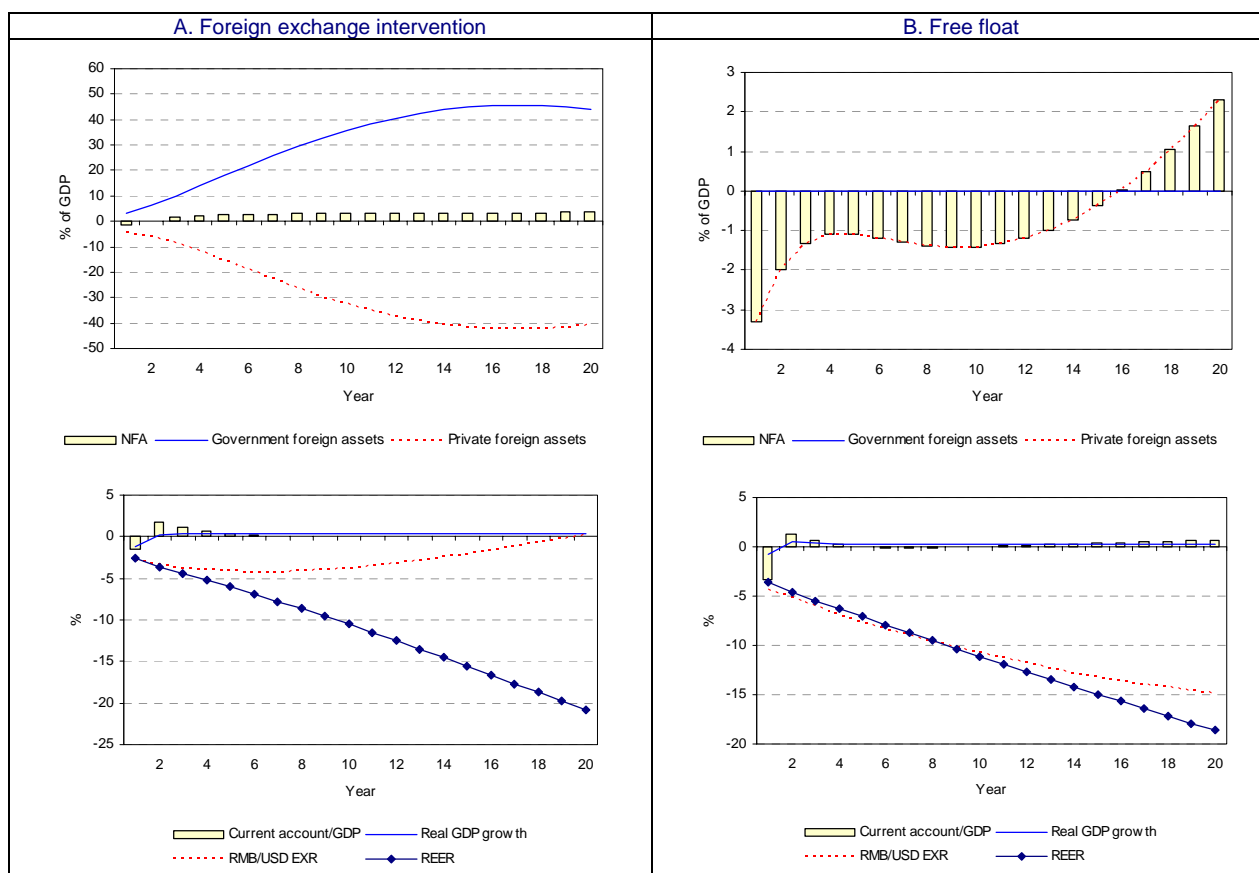
The qualitative patterns are largely robust to the use of alternative values for the elasticity of cross-border capital flows to interest rate differentials, i.e. the degree of factual or legal barriers to the movement of capital. However, with a lower value of $\sigma=0.1$ the RMB appreciates from the start, so that the monetary authority buys foreign assets to prevent appreciation already in early years, which comes closer to the observed evolution.

