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China and Global Macroeconomic Interdependence

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Rod TYERS

Business School, University of Western Australia,
Research School of economics, Australian National University and
Centre for Applied Macroeconomic Analysis (CAMA), Australian National University

Abstract

China's economy is now a member of the small group of large economic regions that interact strategically over macroeconomic policy. Critics see it as having developed at the expense of both investment and employment in the US, Europe and Japan while proponents emphasise improvements in their terms of trade and reductions to the cost of financing that stem from China's supply of light manufactures, its demand for Western capital and luxury goods and its high saving. Insights into the international implications of China's growth and saving are here derived from a simple global general equilibrium model that embodies elemental short run macroeconomic behaviour. The model emphasises bilateral linkages via both trade and investment and so helps clarify the international effects of both China's expansion, its high saving and of the new "inward focus" of its macroeconomic policy regime. Foreign worker displacement and slow investment emerge as the key consequences of China's growth for the other large economies and its turn inward could indeed stimulate a resurgence of employment and investment there.

Keywords

China, Macroeconomic modelling, Macroeconomic coordination

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Address for correspondence:

(E) cama.admin@anu.edu.au

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Business School
University of Western Australia,
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Australian National University, and
Centre for Applied Macroeconomic Analysis (CAMA)
Crawford School of Government
Australian National University

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Abstract

China's economy is now a member of the small group of large economic regions that interact strategically over macroeconomic policy. Critics see it as having developed at the expense of both investment and employment in the US, Europe and Japan while proponents emphasise improvements in their terms of trade and reductions to the cost of financing that stem from China's supply of light manufactures, its demand for Western capital and luxury goods and its high saving. Insights into the international implications of China's growth and saving are here derived from a simple global general equilibrium model that embodies elemental short run macroeconomic behaviour. The model emphasises bilateral linkages via both trade and investment and so helps clarify the international effects of both China's expansion, its high saving and of the new "inward focus" of its macroeconomic policy regime. Foreign worker displacement and slow investment emerge as the key consequences of China's growth for the other large economies and its turn inward could indeed stimulate a resurgence of employment and investment there.

1 Introduction

Critical to understanding the behaviour of the global economy is the interaction between the macroeconomic policy regimes of the major economic regions, the US, the Western Europe and Japan, recently joined by China. These regions are all "large" in that the policies of each affect the others as a group as well as the world's many smaller economies. Their behaviour is therefore highly inter-active and strategic. The rise of China and other Asian, heretofore developing, economies since the 1980s has not only underwritten global economic performance but high East Asian saving rates have contributed to what became known as the Asian "savings glut".¹ Global real interest rates peaked in the mid-1980s and have fallen since, in part because of this relative increase in global savings supply. These changes have been regarded by critics as having been at the expense of both investment and employment in the US, Western Europe and Japan while proponents emphasise improvements in their terms of trade and reductions to the cost of financing that stem from China's supply of light manufactures, its demand for Western capital and luxury goods as well as its high saving.

This pattern of interaction with Asia began to change, first with the slowdown in Japan in the 1990s but more recently with the poor performance of the other large regions. It has become clear that the export-led growth model is unsustainable for China, for three main reasons. First its light manufacturing exports now loom large in global trade and there is insufficient market growth for their expansion to continue. Second, a demographic contraction is imminent that

¹ See Bernanke (2005), Chinn and Ito (2007), Choi et al. (2008) and Ito (2009).

will reduce the availability of surplus agricultural workers, raising labour costs and slowing productivity growth. And third, reforms that will help continue China's high growth rate must now venture into the heavy manufacturing and services sectors, which have not been export oriented. A "turn inward" is required that will be politically difficult. For these reasons slower growth is likely, not only in China but also in those Asian economies that depend on its market for manufacturing components.² Moreover, Asia's contribution to global saving will also decline as reforms ensure that Chinese households are offered the choice to consume from more of their corporate income and as populations age, particularly in China and Japan.³

Apart from the fact that the world now has much larger East Asian economies than it did in the 1980s, the East Asian slowdown, combined with the decline in their excess saving, now offers the rest of the world shocks that are the opposites of Asian shocks in the decades since. This change presents both opportunities and dangers in the US, Europe and Japan. On the one hand, rising Chinese consumption could be one of the Keynesian stimuli required to raise demand and reduce unemployment queues in the advanced economies. On the other, it will come with a rise in global interest rates. While this would increase saving in the advanced economies, and therefore investment there, it could bring two deleterious effects. First, private portfolios that have tended to hoard money during deflationary times will rebalance and central banks will need to soak up liquidity, including by shedding the non-traditional assets acquired via quantitative easing (QE).⁴ This will raise interest rates on both long and short maturity instruments. Because the long instruments are extensively traded internationally, and held by Asian savers who will not be in the market for more, the rise in financing costs could be very sharp. Second, the rise in financing cost would see a considerable enlargement in the cost of servicing government debt, which will be of particular importance in the US, Europe and Japan, where net interest on sovereign debt is now at least a tenth of government revenue.⁵

