

16

China's real exchange rate

Jane Golley and Rod Tyers

There is increasing international pressure for the Chinese authorities to allow the currency to float more freely. It has been argued that the appreciation of the renminbi since 2005 is just the beginning of a necessary upward trend, given the belief that the currency is currently undervalued, by margins ranging from 'small' to as high as 50 per cent (Frankel 2004; Wang 2004; Goldstein 2004; Coudert and Couharde 2005). Expectations that China's underlying real exchange rate will appreciate in the future are based commonly on the Balassa (1964)-Samuelson (1964) hypothesis. This implies a positive relationship between economic growth and the real exchange rate, driven by productivity catch-up in developing economies' tradable sectors and, in association, rising prices in their non-traded sectors. Yet, while the Balassa-Samuelson characterisation of the growth process is a useful abstraction, it is suspect on several fronts, not least of which is its omission of productivity gains in the non-tradable sector, which tend to be depreciating.¹ Moreover, at its core it relies on the law of one price for tradable goods. Departures from this assumption are now widely recognised, under which circumstance there are numerous other drivers of China's economic growth that affect the real exchange rate (Tyers et al. 2006). These include labour force expansion, skill acquisition, changes in the saving rate and trade and financial reforms, many of which are also depreciating. Thus, the net effect of China's rapid economic growth on its real exchange rate depends on the sources of that growth and the consequent pattern of endowment changes and sectoral distributions of productivity growth and tradability.

This chapter explores the interactions between sources of growth and the real exchange rate and considers the Balassa-Samuelson hypothesis in the context of recent and future sources of Chinese economic growth, offering a variety of reasons why China's behaviour need not be consistent with the hypothesis. China's macroeconomic policy regime and its continuing reforms to the financial sector, both of which have profound implications for the trend of its real exchange rate, are discussed. The issues arising in these sections are assessed using a simulation model of the global economy in which a full demographic sub-model is incorporated. The inclusion of demography captures the impending decline in China's overall labour force and the rise in its skill intensity. Baseline and comparator simulations are constructed to examine the sensitivity of real exchange rate paths to changes in the labour supply (achieved via changes to fertility policy that encourage larger families), alternative labour productivity and skill upgrading scenarios, and financial sector reform.

Balassa-Samuelson: theory and reality

If the nominal exchange rate, E , is defined as the number of units of foreign exchange obtained for a unit of the domestic currency, the real exchange rate, e^R , can be defined correspondingly as the rate of exchange between the home product bundle and corresponding bundles produced abroad. It follows that the bilateral real exchange rate for a focus (home) country with foreign trading partner i can be approximated as the common currency ratio of the gross domestic product (GDP) prices (deflators) of the two countries, $P^Y(p^N, p^T)$ and $P_i^Y(p_i^N, p_i^T)/E_i$, where p^T and p^N are indices over all the focus country's non-traded and traded goods and services, respectively.²

$$e_i^R = \frac{P^Y(p^N, p^T)}{P_i^Y(p_i^N, p_i^T)/E_i} = E_i \frac{P^Y(p^N, p^T)}{P_i^Y(p_i^N, p_i^T)} \quad (1)$$

This is the fundamental relationship between the real and nominal exchange rates. Consider the case in which prices at home and abroad are measured in a common currency, the share of non-traded products in GDP, θ , is the same at home and abroad, prices are aggregated appropriately using a Cobb-Douglas index and the law of one price applies to all traded goods. The latter implies that trade is costless and undistorted, so that $p^T = p_i^T$. Under these conditions, the real exchange rate becomes

$$e_R = \frac{(p^N)^\theta (p^T)^{1-\theta}}{(p_i^N)^\theta (p_i^T)^{1-\theta}} = \left(\frac{p^N}{p_i^N} \right)^\theta \quad (2)$$

From this, the key role of non-traded goods prices is clear. When prices are measured in a common currency, or relative to a common numeraire, it is the ratio of the home and foreign non-traded goods prices that matters in determining the real exchange rate.

Consider a Ricardian exchange in which output per worker is $A^T = ab$, $A^N = ac$, $A_i^T = ab_i$ and $A_i^N = ac_i$. Here, a is common to both sectors and regions, b is a component of productivity that is biased towards the traded sector and c is a component biased towards the non-traded sector. The parameters b and c are different between countries. The relationships between the wage rate and product prices in the traded and non-traded sectors respectively are

$$P^T = P_i^T = \frac{W_i}{A_i^T} = \frac{W}{A^T}, \text{ so that } \frac{W}{W_i} = \frac{A^T}{A_i^T} \quad (3)$$

and

$$P^N = \frac{W}{A^N}, \quad P_i^N = \frac{W_i}{A_i^N} \quad (4)$$

We then have that

$$\frac{P^N}{P_i^N} = \frac{A^T / A^N}{A_i^T / A_i^N} = \frac{b}{b_i} / \frac{c}{c_i} \text{ and } e_i^R = \left(\frac{b}{b_i} / \frac{c}{c_i} \right)^\theta \quad (5)$$

By the Balassa-Samuelson hypothesis, if the focus country has higher tradable productivity growth, $b > b_i$, and assuming that $c = c_i$, its real exchange rate must be appreciating. The hypothesis then implies that, if developing economies are poorer because their tradable labour productivity is lower, then comparatively rapid growth should cause real appreciations.

The key assumptions of the hypothesis are, however, suspect.

Tradable productivity gap

During some periods and in some developing economies, productivity growth has been observed to be higher in the non-tradable sector,³ leading to $c > c_i$ and tending to depreciate the real exchange rate. Modern transport, financial, health and education services offer considerable potential for productivity catch-up. Whatever the relative performance of China's services sector in the past, recent evidence suggests substantial potential for catch-up and accelerated productivity growth in the future (see Ma 2006).

The law of one price for tradable goods

Failures of the law of one price have been observed for tradable goods in specific instances.⁴ Goods and services are not homogeneous across countries but are differentiated at minimum by country of origin.⁵ Supply and/or demand side factors that raise the volume of tradable production move the home country down the global demand curves for its product varieties, reducing its supply prices and resulting in deterioration in the terms of trade and a depreciation of its real exchange rate. Factor endowment growth and changes in policy that lead to substitution in demand for home products depreciate real exchange rates and the magnitudes of their effects depend crucially on the degree of substitutability between the differentiated products.

Labour arbitrage In most developing economies, the marginal product of industrial labour exceeds that of rural labour due to the more rapid accumulation of industrial capital. There is, therefore, a Harris-Todaro gulf between the wages in the expanding and contracting sectors. If labour mobility between the rural and industrial sectors is inferior to that between the rural and service sectors (particularly the construction sector), then industrial productivity growth does not necessarily drive up service wages or service costs.⁶

Closed capital account

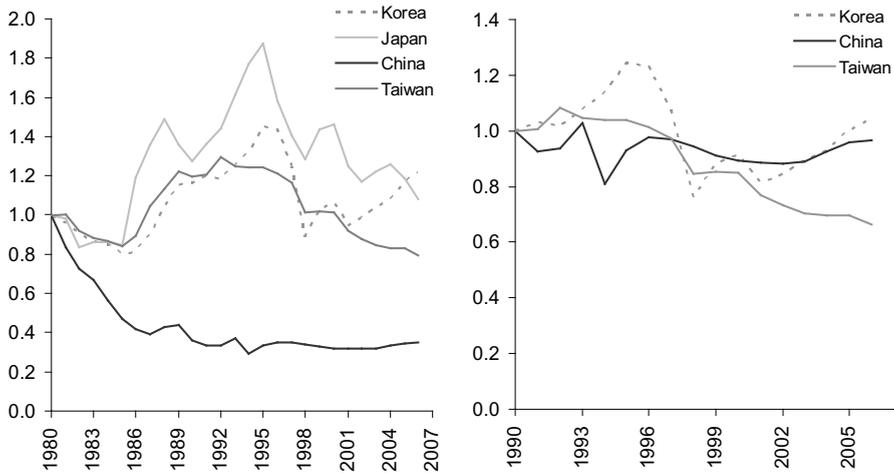
The assumption that the real exchange rate depends only on interactions among countries associated with trade in merchandise is clearly violated in many of today's developing economies, and particularly in China. Its violation, in concert with failures of the law of one price for traded goods, means that any influx of payments (in the form of a foreign direct investment or portfolio capital flow) raises aggregate demand. Since traded goods are supplied more elastically via imports than are non-traded goods—which depend on home resources—such an influx must raise relative non-traded prices and therefore appreciate the real exchange rate. Conversely, effluxes will cause depreciation.