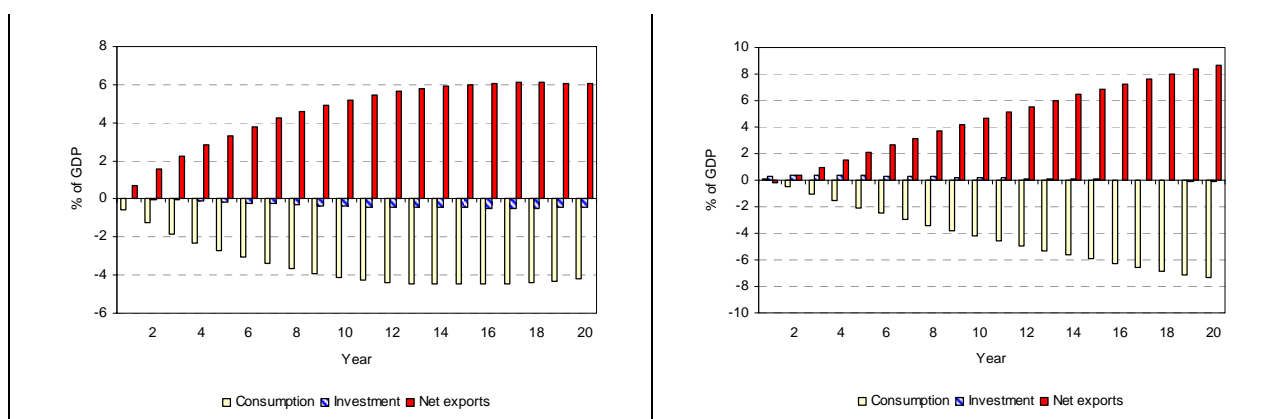
6.6 TRADE INTEGRATION

The Chinese economy has become increasingly integrated in world markets (Figure 3.1; Yu, 2007). Access to international markets has improved especially in the context and aftermath of the country's WTO accession in 2001. Whether integration has raised the price elasticity of China's exports and imports is discarded here. The share of China's exports in world markets has certainly risen.

Data from the AMECO database show an increase of China's share in world exports of 5 percentage points during the past two decades, with one percentage point in 1990s and 4 percentage points in the 2000s. Figure 6.6 illustrates the impact of world-market share growth of 7.5 percentage points in 30 years, which can be interpreted as a preference shift of foreign demand towards Chinese exports. The scenario assumes the export share to rise by 0.25 percentage points per year.

Figure 6.6: Macroeconomic effects of a growing world market share





Strengthening trade integration raises the demand for Chinese exports. The RMB appreciates, so that imports also increase, while the trade balance remains positive. The RMB appreciation against the USD goes pair with massive real effective appreciation. Central bank intervention to maintain the RMB-USD exchange rate at initial levels requires massive foreign reserve accumulation, but does not prevent real effective appreciation; in the latter case real appreciation occurs through domestic inflation.

Figure 6.6 suggest that trade integration in the form of a growing world market shares is only one element of China's economic transition and insufficient to explain the set of stylised facts:

- (1) Increasing the equilibrium market share in world exports gradually improves the trade balance and reduces the output share of domestic consumption in line with the empirical evidence, but does not replicate the observed raise in the investment share. The impact on GDP growth is marginal in either policy regime.
- (2) The preference shift towards exports from China implies nominal appreciation under the RMB float. Exchange rate stabilisation consequently requires the monetary authority to buy foreign currency assets and increases the RMB asset supply.
- (3) Despite the persistent trade surplus, increasing world export shares do not have a permanent effect on the current account. The RMB appreciation reduces the RMB value of returns to net foreign assets, which compensates for higher export revenues. The size of the current account surplus is very moderate and much below the factual magnitude in recent years (Figure 3.5). Hence, the preference shift towards Chinese exports does not create lasting current account surpluses.
- (4) Exchange rate management to prevent a nominal RMB appreciation requires the accumulation of large foreign exchange reserves at the central bank. The size of reserve accumulation reaches similar values to those observed and displayed in Figure 3.6. The total NFA position of the economy is positive and persistent, but moderate in size compared to China's NFA holdings in the second half of the 2000s.