To capture the implications of these shocks, this paper introduces a multi-region general equilibrium model that incorporates elemental macroeconomic behaviour. Importantly, the model incorporates bilateral relationships between savers and investment that allow for the mobility of investable funds but recognise the Feldstein-Horioka (1980) association between home saving and home investment. The results are supportive of the more sanguine Keynesian

² For details on the extent of production fragmentation and networking in Asia, see Athukorala (2011).

³ For a comprehensive analysis of Asian household saving, see Horioka and Terada-Hagiwara (2012), and for discussion of China's high corporate saving see Kuijs (2006), Tyers and Lu (2008).

⁴ See, for example, Bernanke (2009).

⁵ The OECD *Economic Outlook 89 Database* has net debt service costs on sovereign debt at between two and three per cent of GDP in these regions.

view that a surge in Chinese consumption will be a key stimulus for the global economy, moderating both unemployment queues and fiscal deficits. Yet there is a rise in bond yields, and hence also in sovereign debt service costs, with implications for the most indebted regions. In the section to follow a review is offered of the changes in China's relative size and the associated domestic transitions that presage its reduced excess saving. Section 3 then briefly discusses simultaneous developments in the large, developed economic regions. The model used for quantitative analysis is then presented in Section 4 and simulation results are described in Section 5. Conclusions are offered in Section 6.

2. China's Graduation and its Domestic Transition

Although China's rate of expansion during its three decades of reform has been spectacular, it is only in the last decade that its economic size has paralleled those of the US, the EU and Japan. China's exports have grown especially rapidly since the turn of the century and now dominate world trade in light manufactures.⁶ As of 2011 its unadjusted share of global GDP was greater than Japan's and its shares of global exports, saving and investment were larger than those of the US and close to those of the EU (Table 1). The implications of this rapid expansion in output and trade for the large economic regions have been the subject of considerable debate. On the positive side are global benefits in the form of a terms-of-trade improvement (cheaper light manufactured imports relative to exported luxury and capital goods). In just the same way that the case for free trade over autarky in a small economy requires compensation to achieve a Pareto improvement, the case for positive benefits outside China from its expansion requires gainers (the skilled and capital owners) to compensate losers (low skill workers).⁷

Studies emphasising macroeconomic policy have tended to be more critical of China, implying exchange rate distortions that have left at least some of the advanced economies worse off.⁸

⁶ According to trade data from data.worldbank.org, Chinese manufactured exports now sum to more than a third of the collective manufactured imports of the US, the EU and Japan.

⁷ Early contributions to the extensive literature on the effects of trade with developing countries on labour markets in advanced economies were by Wood (1994) and Leamer (1996), both of whom used conventional Heckscher-Ohlin-Samuelson models to show mutual gains from the expansion but to point out the losses to unskilled labour in the advanced economies. A recent reprise on that empirical literature is by Haskel et al. (2012) and new work on US labour market effects is by Autor et al. (2013). These studies see the rise of imports from China as being significant in determining US labour market performance but as explaining a minority share of the observed change. Similarly, recent neoclassical modeling that emphasizes gains from trade stemming from China's rise is by Harris et al. (2011).

⁸ The American perspective is offered by Bergsten et al. (2008) and Lardy (2006, 2012), while the case against the "currency manipulator" charge is made by, amongst others, Tyers and Zhang (2011). The advanced resource

What is clear is that China has contributed considerable excess saving and that this has helped to sustain of cheap credit abroad. In the US and Europe at least, through no fault of China's, this tended to flow into debt-financed consumption and government spending rather than to new investment.⁹ Yet the period that generated this controversy has now passed and the necessity for a change of growth path in China could bring some reversal of the shocks that have been so widely debated.

The domestic transition

There is wide agreement outside China, and more recent concurrence inside, that China's growth will, and should, be increasingly underpinned by rising home consumption rather than exports.¹⁰ Superficially, it would seem that a switch to domestically driven growth should be possible, just by consuming more and exporting less. But this simple idea is problematic because the export led growth strategy focusses production on light manufacturing, while China's growing middle class demands motor vehicles and high quality services that include transport, telecommunications, health and education. To diversify China's output toward these products requires major investment in human capital and infrastructure that will take time.