Not surprisingly then, empirical evidence in support of the Balassa-Samuelson hypothesis is mixed. Choudhri and Khan (2004), for example, find favourable evidence using a small sample of developing economies that does not include mainland China, Taiwan or Hong Kong. Bergin et al. (2006) find a positive association between price levels and real per capita income that is strong only in large samples of countries. Miyajima (2005) uses a sample of 15 Organisation for Economic Co-operation and Development (OECD) countries between 1970 and 2000 to establish that the hypothesis does not always hold during growth surges, which on numerous occasions were led by productivity

growth in non-traded sectors. The East Asian evidence since 1980 also appears mixed. Figure 16.1 plots bilateral real exchange rates against the United States for mainland China and some of its neighbours, demonstrating that there is no clear pattern.

To examine the productivity-gap component of the hypothesis for China, we estimate simple Solow residuals for the economy as a whole and for three sectors: ‘Food’, ‘Industry’ and ‘Services’, adjusting the officially published urban employment data for underestimation, as discussed in Cai and Wang (2006).⁷ The average annual changes in the Solow residuals for each sector are given in Table 16.1. These show strong productivity performance by the Chinese economy since the mid 1980s, with a slow-down in the 1998–2001 period associated with the East Asian financial crisis. Consistent with the analyses of Lu (2006) and Fogel (2006), productivity growth appears to have been strongest in the industrial sector and weakest in the service sector.⁸ Yet,

Figure 16.1 Asian real exchange rates against the United States, 1980–2006^a



^a These are indices of nominal bilateral rates deflated according to $e_R = E \cdot P_Y / P_Y^{US}$, where E is the nominal exchange rate in US dollars per unit of local currency; P_Y is the local GDP price; and P_Y^{US} is the corresponding US GDP price. The left graph sets 1980=1.00 while, to show the trends in the later years, that on the right sets 1990=1.00.

Sources: For Korea, Japan and mainland China the data are from International Monetary Fund (IMF) 2007a. *International Financial Statistics*, the International Monetary Fund, Washington, DC. For Taiwan they are from the websites of the Central Bank of China (Taiwan) and the Directorate-General of Budget, Accounting and Statistics, Executive Yuan.

particularly in recent years, the differences are not large. This has limited the extent of service price inflation, which, while evident in Figure 16.2 since 1995, is not overwhelming.

Taking a different approach, Rodrik (2006) measures the productivity associated with China's exports and shows it to be significantly higher than what would normally be expected for a country at China's income level. He also shows that this has been an important determinant of China's growth during the period 1992–2003. Relevant to the discussion here, he asks whether the Chinese economy will run out of steam once the convergence in export productivity nears completion, or whether it will be able to 'discover' new products on world markets and enable export-led growth to continue. While such speculation suggests future real appreciations based on productivity growth in the tradable sector, considerable future growth could stem from productivity catch-up in the service sector—a depreciating force. The fact that recent productivity growth in manufacturing has been associated with foreign direct investment (FDI) and that service FDI has begun to grow only recently, suggests that services productivity will be a major contributor in the future. Clearly, the sectoral distribution of productivity gains is critical in determining the real exchange rate.

In turn, productivity differences across sectors will be affected by levels of education and training. Fogel (2006) predicts that investment in human capital has the potential to serve as China's key engine of economic growth for the next two decades, a point that is well recognised by China's leaders (as emphasised in the eleventh Five-Year Plan). He qualifies the impact of enhancing the quality of labour through education on the growth rate of per capita income and shows that increasing secondary and tertiary enrolment ratios has a sizeable impact on the growth of labour productivity and the per capita GDP growth rate.⁹ To the extent that services are skill intensive (as they are according to past data), this will boost performance in the service sector—again, tending to depreciate China's real exchange rate. Of course, to the extent that structural changes lead to rapid upgrading in the skill intensity of tradables in the process of economic growth in China, as it has in other countries, this relationship will operate in reverse.

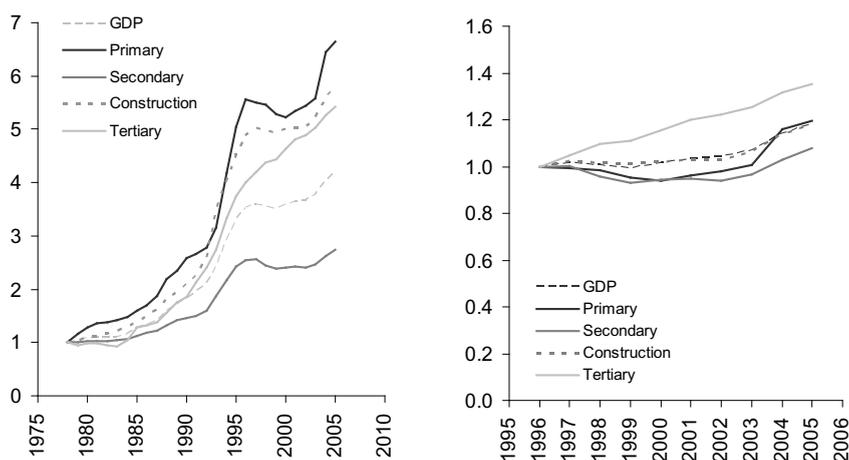
Allowing for failures of the law of one price for tradable goods, there are numerous other forces tending to depreciate the real exchange rate in the long term. During the past two decades one such force has been China's 'demographic dividend', stemming from the high proportion of working-aged people in the total population. This, according to Cai and Wang (2005), accounted for about one-quarter of per capita GDP growth between 1980 and 2003.¹⁰ It has played a critical role in keeping wages and hence the real exchange rate low, thereby enabling the rapid expansion of labour-intensive manufactured exports. In the

Table 16.1 Estimated Chinese total factor productivity growth, by sector, 1986–2005 (per cent per annum)

	Whole economy	Food	Industry	Services
1986–89	3.5	1.4	3.8	3.8
1990–94	5.0	1.6	7.7	2.3
1995–97	5.7	5.5	3.7	3.2
1998–2001	4.1	-0.2	8.9	-0.5
2002–2005	6.0	5.4	6.3	4.6

Source: Tyers, R., Golley, J., Bu, Y. and Bain, I., 2006. *China's economic growth and its real exchange rate*, Working Papers in Economics and Econometrics, No. 476, The Australian National University, Canberra.

Figure 16.2 Chinese sectoral price indices, 1979–2005^a



^a These are sectoral price indices for 'primary industry', which is mainly agriculture; 'secondary industry', which is primarily manufacturing and construction; and 'tertiary industry', which is other services. The left graph sets 1978=1.00 while, to show the trends in the later years, that on the right sets 1996=1.00.

Source: The price indices are implied by volume and value data from National Bureau of Statistics, 2007. *China Statistical Abstract 2006*, China Statistical Press, Beijing.

future, however, the ageing of the population and the consequent decline in the labour supply will have the opposite effect, placing upward pressure on real wages and the real exchange rate.¹¹ Alternative population policies, such as the relaxation of the One Child Policy, clearly stand to affect economic growth via the labour supply, and therefore on the real exchange rate as well.

The Balassa-Samuelson assumption that productivity gains translate into higher wages (Equations 3–5) is underpinned by the assumption of full employment and labour-market arbitrage. While Miyajima (2005) finds that this assumption is satisfied for his OECD sample, it is far from clear that it has also held for China in the past. Cai and Wang (2006) show that, during the period 1995–2002, average annual manufacturing wage growth was 11.6 per cent in China—below their estimate of productivity growth (12.2 per cent), a point that is also supported by Fan (2006). And if, as noted above, rural labour is more mobile into some services than into manufacturing, the wage cost effect on services might have been yet smaller. Thus, labour mobility into the non-rural sectors could have offset the appreciating forces in recent decades.