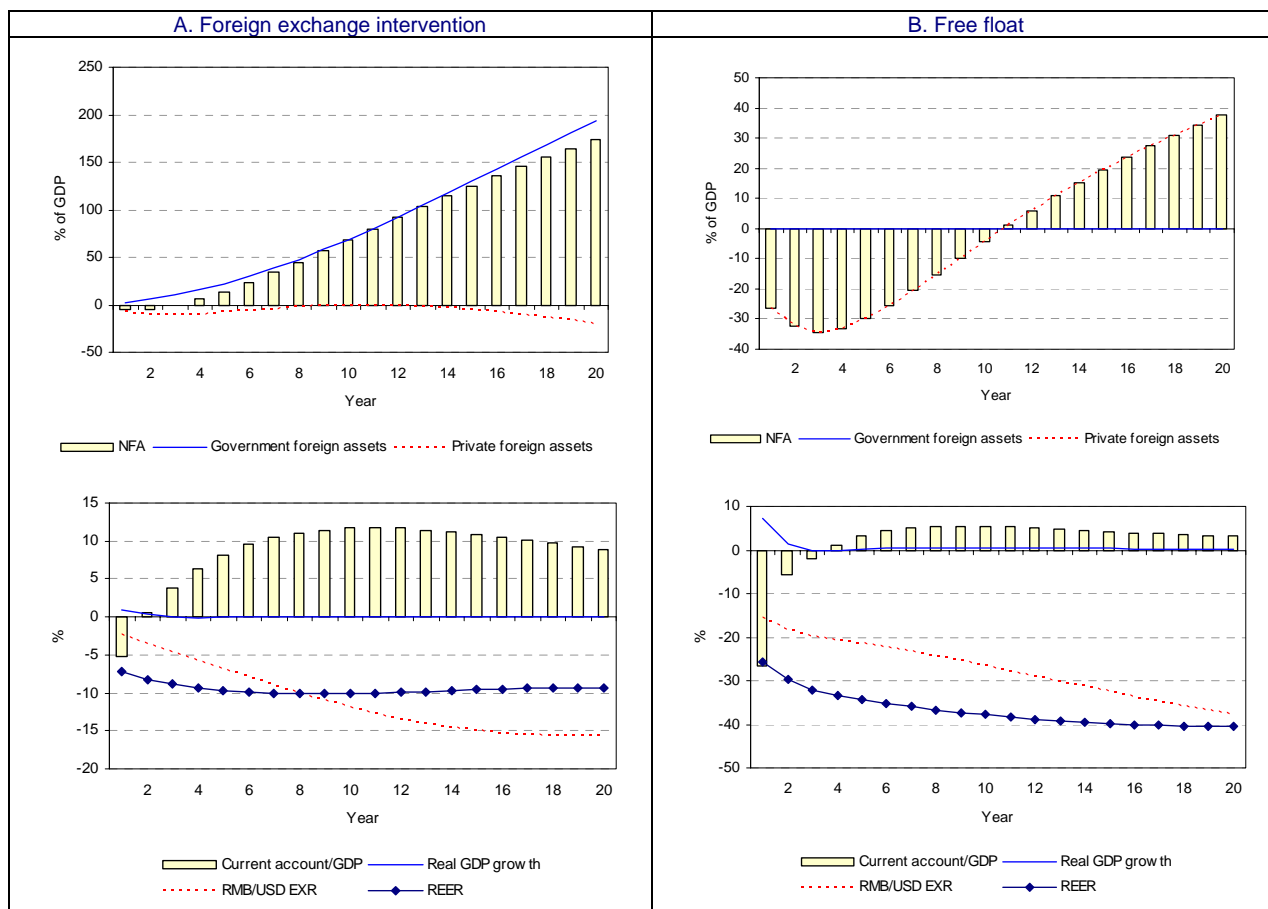
Contrary to the previous scenarios, changing the value of the elasticity of cross-border capital flows to interest rate differentials has strong qualitative and quantitative impact on the results. Lowering the value from $\sigma=1.0$ to $\sigma=0.1$ has counterfactual implications: The consumption-to-GDP ratio increases, whereas the trade balance declines. The RMB tends to depreciate in the medium term. The current account and net foreign assets remain at their baseline levels; the monetary authority sells foreign assets to prevent RMB depreciation, whereas the private sector accumulates a sizable positive foreign asset position.⁹

⁹ Globalisation-related scenarios also include the decline of portfolio home bias as potential determinant of exchange rate and foreign asset dynamics. In the model, financial globalisation can translate into declining equilibrium shares of domestic assets in domestic portfolios and a growing sensitivity of cross-border capital flows to expected return