Yet, that priority should be given to seeking alternative sources of growth is clear as China's export-led growth strategy confronts four headwinds. First, further export expansion is constrained by poor performance abroad; second, there has been an accelerated rise in domestic labour costs, foreshadowing a Lewis "turning point"¹¹, which is associated with the depletion of mobile labour in rural areas and a nation-wide demographic contraction stemming from China's "one child policy". Third, there are high environmental costs associated with China's manufacturing expansion to date, which are not yet fully covered; and fourth, the increased income inequality stemming at least in part from rents in the state-owned sector will require further expensive social policy correction.¹²

economies like Australia and Canada all enjoyed undisputed gains from China's rise, via their raw material exports. Asian neighbors were hurt by China's export competition in the early stages (Tyers, Bu and Bain 2008) but helped in the later stages as China became a major destination for component exports (Athukorala 2011).

⁹ This is noted by Chinn et al. (2012), who also make the point that, while China's current account surplus has been large, other important pre-GFC contributors to global excess saving included the oil exporters (who enjoyed a surge in export prices 2004-8) and some European countries.

¹⁰ For the Chinese official line on the "rebalancing" of its economy, including its external accounts, see Wen (2007, 2011).

¹¹ The timing of China's Lewis turning point is a subject of controversy, as suggested by the contrasts between the views expressed by: Cai (2010), Garnaut (2010) and Golley and Meng (2011), which offer just a sampling of a substantial literature. There is, however, little doubt that the turning point is on its way, even if there is little agreement as to whether recent real wage rises suggest its presence.

¹² For a discussion of the institutional and industrial reform agenda and its difficulty, see for example Tyers and Lu (2008), Riedel (2011) and Deer and Song (2012).

And the potential for substantial new growth from domestic sources does exist. This stems, in particular, from the extension of industrial reforms into hitherto protected industries in heavy manufacturing and services, where reductions in costs and prices could have a major stimulatory effect on the economy as a whole. Such reforms include further pure privatisation, the fragmentation of state-owned enterprises to induce more competitive pricing, price cap regulation and greater access to services and heavy manufacturing by foreign investors. Because the oligopoly rents earned in these sectors are linked to corporate saving (Kuijs 2006, Song et al. 2011) the latter is comparatively large in China, last measured in the region of a fifth of GDP. Industry policy reforms that foster further privatisation, or that otherwise reduce oligopoly rents, are readily shown to reduce the aggregate level of Chinese saving by amounts sufficient to eliminate its current account surplus and hence its provision of excess saving to the global economy (Tyers 2012a).

Saving and China's external accounts

National saving includes that by households, corporations and government. Savings that exceed the value of domestic private and public investment result in the net acquisition of foreign assets and they are measured by the current account surplus:

$$(1) \quad CA = S_{HH} + S_C + (T - G) - I = S_D - I = \Delta R - FI_{Inward} + FI_{Outward} = X - M + N$$

Where S_{HH} is household saving, S_C is corporate saving, $(T-G)$ is government saving or the fiscal surplus, S_D is total domestic saving, I is investment (including public investment), CA is the current account balance and N is net foreign income factor income.¹³ FI signifies foreign investment, inflows or outflows. In China's case these terms are dominated by FDI since cross-border portfolio investments are restricted by its capital controls (Ma and McCauley 2007).

Thus, to explore the implications for external accounts we must consider changes to household saving, corporate saving and government saving and compare these with changes in investment. Beyond this, to assess potential changes in the direction of the outward financial flows associated with China's excess saving it is important to compare the regional distribution of China's reserve holdings with that of its growing outward FDI.

¹³ This identity is readily obtained by combining the expenditure identity, $Y=C+I+G+X-M$ with the disposal identity for GNP, $Y+N=C+T+S$, where $S=S_{HH}+S_C$.

Household saving

The pattern and time trend of household saving in other Asian economies is analysed by Horioka and Terada-Hagiwara (2012). They point out that the three main determinants of rates of measurable household saving are the age structure of the population and the levels of income and financial sector development. Saving rates follow a concave path, rising in the early stages of development and subsequently declining with ageing and financial development, which lowers credit constraints. They suggest that private saving in China could remain stable, affected by offsetting, opposing forces – ageing and financial development tend to reduce it and higher incomes tend to raise it. Changes in this projected pattern might be expected, however, in the aftermath of the GFC and with the commencement of China’s inward-focussed strategy. Moreover, the projections of Horioka and Terada-Hagiwara neither include corporate nor government saving, and changes in these are yet more likely. Official estimates of household saving are shown in Figure 1 through 2010. For the reasons discussed above, these are subject to question, with household saving very likely having followed a lower path at least more recently.