Yet there is evidence that this is about to change. The emergence of a shortage of rural migrant workers in the past few years signals a transition to a more limited labour surplus (Cai and Wang 2006).¹² In combination with the demographic transition towards a declining proportion of the population of working age, it is likely that wage growth will keep pace with productivity growth in the future. Moreover, continuing World Trade Organization (WTO) commitments could deliver further productivity gains in traded sectors—especially in agriculture—as domestic markets are increasingly expected to compete internationally or perish. If these trade-related productivity gains dominate China's pattern of growth then, in combination with tightening labour markets, Balassa-Samuelson appreciations could start to materialise.

The nominal exchange rate regime and capital controls

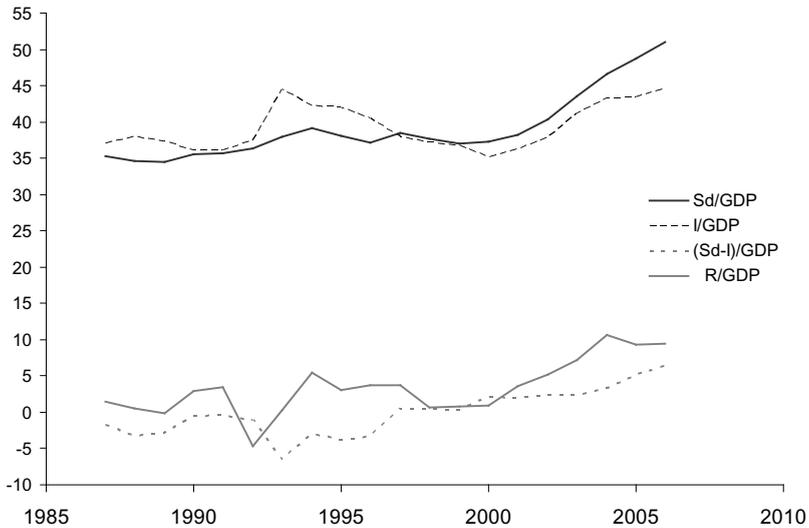
The exchange rate reforms launched by the Chinese authorities in July 2005 were intended to at least demonstrate a departure from the *de facto* fixed US dollar peg, nominally allowing the currency to fluctuate by up to 0.3 per cent a day. These reforms have, however, had a limited impact so far, yielding a cumulative bilateral appreciation of about 6 per cent by May 2007. These are long term not recent forces. Notwithstanding China's high rate of inward FDI, the past decade has seen net outflows on its combined financial and capital accounts (hereafter referred to simply as 'the capital account') and associated current account surpluses. These net outflows represent an excess of domestic savings over investment.

To see this, note that the equality of net flows on the capital account to the investment–saving gap follows from the standard aggregate expenditure and disposal identities.¹³ Defining net inflows as positive, the result can be written as

$$KA = S_{NF} - \Delta R = I - S_D \tag{6}$$

where I is investment, S_{NF} (net foreign saving) is net private inflow on the financial account and ΔR is the annual addition to official foreign reserves. In the presence of capital controls, S_{NF} is roughly equal to inward FDI. Both sides of the equation are negative in the case of China, indicating net outflows. These net outflows have expanded since the mid 1990s, particularly since 2004 (Figure 16.3). Extraordinarily, even though investment accounts for 45 per cent of China’s GDP, more than half of its GDP is saved.

Figure 16.3 **China’s investment–saving and external balances, 1985–2010** (percentage of GDP)^a



^a Since errors and omissions are large, we have adjusted the least accurately measured items in each sub-account (usually net factor income and net private flows on the financial account) to ensure balance.

Sources: International Monetary Fund, 2007a. *International Financial Statistics*, International Monetary Fund, Washington, DC; International Monetary Fund, 2007b. *World Economic Outlook Database*, International Monetary Fund, Washington, DC. Some 2006 figures are from the Economist Intelligence Unit as derived from National Bureau of Statistics (2007).

It would therefore appear that a key to the puzzle as to why China's real exchange rate has not appreciated in the Balassa-Samuelson manner is its very high total saving rate. Some external commentators bemoan the dearth of consumption and advocate its stimulus (Bernanke 2006). Expressing a widely held view outside China, Lardy (2006:85) argues that: 'As the world's second largest surplus country, China must allow its currency to appreciate against the dollar and it must take steps to allow a transition to a growth path driven more by domestic consumption than by further increases in its external surplus.' Since the gross outflows on its capital account take the form of reserve accumulation, China, in combination with other Asian economies that are also raising reserves, has been accused of 'monetary mercantilism' (Aizenman and Lee 2006). It is implied that reserve accumulation is chosen freely in order to keep the real exchange rate low. That this is unfair criticism is evident from the identities. By definition, from Equation 6 we have that

$$\Delta R = S_D - I + S_{NF} \quad (7)$$

This indicates that, as long as total domestic savings exceed investment and capital controls prevent the matching of inward FDI by private outflows, ΔR must be positive. The magnitudes in Equation 7 are also indicated in Figure 16.3. The monetary mercantilist critique of the rate of reserve accumulation would therefore be better directed at the high saving rate and the capital controls.

Prasad et al. (2005) posit that, with persistent external political pressure for real exchange rate appreciation, it would be better to let this happen by allowing the nominal exchange rate to appreciate rather than through domestic inflation, and they describe in detail how greater exchange rate flexibility would pave the way for capital account liberalisation. This raises two issues. First, are there non-mercantilist reasons why China has resisted the pressure to make the renminbi significantly more flexible, even while its financial sector is being reformed? And, second, what would be the effects of the reforms (combined with the removal of capital controls) on the real exchange rate and the renminbi?

Consider whether it is reasonable to expect increased exchange rate flexibility before the uptake of the reforms essential to financial and capital account liberalisation. The reason why the People's Bank of China (PBC) sterilises US dollar inflows net of import costs is because, short of these reforms, there is no private market on which those large volumes of US dollars can be exchanged for renminbi. Hitherto, China's banking system has lacked derivative markets for currency and debt instruments to do the necessary hedging and it is not sufficiently distant from decades of soft budget constraints associated with

the channelling of government subsidies to state-owned enterprises through accumulated debt. This has necessitated the placing of the PBC's US dollar receipts abroad. And, to avoid excess liquidity, these placements have been sterilised. However, holdings of domestic credit have been insufficient to sterilise this flow on the asset side of the balance sheet, so 'sterilisation bonds' have been issued on the debit side (Table 16.2). Just as the reserves have come to dominate the asset side of the balance sheet, sterilisation bonds have assumed significance on the debit side. In effect, the PBC has acted as a conduit for domestic savers who might otherwise acquire foreign assets but are restricted from doing so by capital controls. The current pressure from abroad to revalue therefore places the PBC in a difficult position. Since the PBC's assets are primarily in US dollars and its liabilities are in renminbi, too prompt an appreciation of the renminbi would result in substantial losses that would need to be covered in renminbi from the government budget. This suggests that a larger role for the nominal exchange rate must await the fruits of continuing financial reforms and capital market deepening.¹⁴

Second, when capital controls are eventually relaxed and the renminbi becomes fully convertible, it is not guaranteed that an appreciation will result. While the majority of recent scholarly research finds the renminbi to be undervalued, a number of studies do not.¹⁵ Prasad et al. (2005) point to the potential for depreciation after the gradual liberalisation of the capital account,

Table 16.2 **The balance sheet of the People's Bank of China, ca. 2006**

Assets	Liabilities
Domestic credit, DC	The monetary base, M_B
Central bank claims on depository and other financial corporations and on the central government	Currency and bank reserves
20 per cent of GDP	37 per cent of GDP
Official foreign reserves, R	Sterilisation bonds, SB
41 per cent of GDP	Debt to the Chinese public
	14 per cent of GDP
	Other liabilities, OL
	Includes government ownership
	10 per cent of GDP