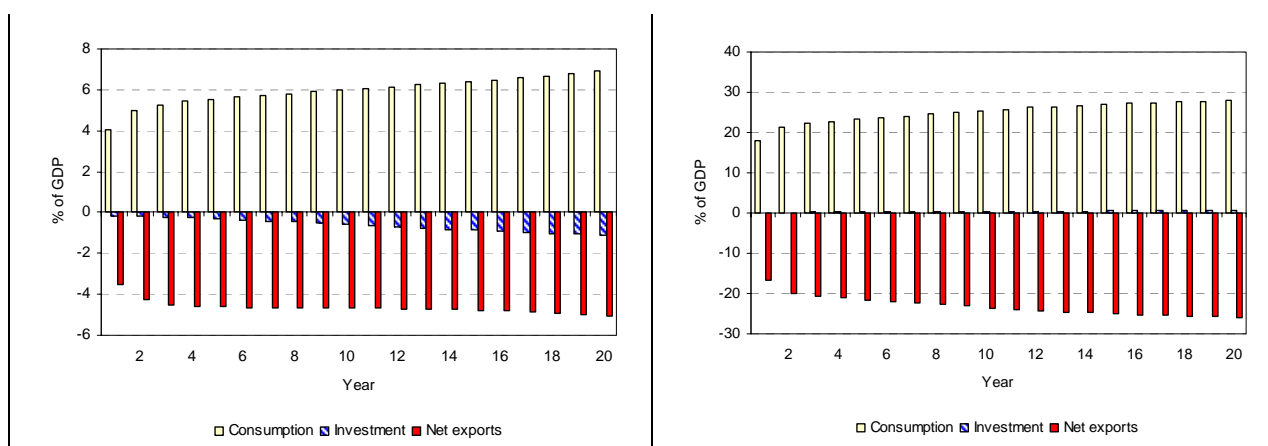
6.7 US SAVINGS GAP

Low savings and associated capital imports in the United States have been considered the major "pull" factor behind global imbalances and specifically behind China's growing net creditor position. This subsection looks at the impact of the US savings gap on the Chinese economy in the model in comparison with main stylised facts. The Figure 6.7 shows a scenario in which a demand expansion in the US economy deteriorates its current account by 1.5% of GDP. The US demand expansion builds up over 10 years, lasts for another decade before it then decays gradually.

Figure 6.7: Macroeconomic effects of US external deficits



differentials. The Lane and Milesi-Ferretti (2007) data in Figure 3.7 suggest that gross foreign asset holdings of Chinese households have indeed increased from 12% (1990) to 22% of GDP (2007). Simulations for a lower equilibrium share of RMB assets in Chinese household wealth point to consumption and investment shares in GDP, which are at least qualitatively similar to the data, and large movements in nominal exchange rate and foreign reserve positions. However, the implications of declining home bias for the RMB exchange rate, monetary policy and foreign balances depends entirely on the symmetry or asymmetry of the preference shift, i.e. whether or not the shift of Chinese households away from RMB holdings is offset by a preference shift of foreign households towards RMB holdings. If foreign investors increase desired RMB asset positions at the same pace as Chinese investors shift away from RMB assets, higher demand and supply of foreign assets would match exactly. In this case, the preference shift alone would not have any impact on exchange rates, demand and output. Lacking information on the symmetry or asymmetry of preference shifts precludes an informative scenario for portfolio home bias reduction.



The savings shortage increases the supply of dollar-denominated debt. The RMB appreciates in nominal terms against the USD and also in real effective terms. As exports fall and imports increase, the trade balance deteriorates despite the improving terms of trade. Domestic consumption increases in response to the positive wealth effect from improving terms of trade. The domestic expansion is less pronounced in the case of exchange rate management (panel A) that limits nominal and real appreciation and the positive wealth effect. The weaker expansion of domestic demand comes with less deterioration of the trade balance, a large and persistent current account surplus and a massive accumulation of foreign reserves.