Corporate saving

The trend to 2010 in corporate saving is also illustrated in Figure 1. The estimates are from national accounts “flow of funds” data that are not yet updated beyond this point. Looking forward, changes in total corporate saving might be anticipated for three reasons. First, to the extent that slower global growth since the GFC has affected profitability in the state sector, corporate savings might be expected to have also declined in recent years. Second, on-going industrial policy reforms, which include the subdivision of some SOEs, are likely to have further reduced profitability and hence corporate saving. Finally, financial development and the integration of formal and informal financial markets across the country have been proceeding apace. With more options and more security in the management of funds, it might be expected that the trend of corporate saving would be downward from its extraordinary heights of three years ago.

Government saving

Since the implementation of China’s tax law in 1994, the domestic economy has gradually integrated, with an increasing share of economic activity taking place in the “formal sector”. This has meant that central government tax revenue has grown steeply, at a rate that is notably

faster than GDP.¹⁴ Along with this, *central* government financial surpluses have expanded continuously. At the same time, however, with the maintenance of capital controls, financial integration has caused China's high-saving households and firms to deposit their savings in domestic commercial banks. These banks have a long tradition of lending to SOEs and provincial governments, where debt has been effectively underwritten centrally. The comparatively recent development in this lending is an expansion in the share directed to provincial governments to finance local public investment.¹⁵ As shown in Figure 2, this has grown significantly since 2002 and it accelerated with the onset of the GFC and the government's plan to increase public works expenditure when export demand fell away temporarily. After 2007, the sum of the provincial deficits exceeded the central surplus, leading to a return to overall deficits with magnitudes expanding to unprecedented levels. Thus, government saving is also shifting in the negative direction in the post-GFC years.¹⁶

Implications for overall Chinese excess saving relative to investment

The above discussions suggest that there has been a diminution of China's total domestic saving since 2010, though this may not be fully represented in the official statistics, which only show a slight decline in 2011. At the same time, total (private and public) investment rose to nearly half of GDP. Indeed, the growth rate of completed investment in fixed assets was 24 and 20 per cent in 2011 and 2012, still much faster than recorded GDP growth. This underlies the continuously rising investment share of GDP shown in Figure 3 and it confirms that investment has made the greatest single contribution to China's "rebalancing" in recent years.¹⁷ The result has been a contracting current account surplus in the post-GFC period, particularly since 2010.¹⁸ Although China's surplus sank below the aggregate of the rest of the world in 2012, it remained the single largest surplus across individual countries.¹⁹

Looking ahead, it is difficult to imagine a higher rate of investment without the prospect of increasingly wasteful projects. Moreover, the recent boost in public investment has stemmed from, first, national post-GFC stimulus policy, second, the preference on the part of commercial banks to lend to protected provincial government and SOEs and, third, the substantial excess supply of saving, bottled up in the home market by capital controls. All

¹⁴ According to China's NBS *Statistical Yearbook* (2012), central government revenue has expanded its share of nominal GDP from 10% in 1994 to 23% in 2012.

¹⁵ This is notwithstanding central government sharing of national revenue with the provinces at a 50-50 rate in 2011.

¹⁶ Government saving is here defined as $T-G$, where G is total government spending, including transfers.

¹⁷ This pattern was foreshadowed by Lee and McKibbin (2007).

¹⁸ A full current account figure for 2012 is yet to come available, though an estimate is offered in the figure.

¹⁹ IMF, *IFS Database*.

three conditions should fade through time, so that the implications for future excess saving then depend on the differences between the rates of decline of total domestic saving on the one hand and investment on the other. Continued decline in excess saving appears the most likely future course, not just because this is the apparent path since 2010 but also considering the trend toward financial deepening and the mounting evidence that consumption expenditure is growing faster than officially estimated.