Source: People's Bank of China, 2006. *Balance Sheet of Monetary Authority*, People's Bank of China, Beijing.

which could lead to net outflows as domestic investors seek to diversify their portfolios. Moreover, there is already substantial evidence of informal private outflows from China (Prasad and Wei 2005), which would be expected to expand if legalised, placing further downward pressure on the real exchange rate.¹⁶ In addition, the recent surge in speculative inflows in anticipation of appreciation is likely to be temporary and could easily be reversed.¹⁷

The eventual establishment of a complete and stable private market for the renminbi will have two effects. First, a more flexible exchange rate will allow the PBC to follow the practice of central banks abroad and focus on the control of inflation. This means that the forces underlying real exchange rate dynamics will also determine the path of the nominal exchange rate. Second, the accumulation of official foreign reserves can abate, to be replaced by private outflows. Yet, at least in the short term, whether this will cause an appreciation (nominal or real) depends on whether the PBC's reserves are the equivalent of the private sector's desired foreign holdings. If the net effect of the capital controls (with reserve accumulation replacing private outflows) is to have restricted the scale of China's collective foreign holdings, depending on the PBC's response, liberalisation will raise outflows and, at least temporarily, depreciate the real exchange rate. If, on the other hand, the reserves are larger than the foreign holdings that would otherwise be chosen by the private market, liberalisation would result in net inflows and a real appreciation.¹⁸

A further determinant of the direction of any change in external flows is perceived risk. The two key determinants of investment are the anticipated rate of return on installed capital, net of depreciation, on which the investment volume depends positively, and the real cost of funds (the real borrowing rate), on which it depends negatively. Although these might be expected to converge on common values in a steady state, this is rare in practice. In developing economies, there are interest premiums that drive both above the corresponding levels in the industrialised world. Indicative of this premium for the case of China is the spread between its domestic bond yields and those of US Treasury bonds, which has held at about 40 per cent during the past decade. These 'interest premiums' have two components: a risk-free component, due in China's case to the financial market segmentation that will be relaxed with liberalisation, and a risk premium that compensates investors for exchange rate risk, information asymmetries and perceived risks of expropriation. Changes in the stability of the Chinese economy or of its politics will greatly influence this risk component, casting further uncertainty over the short-term path of financial flows.¹⁹

Modelling the determinants of China's real exchange rate

Here we examine quantitatively the relationship between shocks associated with China's economic growth and its real exchange rate. To do this effectively, a numerical model is required that is global in scope and that incorporates the generalisations of the Balassa-Samuelson assumptions discussed above. Recall that these included a means to allow productivity growth in non-tradable as well as tradable sectors, departures from the law of one price for tradable goods, a more sophisticated representation of the labour market and an open capital account. With these generalisations, almost all shocks to the economy have implications for the real exchange rate.

We use a model that offers these generalisations. Adapted from Tyers and Shi (2007a, 2007b), it is a multi-region, multi-product dynamic simulation model of the world economy.²⁰ In the version used, the world is subdivided into 14 regions (Table 16.3). Industries are aggregated into three sectors: food (including processed foods), industry (mining and manufacturing) and services (including construction)—the latter being little traded in comparison with the other two. Failures of the law of one price are represented by product differentiation, so that consumers substitute imperfectly between products from different regions. As in other dynamic models of the global economy, the endogenous component of simulated economic growth is physical capital accumulation. Technical change is introduced in the form of exogenous productivity growth that is sector and factor specific, allowing the analysis of productivity performance that differs between tradable and non-tradable sectors. Consistent with the results indicated in Table 16.1, baseline productivity in the food sector is assumed to grow more rapidly than that in the other sectors in China. This allows continued shedding of labour to those sectors.²¹ In general, baseline productivity growth rates in services are modelled as lower than in the tradable goods sectors in all regions.

All regional capital accounts are open and investors have adaptive expectations about real regional net rates of return on installed capital. In each region, the level of investment is determined by a comparison of expected net rates of return on domestic installed capital with borrowing rates yielded by a global trust, to which each region's saving contributes, adjusted by calibrated region-specific interest premiums. Lagged adjustment processes ensure, however, that financial capital is not fully mobile internationally in the short term, but that the paths of domestic and global interest rates become parallel, separated only by exogenous premiums in the long term. In representing China, however, one caveat is that no explicit control is imposed on the outflow of private financial capital. General financial reform is represented by a diminution

of the interest premium and this causes an unambiguous influx of financial capital to China.

To augment the model's characterisation of changes in labour supply and quality, it encompasses demographic and economic change. It tracks populations in four age groups, two genders and two skill categories: a total of 16 population groups in each of the 14 regions. The skill subdivision is between production labour (unskilled) and professional labour (skilled).²² Each age–gender–skill group is represented as a homogeneous sub-population with a group-specific birth and death rate, labour force participation rate and rates of immigration and emigration. By thus capturing the effects of China's low fertility, the model projects the reversal of its labour supply trend, as indicated in Figure 16.4. The implication of this for the real exchange rate is that a labour

Table 16.3 Regional composition in the global model

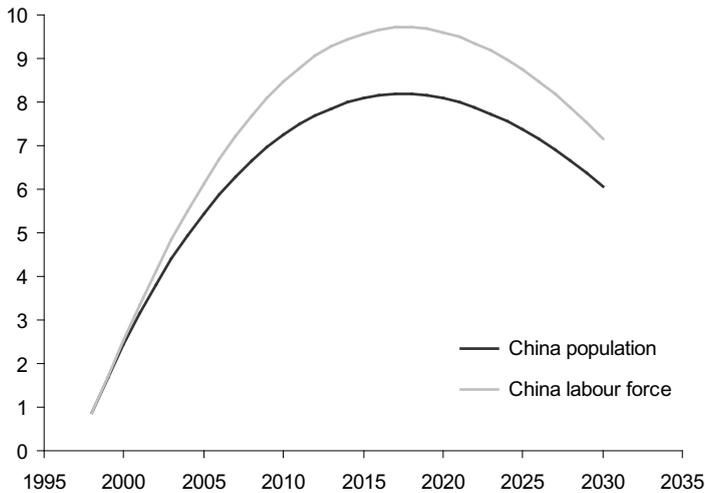
Region	Composition of aggregates
Australia	
North America	Canada, Mexico, United States
Western Europe	European Union, including Switzerland and Scandinavia but excluding the Czech Republic, Hungary and Poland
Central Europe and the former Soviet Union	Central Europe, including the Czech Republic, Hungary and Poland
Japan	
China	Includes Hong Kong and Taiwan
Indonesia	
Other East Asia	Republic of Korea, Malaysia, the Philippines, Singapore, Thailand and Vietnam
India	
Other South Asia	Bangladesh, Bhutan, Maldives, Nepal, Pakistan and Sri Lanka
South America	Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Peru, Venezuela and Uruguay
Middle East and North Africa	Includes Morocco through to the Islamic Republic of Iran
Sub-Saharan Africa	The rest of Africa
Rest of world	Includes the rest of Central America, the rest of Indo-China, the small island states of the Pacific, Atlantic and Indian Oceans and the Mediterranean Sea, Myanmar and Mongolia, New Zealand and the former Yugoslavia

Source: GTAP Global Database, Version 5.

force that is growing faster than those of trading partner countries—other things being equal—lowers costs and depreciates the real exchange rate. A relative decline in the labour supply would be expected to have the reverse effect.

For the Balassa-Samuelson hypothesis, the key is the difference between the performances of traded and non-traded sectors. To the extent that their labour intensities differ, labour supply trends make a difference. As it turns out, however, trends in skill composition are more important. These depend on the rate at which each region's education and social development institutions transform unskilled (production-worker) families into skilled (professional-worker) families. Each year a particular proportion of the population in each production-worker age–gender group is transferred to professional status. The initial values of these proportions depend on the regions' levels of development, the associated capacities of their education systems and the relative sizes of

Figure 16.4 **China's projected population and labour force, 1995–2035^a**



^a These are cumulative percentage departures from the base year 1997, drawn from the baseline simulation in which China's fertility is projected to decline from 1.9 to 1.5.