The adjustment in a managed exchange rate regime (panel A) in Figure 6.7 alone is difficult to reconcile with China's stylised facts in quantitative terms, despite some similarities in qualitative terms:

- (1) Contrary to the empirical evidence, the simulation does not generate sustained output growth and implies a counterfactual behaviour of the consumption, investment and net export share in GDP.
- (2) The exchange rate management in the left column limits the RMB appreciation relative to the US dollar. Full stabilisation would require more aggressive intervention. The intervention shown in panel A already implies a massive purchase of dollar-denominated assets, however.
- (3) The capital export implies a large and persistent current account surplus. The surplus is larger with foreign exchange intervention, because of the more moderate appreciation. Limiting RMB appreciation relative to the USD makes capital imports cheaper for the US and limits the wealth-related expansion of domestic demand in China compared to the float with strong RMB appreciation.
- (4) Capital exports imply a surplus in the current account and the accumulation of net foreign assets. However, the size of NFA and foreign reserve positions in panel A of 175% of GDP after 20 years is far beyond the Chinese economy's NFA position in Figure 3.7 and most likely beyond any reasonable bound.

The results are qualitatively robust to alternative values of the elasticity of cross-border investment to interest rate differentials. However, higher elasticity values imply a still larger accumulation of net foreign assets in the medium and long term in both the managed and the floating exchange rate regime.

6.8 COMBINING TRANSITION AND GLOBALISATION SHOCKS

Each of the above factors matches some characteristics of China's economic transition, but none matches the set of the stylised facts: high GDP growth; falling consumption and rising shares in GDP; positive current account; net foreign asset accumulation with growing foreign currency reserves and private sector net foreign debt. Table 6.1 summarises the fit of the individual shocks; basic supply shock such as TFP growth, labour force growth and labour reallocation can generate high GDP growth, while the international envi-

ronment, i.e. world market integration and the US savings gap, replicate main features of the external position; labour reallocation is the individual scenario that does best in combining the internal and external aspects of transition.

Table 6.1: Comparing scenarios and stylised facts

Scenario:	GDP growth	Demand composition		Current account +	Net foreign assets		
		Consumption/ GDP↓	Investment/ GDP↑		Total +	Public +	Private -
TFP growth	xx					(x)	(x)
Labour force growth	xx					(x)	(x)
Labour reallocation	xx	x	x	x	xx	(x)	(x)
Investment incentives		xx	xx	x	xx	(x)	(x)
Savings growth		xx	xx	x	xx		
Trade integration		xx		x	x	xx	x
US external deficit				xx	x	x	xx

Note: xx - impact has same sign and profile and similar size as in the data; x - impact has same sign as in data; (x) - impact has same sign as in the data for sub-periods.

The technology and labour supply shocks are able to explain the biggest part of Chinese output growth during the period 90-06 (Table 6.2). Growth accounting as a simple back-of-the-envelope disaggregation of per capita income growth illustrates the contribution of the individual components:

- Labour force growth (1.1% per year);
- TFP world trend growth (1.5% per year);
- TFP catch-up growth (2.4% per year);
- Labour reallocation (annual 1.1 percentage-point growth of non-agriculture share).

The impact of labour reallocation in Table 6.2 is calculated as the change of average labour productivity that results from the reallocation out of agriculture into non-agriculture activities for given agriculture and non-agriculture productivity. The output per worker has reached 1.300 RMB (2.876 RMB) per year in agriculture and 5.220 RMB (18.097 RMB) in non-agriculture activities in 1990 (2006, in 1990 RMB). TFP growth is the residual share of labour productivity growth that is unexplained by input growth and sectoral change.

Table 6.2: Growth accounting

Output growth and contributions	Output	Employment	Output per worker	TFP	Labour reallocation	Capital deepening
90-06	10.3	1.1	9.2	3.9	1.3	4.0 ¹
93-04 (Bosworth and Collins, 2008)	9.7	1.2	8.5	3.9	-	4.5 ²

¹ Based on capital stock estimates for 90-03 by Holz (2006), which indicate annual growth rates of the capital stock of around 10%, and a capital share in production of 0.40 as in Bosworth and Collins (2008).

² This estimate includes physical (4.2) and human capital (0.3).