Source: Base line simulation of the model described in the text. For a more detailed description of the demographic aspects of this simulation, see Golley, J. and Tyers, R., 2006. 'China's growth to 2030: demographic change and the labour supply constraint', in R. Garnaut and L. Song (eds), *The Turning Point in China's Economic Development*, Asia Pacific Press, The Australian National University, Canberra:203–26 (version in Chinese forthcoming in *Chinese Labor Economics*).

their production and professional labour forces. Rates of transformation change through time with real per capita income and the level of the skilled wage premium. China's skill share is projected to rise through time while that in North America remains static. The contrast is due to North America's higher initial skill share, its high rate of unskilled immigration and its higher fertility rate.

The 16 age-gender-skill groups differ in their shares of regional disposable income, consumption preferences, saving rates and labour supply behaviour. While the consumption–savings choice differs for each group, it is dependent for all on group-specific real per capita disposable income and the real lending rate. Governments are assumed to balance their budgets while saving and borrowing are undertaken by the private sector. The baseline scenario is a 'business-as-usual' projection of the global economy until 2030. In part because of its comparatively young population and hence its continuing rapid labour force growth, India attracts substantial new investment and is projected to take over from China as the world's most rapidly expanding region. Comparatively rapid population growth, however, detracts from India's long-term real per capita income performance. By this criterion, China is the strongest performing region through the three decades.

Growth shocks and China's real exchange rate

Our focus is on shocks that enhance the rate of GDP growth, for which we draw on simulations carried out by Tyers et al. (2006). These include once-and-for-all productivity increases, skill transformation rate increases, birth-rate increases, interest premium decreases and tariff decreases (increases in openness). In each case, we run a new simulation in which the determinant in question is shocked once and for all, as of 2005. We then extract the elasticity of China's real exchange rate to each shock, tracking the values through time to 2030. We focus on the bilateral real exchange rate, measured as in Equation 1, against the region 'North America', since this best parallels China's nominal exchange rate policy and the renminbi valuation debate.

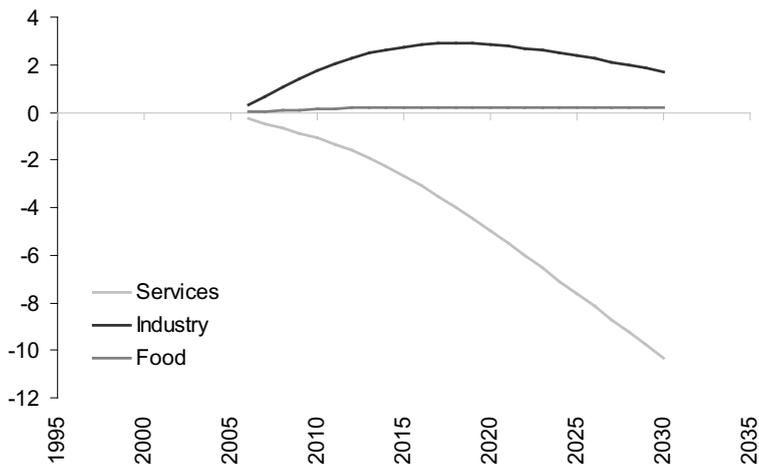
Productivity growth increase

We first shock total factor productivity separately in each sector. The elasticity is the percentage departure of the projected real exchange rate for each percentage per annum increase in total factor productivity. The overall rate of economic growth proves to be quite sensitive to such productivity shocks since the larger these are for a particular region, the larger is that region's marginal product of capital. The region therefore enjoys higher levels of investment and hence a double boost to its growth rate. Productivity growth in both tradable

sectors yields real appreciations but ‘industry’ is by far the greater contributor to China’s trade and therefore the most significant for the real exchange rate (Figure 16.5). The appreciating effects of tradable productivity increases are consistent with the Balassa-Samuelson hypothesis and are, as expected, due to wage growth and relative service price inflation. They are bolstered in the short term by increased investment and hence greater net inflows on the capital account. In the long term, however, the enlargement of the capital stock reduces costs and hence offsets the real exchange rate gains. Also, as expected from the dominance of non-traded sector prices in Equation 2, faster service productivity growth depreciates the real exchange rate—modestly in the early years but to a dominant extent in the long term, when it is reinforced by associated capital accumulation.

If productivity is boosted equi-proportionally in all sectors, the net effect is a small real appreciation in the short term and a substantial real depreciation in the long term. The Balassa-Samuelson effect is dominant in the short term

Figure 16.5 **Elasticities of the projected real exchange rate to the rate of total factor productivity growth in each sector, 1995–2035^a**



^a This is the percentage departure of the projected real exchange rate for each percentage per annum increase in total factor productivity in each of the three sectors after 2005.

Source: Tyers, R., Golley, J., Bu, Y. and Bain, I., 2006. *China’s economic growth and its real exchange rate*, Working Papers in Economics and Econometrics, No. 476, The Australian National University, Canberra.

but is overwhelmed by services productivity in the long term. The short-term net appreciation is bolstered by the associated rise in capital returns and hence the attraction of increased investment from abroad. Beyond a decade, as costs are reduced by the across-the-board rise in productivity, combined with the associated capital expansion, the elasticity turns negative and very quickly expands in that direction. The particular strength of changes in service productivity is notable, suggesting that the forecasting of real exchange rates depends importantly on this difficult-to-measure behaviour. Indeed, if our productivity estimates in Table 16.1 are correct, recent differences between China's productivity performance in the tradable and service sectors are not large. This suggests that, if China's future growth is driven increasingly by services productivity improvements, its real exchange rate could continue on a depreciating trend.

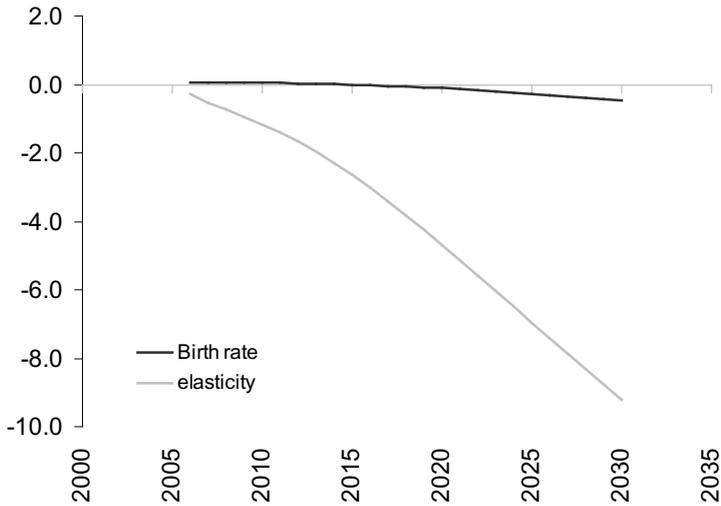
Skill acquisition rate increase

When the skill acquisition rate is increased in developing regions such as China, where the unskilled (or production) worker population is larger than its skilled (or professional) counterpart, the proportional boost to skilled workers is larger than the proportional loss of unskilled workers. The result is greater output and, other things being equal, a real depreciation. This tendency is enhanced, however, by the fact that the services sector is comparatively skill intensive, so that the shock causes a relatively large boost to service output and hence a relatively large fall in the service price. The result is a strong responsiveness of GDP growth to skill acquisition and a relatively large real depreciation. The elasticities in this case are percentage departures of the growth rate and real exchange rate for each percentage of the population in production-worker families that is transformed each year. Defined this way, skill transformation places downward pressure on the real exchange rate of a magnitude similar to total factor productivity in services (Figure 16.6).

Birth rate increase

The birth rate affects the real exchange rate by raising the population (initially) and the labour force (subsequently). The initial effect is to raise aggregate demand but not to contribute to supply since income is redistributed to the non-saving and non-working young. Net inflows on the capital account rise and the real exchange rate appreciates. In the long term, when the increased birth rate yields a larger workforce, the supply effects predominate. Wage costs are lower and the real exchange rate declines. It is somewhat surprising that the

Figure 16.6 **Elasticities of the projected real exchange rate to the fertility rate and the skill acquisition rate, 2000–2035^a**



^a This is the percentage departure of the projected real exchange rate for each percentage point change in the total fertility rate and for each additional percentage of the population of production-worker families that is transformed annually to professional status.

Source: Tyers, R., Golley, J., Bu, Y. and Bain, I., 2006. *China's economic growth and its real exchange rate*, Working Papers in Economics and Econometrics, No. 476, The Australian National University, Canberra.

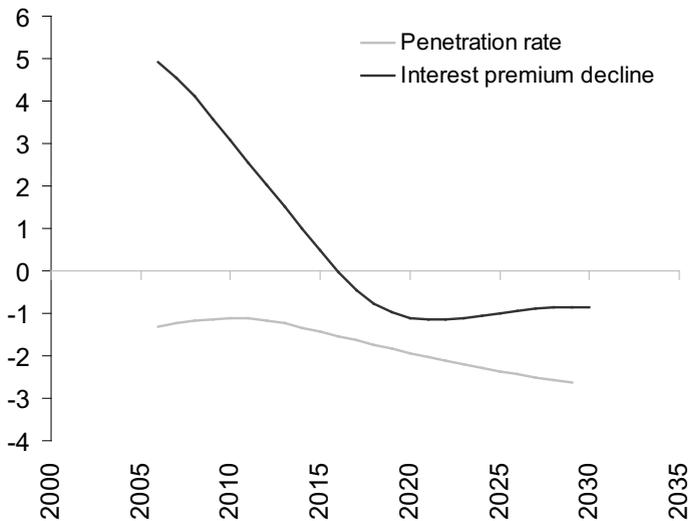
elasticity of the real exchange rate to the birth rate is so small (Figure 16.7). The results suggest that China's birth rate, and hence its low fertility, will be only a modest contributor to the future of its real exchange rate.

Interest premium decline

In the short term, the decline in China's interest premium results in net capital inflows, which raises investment and therefore increases aggregate demand and the real exchange rate. A positive demand-driven effect is therefore expected in the first instance. In the long term, however, when the effect of the investment on the capital stock is realised, the supply side dominates. More abundant and hence cheaper capital reduces production costs, yielding a real depreciation. The elasticity-to-premium decline is large and positive in the short term, with the lag to the switch in sign at least 15 years (Figure 16.7).

This simulation helps to explain the lack of appreciation of the real exchange rate to date. It says that an expansion of net inflow on the financial and capital accounts of the balance of payments causes a real appreciation in the short-medium run. Since there has in fact been an expansion in net outflows on these accounts (Figure 16.3), the effect has been to apply downward pressure on China's real exchange rate. While domestic savings continue to dominate investment, this substantial depreciating effect is likely to continue offsetting the short-term (Balassa-Samuelson) appreciating effect of productivity changes (Figure 16.5).

Figure 16.7 **Elasticities of the projected real exchange rate to trade openness (penetration rate), the savings rate and interest premium decline, 2000–2035^a**



^a This is the percentage departure of the projected real exchange rate for each 1) percentage increase in the overall import penetration ratio, 2) percentage point increase in the concurrent average savings rate (all group savings rates are shifted by equal proportions), and 3) percentage point reduction in the domestic interest rate due to a reduced premium, starting in 2005.

Source: Tyers, R., Golley, J., Bu, Y. and Bain, I., 2006. *China's economic growth and its real exchange rate*, Working Papers in Economics and Econometrics, No. 476, The Australian National University, Canberra.

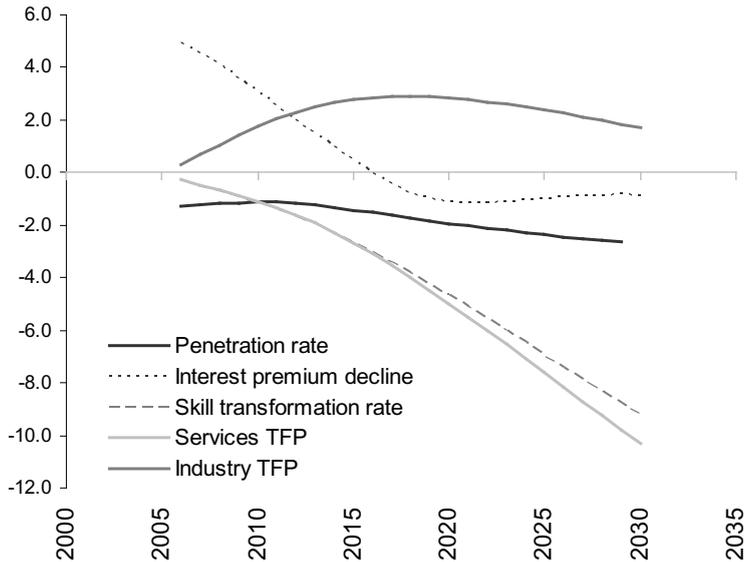
Trade liberalisation

Trade liberalisation switches demand away from home-produced goods and services towards imported varieties. For a single region, the supply of goods and services from the much larger foreign market is more elastic than that of home varieties, constrained as they are by local factor supplies and technology. The effect of the demand switch, then, is to reduce the relative prices of the home varieties and hence to depreciate the real exchange rate. The elasticity of openness is constructed by dividing the percentage change in the real exchange rate by the percentage point change in the overall import penetration ratio (the ratio of the value of imports to the total value of domestic consumption). The shock on which it is based is a phased removal of all China's merchandise trade barriers over five years.²³ The elasticity has the expected negative sign, and its magnitude grows through time (Figure 16.7). The decline occurs because of the concentration of China's merchandise protection in capital-intensive industries. Although the effects on GDP are positive, lower home-product prices in these industries reduce average home capital returns and hence reduce investment and capital growth, enlarging the negative elasticity through time.

Conclusion

While the Balassa-Samuelson hypothesis is borne out for China—in that productivity has apparently grown faster in the tradable than in the non-tradable sectors and there has been relative service price inflation—the effect of this on the real exchange rate has been counteracted by other forces. It is likely that the strongest of these forces is the rise of China's total savings relative to its investment and the associated expansion of net outflows on its capital account. Other depreciating forces that are likely to have contributed include the demographic dividend and the associated elasticity of labour supply, trade reform, skill acquisition and services productivity growth. Much attention is paid in the literature to China's monetary policy and, in particular, to the PBC's accumulation of foreign exchange reserves. In our view, however, the PBC's monetary stance—embodying as it does the objective of exchange rate stability—is necessitated by financial immaturity. In particular, while China's savings exceed its investment, the reserves and capital controls merely alter the public–private composition of external flows but need not significantly affect their magnitudes. Indeed, it is possible that the future removal of China's capital controls could see accelerated outflows as Chinese institutions seek to enlarge their private holdings of foreign assets. Depending on the PBC's response, the short-term effect of this could be further downward pressure on the real exchange rate.

Figure 16.8 **Elasticities of the projected real exchange rate to its key determinants, 2000–2035^a**



^a This is the percentage departure of the projected real exchange rate for each percentage increase in the overall import penetration ratio, M/C , caused by tariff reductions that began in 2005.

Source: Tyers, R., Golley, J., Bu, Y. and Bain, I., 2006. *China's economic growth and its real exchange rate*, Working Papers in Economics and Econometrics, No. 476, The Australian National University, Canberra.

To examine the effects of the full variety of growth-related shocks on the real exchange rate in the future, we turned to a dynamic model of the global economy. A baseline business-as-usual simulation is constructed to 2030, wherein China's growth rate slows due to ageing and slower labour force growth. The principal determinants of China's economic growth are then shocked separately and their independent effects on the real exchange rate observed over time. Sectoral total factor productivity is raised, the rate of skill acquisition by the workforce is increased, the fertility policy is relaxed, financial reform reduces China's interest premium, and trade reforms further open the economy. In each case, an elasticity of the real exchange rate to the original shock is charted (Figure 16.8).