Table 6.1 illustrates that none of the individual shocks replicates the entire set of stylised facts about internal transition and external balances. As a final step this suggests combining the shocks in simulations to investigate their joint effect. Figure 6.8 displays the joint impact of the domestic shocks from the subsections 6.1-6.5 in a managed exchange rate environment as before. Panel A includes the TFP, labour supply, labour reallocation and investment incentive shocks; panel B adds the decreasing preference for pre-

sent relative to future consumption. The combination generates high GDP growth, falling consumption-to-GDP and rising investment-to-GDP shares. It does not replicate large and persistent current account surpluses and positive net foreign asset positions, however; RMB depreciation pressure leads to counterfactual sales of foreign reserves and positive net foreign asset holdings of the private sector.

Figure 6.8: Macroeconomic effects of combined domestic shocks

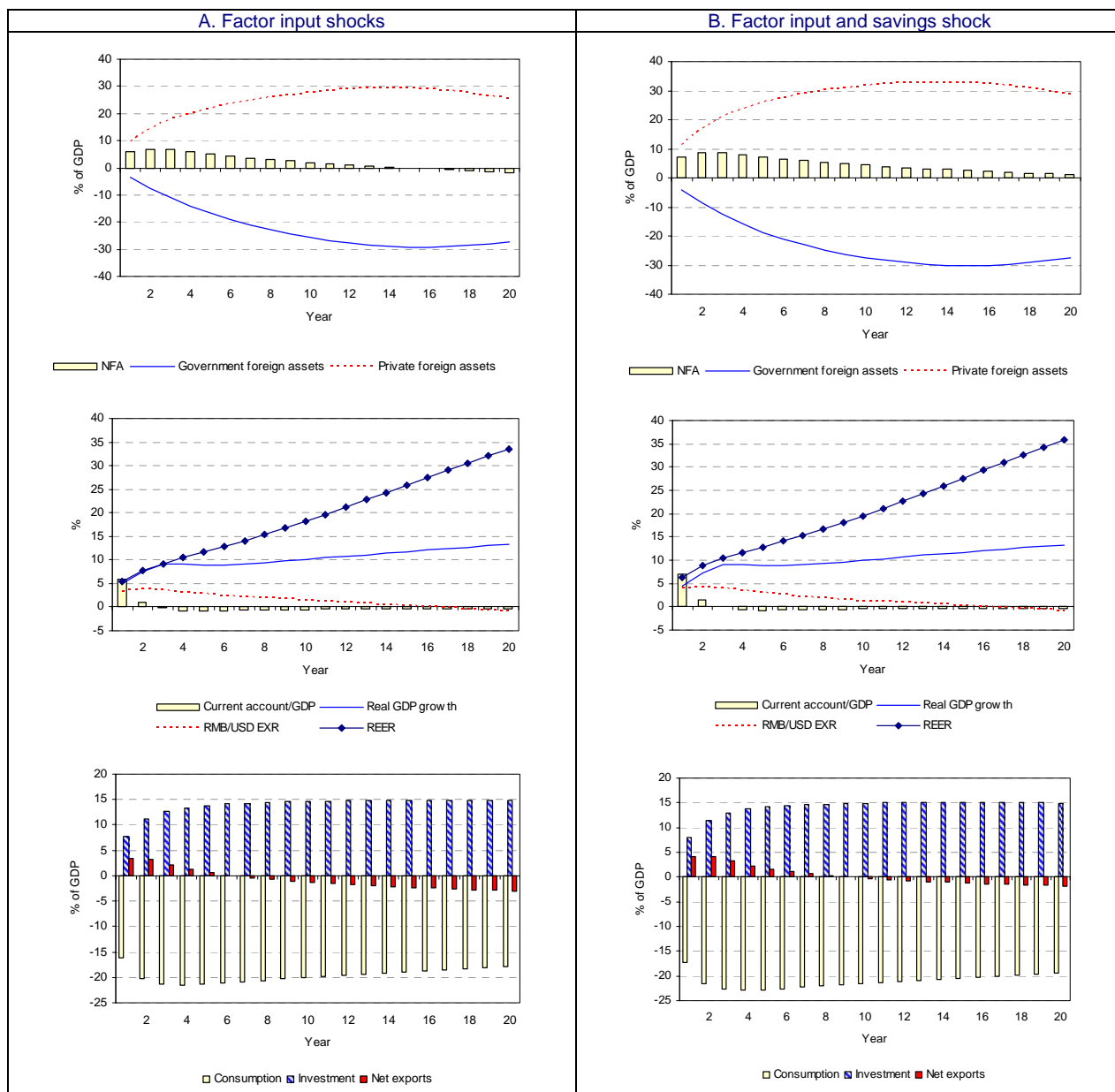
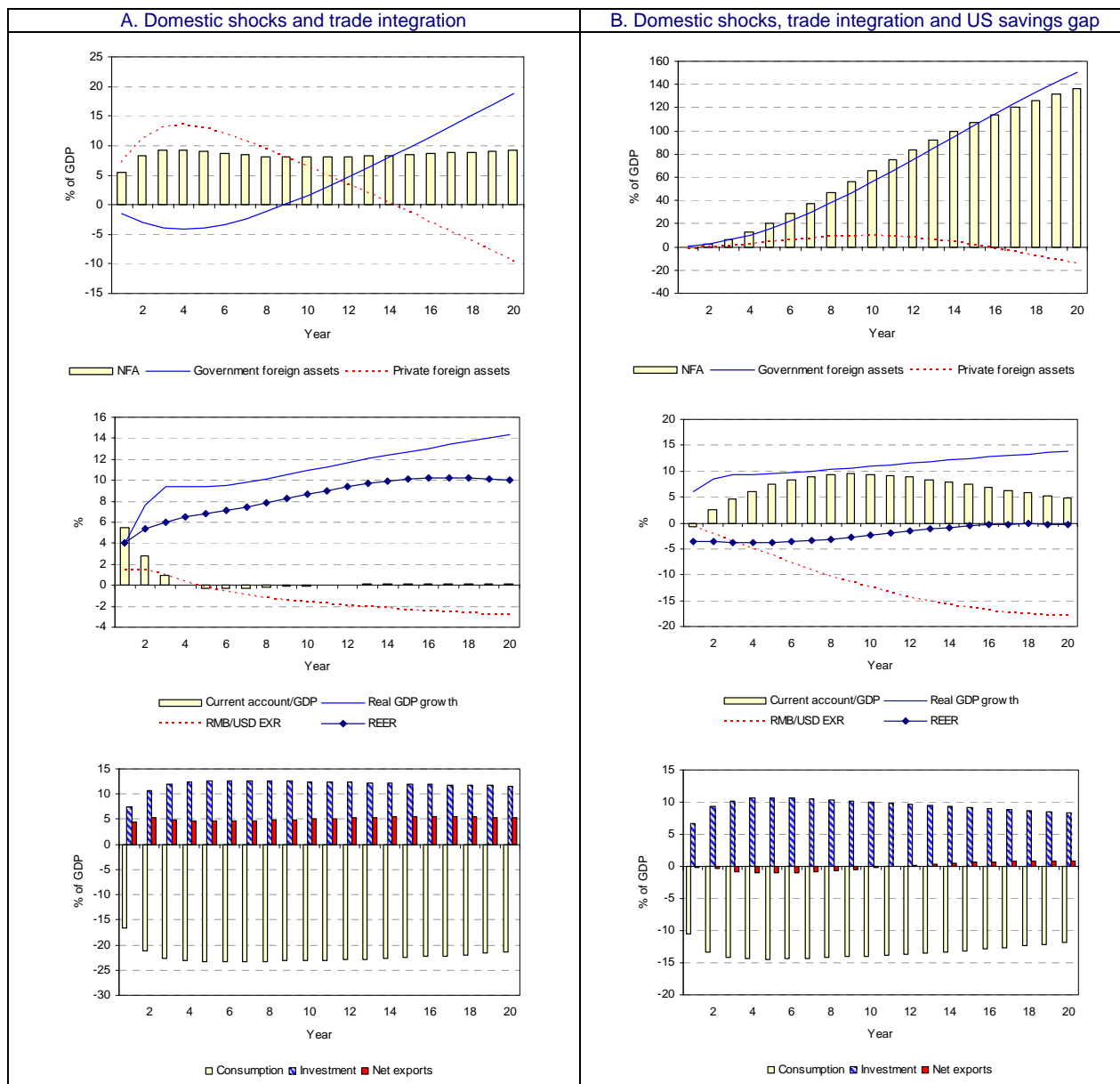