The results suggest that, while population policy affects the real exchange rate in the directions expected, demographic change is not a strong

determinant, at least within the three decades examined. In the short term, the key determinant is net financial capital influx, which appreciates the real exchange rate, or efflux, which depreciates it. In the medium term, scope does emerge for Balassa-Samuelson real appreciation, if services lag sufficiently behind industrial productivity. In the long term, however, if services remain relatively skill intensive on average, their performance will be bolstered by both direct productivity improvements and skill acquisition, and the sensitivity of the real exchange rate to these effects is very large. Since Chinese productivity growth has been higher than that of its trading partners for more than a decade, and considerable scope remains for productivity catch-up in services, these long-term forces might bear down on the real exchange rate in future. If, instead, service sector productivity growth continues to be comparatively weak, real appreciations could also occur. It is difficult to ignore the fact, however, that the majority of the growth-related shocks examined—including overall (and particularly services) productivity growth, professional training and further trade reform—cause the real exchange rate to depreciate in the long term.

Fundamentally, whichever productivity pattern dominates, the future path of the real exchange rate will depend most on the continuation of shocks to aggregate demand due to net flows on the capital account and hence on the future path of China's domestic savings relative to its investment. It is difficult to imagine increases in its savings rate beyond those already recorded. Eventually, it must fall. When it does, net flows on the capital account are likely to be reversed, resulting in an appreciating force. The long-term outcome will then depend on the extent to which this force is offset by continued skill acquisition and services productivity growth.

Notes

- 1 Miyajima (2005) notes the prominence of services productivity in the growth experience of many Organisation for Economic Co-operation and Development (OECD) countries.
- 2 Here we imagine that, rather than the continuum of tradability that is observed across goods and services, traded and non-traded goods are separated starkly as T, N.
- 3 For example, the Cold War infrastructure investments in Korea and Taiwan reduced service costs at early stages in their periods of rapid expansion.
- 4 See, for example, Bergin et al. (2006); Crucini et al. (2005); and Drine and Rault (2005).
- 5 This is a standard assumption in the most widely used numerical models of open economies and global trade (see, for example, Dixon et al. 1982; McKibbin and Sachs 1991; Hertel 1997; and Dixon and Rimmer 2002).
- 6 Evidence for this is offered by Chang and Tyers (2003).
- 7 The 'Food' sector is defined as Primary Industry plus Food Processing; 'Industry' as Secondary Industry minus Construction and Food Processing; while 'Services' is defined as Tertiary Industry plus Construction. See Tyers et al. (2006) for further details.

- 8 Moreover, it must be borne in mind that services output volumes and prices are measured more poorly than those in merchandise sectors in all countries. These comparative measures therefore carry large error margins. Lu (2006) estimates labour productivity in China's manufacturing and service sectors between 1978 and 2004. He describes the evolution of China's manufacturing labour productivity after 1978 as a two-stage process: during the first stage (1978–90) it was only 1.9 per cent per annum, compared with a per capita GDP growth rate of 7.5 per cent; while during the second stage (1991–2004) it increased dramatically, averaging 13.1 per cent—significantly higher than the official per capita GDP growth rate of 8.2 per cent. Labour productivity in the service sector averaged 4.3 per cent per annum for the entire period. Fogel 2006 disaggregates per capita income growth between 1978 and 2002 and shows that 69 per cent of growth was due to increases in labour productivity, which grew most rapidly in industry (6.2 per cent per annum), nearly as high in agriculture (5.7 per cent) and lowest, but still substantial, in services (4.5 per cent).
- 9 For example, he calculates that if the tertiary enrolment ratio rose from six to 25 in the next 20 years (putting China where the Western European nations were in 1980), the growth rate of labour productivity would rise by 4.4 per cent between 2000 and 2020, and that this would account for more than 60 per cent of the per capita GDP growth target set in 2002. With the tertiary ratio increasing from 12.5 per cent to 19 per cent between 2000 and 2004, if anything, his estimates could be too conservative.
- 10 See Bloom and Williamson (1998) for a generic discussion of the demographic dividend in developing economies.
- 11 Golley and Tyers (2006) confirm this, finding that the non-working aged dependency ratio could rise to 43 per cent.
- 12 They note that by 2003, there was a shortage of migrant workers in the Pearl River Delta region, a phenomenon that has since spread to the Yangtze River Delta region and even to some central provinces, such as Jiangxi, Anhui and Henan, which are usually the source of migrants, not the destination.
- 13 The right hand side of this identity stems from the combination of aggregate expenditure on GDP, $Y = C + I + G + X + M$; the fact that GNP is $Y_N = Y + N$, where N is net factor income from abroad; the GNP disposal identity, $Y_N = C + T + S$, and the balance of payments, $BoP = 0 = KA + CA$, where the current account is $CA = X - M + N$.
- 14 In the meantime, the approach being taken by the Chinese government to control 'external imbalances' focuses on the rate of economic expansion. Growth is constrained by control over land releases and liquidity, the latter through limits on base money growth, aided by sterilisation bonds, as Figure 16.4 indicates. Other policies serving this purpose include reductions in export facilitation (in the rate of reimbursement of some export taxes) and, at least in prospect, the reduction of import tariffs on some luxury products. Financial reforms are proceeding quickly, however, so that some increased exchange rate flexibility is being offered by the People's Bank of China, as suggested by the extension of the daily renminbi–US dollar rate fluctuation bounds from 0.3 per cent to 0.5 per cent as of late May.
- 15 Frankel 2004 finds that the renminbi was undervalued by 36 per cent in 2000; Goldstein 2004, who claims it was undervalued by 15–30 per cent in 2004; and Coudert and Couharde 2005, who find the undervaluation to be larger. See Dunaway and Li 2005 for a survey, including one that finds overvaluation (Wang 2004, 2005). Tyers et al. (forthcoming) use a structural model to find evidence of undervaluation in the mid to late 1990s but offer no clear finding for 2004.
- 16 Further evidence of large sums of capital flight out of China is offered by Sicular (1998) and Gunter (2004).
- 17 According to Fan (2006), speculative inflows were as high as US\$105 billion in 2004 (see also Prasad and Wei 2005).

- 18 In separate work by the authors, the foreign asset share of China's collective portfolio is estimated to be lower than average for countries of its size and development level, its substantial reserves notwithstanding. This suggests the former outcome is the more likely one.
- 19 Tyers and Golley (2006) use measures of China's investment premium to explore the implications of financial reform. Their modelling approach underlies the results presented in the remainder of the chapter.
- 20 The model has its origins in *GTAP-Dynamic*, the standard version of which is a derivative of its comparative static progenitor, *GTAP* (Hertel 1997). Its dynamics are described in Ianchovichina and McDougall (2000).
- 21 Wang and Ding (2006) recently estimated that there were 40 million surplus workers in China's agricultural sector. While underemployment is not explicit in our model, the assumption of high labour productivity growth in agriculture implies that agriculture is capable of shedding labour more quickly than other sectors. This essentially mimics the surplus labour problem, which is thereby accounted for implicitly.
- 22 The subdivision between production workers and professionals and para-professionals accords with the International Labour Organization's occupation-based classification and is consistent with the labour division adopted in the GTAP Database. See Liu et al. (1998).
- 23 The elasticity is insensitive to the scale of the liberalisation though not to the composition of China's protection. For the levels of protection embodied in the database for 1997, see Dimaranan and McDougall (2002).

References

- Aizenman, J. and Lee, J., 2006. *Financial versus monetary mercantilism: long run view of large international reserves hoarding*, Working Paper WP/06/280, International Monetary Fund, Washington, DC.
- Balassa, B., 1964. 'The purchasing power parity doctrine: a reappraisal', *Journal of Political Economy*, 72(6):584–96.
- Bergin, P.R., Glick, R. and Taylor, A.M., 2006. 'Productivity, tradability and the long run price puzzle', *Journal of Monetary Economics*, 53(8):2,041–66.
- Bernanke, B., 2006. Speech to the Chinese Academy of Social Sciences, Beijing, 15 December.
- Bloom, D.E. and Williamson, J.G., 1998. 'Demographic transitions and economic miracles in emerging Asia', *World Bank Economic Review*, 12(3):419–55.
- Cai, F. and Wang, D., 2005. 'Demographic transition: implications for growth', in R. Garnaut and L. Song (eds), *The China Boom and its Discontents*, Asia Pacific Press, The Australian National University, Canberra:34–52.
- , 2006. 'Employment growth, labour scarcity and the nature of China's trade expansion', in R. Garnaut and L. Song (eds), *The Turning Point in China's Economic Development*, Asia Pacific Press, The Australian National University, Canberra:143–71.
- Chang, J. and Tyers, R., 2003. 'Trade reform, macroeconomic policy and sectoral labour movement in China', in R. Garnaut and L. Song (eds), *China:*

- new engine of world growth*, Asia Pacific Press, The Australian National University, Canberra:231–75.
- Choudhri, E.U. and Khan, M.S., 2004. *Real exchange rates in developing countries: are Balassa-Samuelson effects present?*, Working Paper, No.WP/04/188, International Monetary Fund, Washington, DC.
- Coudert, V. and Couharde, C., 2005. *Real equilibrium exchange rate in China*, Working Paper, No.2005-01, CEPPII, Paris.
- Crucini, M.J., Telmer, C.I. and Zachariadis, M., 2005. 'Understanding European real exchange rates', *American Economic Review*, 95(3):724–38.
- Dimaranan, B.V. and McDougall, R.A., 2002. *Global Trade, Assistance and Production: the GTAP 5 data base*, May, Center for Global Trade Analysis, Purdue University, Lafayette.
- Dixon, P.B., Parmenter, B.R., Sutton, J. and Vincent, D.P., 1982. *ORANI, a Multi-Sectoral Model of the Australian Economy*, North Holland, Amsterdam.
- Dixon, P.B. and Rimmer, M.T., 2002. *Dynamic General Equilibrium Modelling for Forecasting and Policy: a practical guide and documentation of Monash*, North Holland, Amsterdam.
- Drine, I. and Rault, C., 2005. 'Can the Balassa-Samuelson theory explain long run real exchange rate movements in OECD countries?', *Applied Financial Economics*, 15(8):519–30.
- Dunaway, S. and Li, X., 2005. *Estimating China's 'equilibrium' real exchange rate*, Policy Discussion Paper 05/202, International Monetary Fund, Washington, DC.
- Fan, G., 2006. 'Global imbalance, China and the international currency system', in R. Garnaut and L. Song (eds), *The Turning Point in China's Economic Development*, Asia Pacific Press, The Australian National University, Canberra.
- Fogel, R., 2006. *Why is China likely to achieve its growth objectives?*, Working Paper W12122, National Bureau of Economic Research, Cambridge, MA.
- Frankel, J., 2004. *On the renminbi: the choice between adjustment under a fixed exchange rate and adjustment under a flexible rate*, Working Paper 11274, National Bureau of Economic Research, Cambridge, MA.
- Golley, J. and Tyers, R., 2006. 'China's growth to 2030: demographic change and the labour supply constraint', in R. Garnaut and L. Song (eds), *The Turning Point in China's Economic Development*, Asia Pacific Press, Canberra; version in Chinese forthcoming in Chinese Labor Economics.
- Goldstein, M., 2004. Adjusting China's foreign exchange rate, Revised version of a paper delivered at the International Monetary Fund's seminar on China's Foreign Exchange Rate System, Dalian, 26–27 May. Available from www.iie.com (accessed September 2006).

- Gunter, F., 2004. 'Capital flight from China: 1984–2001', *China Economic Review*, 15:63–85.
- Hertel, T.W. (ed.), 1997. *Global Trade Analysis Using the GTAP Model*, Cambridge University Press, New York.
- Ianchovichina, E. and McDougall, R., 2000. *Theoretical structure of Dynamic GTAP*, GTAP Technical Paper, No. 17, Purdue University, Lafayette.
- International Monetary Fund (IMF), 2007a. *International Financial Statistics*, International Monetary Fund, Washington, DC.
- , 2007b. *World Economic Outlook Database*, International Monetary Fund, Washington, DC.
- Lardy, N., 2006. 'China's interaction with the global economy', in R. Garnaut and L. Song (eds), *The Turning Point in China's Economic Development*, Asia Pacific Press, The Australian National University, Canberra.
- Liu, J., Van Leeuwen, N., Vo, T.T., Tyers, R. and Hertel, T.W., 1998. *Disaggregating labor payments by skill level in GTAP*, Technical Paper, No. 11, Center for Global Trade Analysis, Department of Agricultural Economics, Purdue University, Lafayette.
- Lu, F., 2006. *China's productivity growth, an international comparison*, China Center for Economic Research Working Paper C200604, Peking University, Beijing (in Chinese).
- Ma, Y., 2006. *A comparative study of the competitiveness of the domestic and foreign-invested service industries in China*, Centre for Public Policy Studies Working Paper, No. 176, Lingnan University, Hong Kong, December.
- McKibbin, W.J. and Sachs, J., 1991. *Global Linkages: macroeconomic independence and cooperation in the world economy*, Brookings Institution, Washington, DC.
- Miyajima, K., 2005. *Real exchange rates in growing economies: how strong is the role of the nontradables sector*, Working Paper 05/233, International Monetary Fund, Washington, DC.
- National Bureau of Statistics, 2006. *China Statistical Abstract 2006*, China Statistical Press, Beijing.
- People's Bank of China, 2006. *Balance Sheet of Monetary Authority*, People's Bank of China, Beijing.
- Prasad, E., Rumbaugh, T. and Wang, Q., 2005. *Putting the cart before the horse: capital account liberalization and the exchange rate in China*, Policy Discussion Paper 05/01, International Monetary Fund, Washington, DC.
- Prasad, E. and Wei, S.J., 2005. *The Chinese approach to capital inflows: patterns and possible explanations*, Working Paper WP/05/79, International Monetary Fund, Washington, DC.

- Rodrik, D., 2006. *What's so special about Chinese exports?*, Working Paper, No. 11947, National Bureau of Economic Research, Cambridge, MA.
- Samuelson, P., 1964. 'Theoretical notes on trade problems', *Review of Economics and Statistics*, 46(2):145–54.
- Sicular, T., 1998. 'Capital flight and foreign investment: two tales from China and Russia', *The World Economy*, 21(5):589–602.
- Tyers, R. and Golley, J., 2006. *China's growth to 2030: the roles of demographic change and investment premia*, Working Papers in Economics and Econometrics, No. 461, The Australian National University, Canberra.
- Tyers, R., Golley, J., Bu, Y. and Bain, I., 2006. *China's economic growth and its real exchange rate*, Working Papers in Economics and Econometrics, No. 476, The Australian National University, Canberra.
- Tyers, R. and Shi, Q., 2007a. 'Global demographic change, policy responses and their economic implications', *The World Economy*, 30(4):537–66.
- , 2007b. *Global demographic change, labour force growth and economic performance*, Working Papers in Economics and Econometrics, No. 462, The Australian National University, Canberra.
- Tyers, R., Bu, Y. and Bain, I., (forthcoming). 'China's equilibrium exchange rate: a counterfactual analysis', *Pacific Economic Review*, October.
- Wang, J. and Ding, S., 2006. 'A re-estimation of China's agricultural surplus labour—the demonstration and modification of three prevalent methods', *Frontiers of Economics in China*, 1(2):171–81.
- Wang, T., 2004. 'Exchange rate dynamics', in E. Prasad (ed.), *China's Growth and Integration into the World Economy: prospects and challenges*, International Monetary Fund Occasional Paper 232, Washington, DC.
- , 2005. 'Sources of real exchange rate fluctuations in China', *Journal of Comparative Economics*, 33(4):753–71.

Acknowledgments

Funding for the research described in this chapter is from the Australian Research Council Discovery Grant No.DP0557889. Thanks are due to Bu Yongxiang, Huang Yiping and Chris Milner for useful discussions on the topic; to Christopher Kent and participants in an April 2007 Reserve Bank of Australia seminar for valuable comments; to Terrie Walmsley for technical assistance with the GTAP Database; Wang Xiaolu for help with China's national accounts; and to Iain Bain and Hsu Pingkun for research assistance.