Figure 6.9 augments the domestic shocks by trade integration and the US savings gap. The scenarios still generate high GDP growth as well as falling consumption and rising investment shares in GDP. Inclusion of the US savings gap in panel B is necessary to obtain substantial appreciation pressure on the RMB and a high and persistent surplus in the current account. Currency reserves are the dominant form of net foreign assets. For the given calibration of the US savings gap, the amount of central bank reserves and total net foreign assets exceeds the actual positions in Figure 3.6, and the moderate degree of foreign exchange intervention does not prevent RMB appreciation against the USD at an annual average rate of close to 1%

during two decades. Taken at face value, the results in Figure 6.9 suggest that China's international creditor position is more the result of foreign savings demand than of a domestic "savings glut".

Figure 6.9: Macroeconomic effects of combined domestic and foreign shocks



The impact of foreign savings demand on China's external surplus is larger than the observed NFA and foreign reserve accumulation. Possible explanations for the quantitative deviations include the approximate calibration of shocks and parameters, omitted shocks and structural specificities of the Chinese economy that dampen the reaction to savings demand, developments in other regions of the world, e.g. excess savings in other world regions, that reduce foreign demand for Chinese savings. Reducing the elasticity of cross-border capital flows with respect to expected return differential does not decisively affect the size of China's NFA position, however. Using an elasticity value of $\sigma=0.1$ instead of the $\sigma=1.0$ used in Figure 6.9 reduces the total NFA accumulation relative to GDP by 11 percentage points and foreign exchange reserves to GDP by 9 percentage points after 20 years.

7. CONCLUSIONS

The paper uses a multi-region DSGE model of the world economy (China, US, euro area, rest of the world) to look at China's situation as emerging economy and the world's largest international creditor. The model includes a portfolio approach to distinguish gross versus net and private versus public sector foreign asset positions; it also allows varying the elasticity of cross-border capital flows to expected returns to proxy for factual or legal restrictions on cross-border investment. This model setup includes two elements of Chinese macroeconomic policy: (1) Restrictions to cross-border capital flows and (2) exchange rate stabilisation via foreign exchange intervention.

The paper considers a series of shocks that characterise the transition and globalisation of the Chinese economy over the past two decades (TFP, labour force, labour reallocation, investment incentives, household savings, trade integration, US savings gap) and investigates their individual and combined impact on output, demand composition and external balances, i.e. their ability to match key stylised facts: (1) High GDP growth; (2) declining consumption and increasing investment shares in GDP; (3) large current account surpluses; (4) the build-up of large aggregate NFA holdings, combining an even larger foreign reserve position of the central bank and net foreign debt of the private sector.

The simulation results suggest the following main conclusions:

- None of the domestic and "globalisation" shocks is sufficient to individually replicate the domestic and external characteristics of China's macroeconomic transition: the domestic supply shocks (TFP, factor inputs) match high output growth and the change in demand composition, while the "globalisation" shocks are needed to replicate a persistent external surplus;
- The combination of domestic and "globalisation" shocks matches the stylised facts at least quantitatively;
- The importance in the simulations of the US savings gap to match the external dimension suggests a major role of foreign savings demand as opposed to a "savings glut" for China's external surplus and NFA accumulation.

The simulations also show that most shocks (TFP, labour force, labour reallocation, household savings, US savings gap) generate long-run implications for NFA positions that are qualitatively similar for foreign exchange intervention and a hypothetical RMB float. The result suggests that exchange rate policy may play a limited role for long-run foreign positions, except for the decomposition into private and government sector positions, to the extent that real effective exchange rate can adjust via relative prices.

The paper tests the robustness of the results for alternative values of the elasticity of international capital flows to expected return differentials. The robustness checks confirm a common general adjustment pattern for alternative values of the elasticity of cross-border capital flows to expected returns. However, high elasticity values imply volumes of foreign reserve accumulation that exceed current estimated reserve holdings in China, which also illustrates the limits to successful foreign exchange intervention.

The model leaves ample space for improvements, refinements and further analysis. The latter could, e.g., include the analysis of regime shifts in monetary and exchange rate policy to illustrate implications of a potential change in the policy framework. Additional work on the empirical validation of the model structure, the parameter calibration and the calibration of shocks would certainly improve the analytical value of the results.

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