Reserves and outward FDI

A key element of China's excess saving is its rate of official foreign reserve accumulation. Effective capital controls have been retained notwithstanding progress toward the "internationalisation" of the RMB. These restrict, though they do not eliminate, all private financial flows other than officially sanctioned inward and outward FDI. The persistent excess of home saving over investment engenders a correspondingly persistent excess of foreign exchange revenues from net exports. This surplus foreign exchange is deposited with China's commercial banks yet the capital controls prevent it from being used in international asset transactions by bank deposit holders and so the common practice has been for it to be acquired by the Peoples Bank of China (PBC) in exchange for newly printed Yuan. In the absence of full convertibility, these funds have then had to be deposited abroad, mainly via purchases of government bonds in the US.²⁰ Commencing in 2007, the US\$ domination of the PBC's assets began to be addressed by swaps with central government debt that deposited the US\$ assets with the China Investment Corporation (CIC), via which the early part of China's official outward portfolio investment and outward FDI was financed. Since then it has been possible for the CIC to acquire the foreign exchange from the commercial banks directly. Combined with slower growth in private saving and an associated contraction in the trade surplus, this has seen slower accumulation of official foreign reserves and their reduced role on the PBC's balance sheet.²¹

Thus, while China's reserve accumulation has been large by international and historical standards, it has been a figment of capital controls. In effect, while the law has prevented prevents ordinary citizens from holding substantial assets abroad, the PBC, and more recently the CIC and the mainly state-owned foreign direct investors, have been holding foreign assets

²⁰ The resulting monetary expansion was originally sterilized via the sale by the PBC of "sterilization bonds" (Tyers and Zhang 2011). More recently, the approach has been to reduce money creation by the commercial banks via measures such as high reserve to deposit ratios.

²¹ According to the PBC's *Balance Sheet of Monetary Authority* (1999-2012), following steady growth in its share of PBC assets since the 1990s, reserve holdings peaked at 54% in 2009, falling to 47% by 2012.

on their behalf. Importantly, however, the substitution between reserve accumulation, which takes the form of low-yielding foreign government bonds and likely better yielding portfolios of the CIC and the outward investing SOEs may be causing a redirection of China's excess saving away from the US (Tyers et al. 2013).

3. The External Accounts of the Developed Regions

Global financial markets continue to be dominated by the US, which has sustained a structural current account deficit since the 1990s. Though much that has been unpalatable since 2007 has been blamed on the GFC, the broad pattern of international finances did not appear to be permanently changed by it. Critically, it brought about a reversion by the private sectors in the US, the EU and Japan to net saving positions while all three governments assumed net borrowing positions, as shown in Figure 4. It therefore replaced private debt, some of which had been unsustainable, with sovereign debt, some of which is also unsustainable, leaving heightened global uncertainty as to sovereign financing.²²

A key change took place around 2005, before which the large US deficit had been financed by surpluses in Japan and the oil producing countries. Thereafter, however, the burden of this financing rested increasingly with China, whose dollar contribution became the single largest in 2005 and peaked in 2008 (Tyers et al. 2013). China had joined the club of major economies and was the dominant supplier of finance to the rest of the world while the regions other than it and the US were in comparative current account balance. The international financing game had become one between China and the US. After 2010, though, China's relative role as surplus financier began to diminish with the shifts in its domestic saving-investment balance already discussed. It remains the world's largest single national buyer of US debt and equities, however, highlighting the potential for disruption in US financial markets should China's excess saving continue to decline.

Global finance over two decades

Some insight into the macroeconomic events leading up to the GFC is offered by Figure 5, which shows the yields on short and long term US Treasury bonds since the beginning of the 1990s. Consistent with the market segmentation theory of the yield curve, imagine that the

²² According to the OECD Economic Outlook 89 Database, the sovereign debt *stock* problems of continental European economies and Japan predated the GFC though they were exacerbated by it. The largest proportional impacts of the GFC were to the US and the UK. Even so, though these countries' debt stock to GDP ratios became not significantly larger than that of France and are dwarfed by those of Portugal, Italy, Greece and Japan.

transaction cost of financing long via a succession of short contracts to be prohibitive, allowing short and long maturity instruments to trade at substantially different prices. Moreover, short bonds are instruments of conventional domestic monetary policy and they are traded little between countries, or at least between the major economic regions considered here. Long bonds, by contrast, are instruments of private saving and investment.²³ They are substitutes for equity holdings and are extensively traded internationally. Long bond yields are therefore more stable through time than short yields and reflect movements in the equilibrium between global saving and investment. Short yields, on the other hand, reflect monetary easing and tightening through business cycles that have often been specific to particular economies. Considering this, Figure 5 clearly shows the two large US cycles that preceded the GFC and the tightening that led up to it in 2004-5, when petroleum prices rose.²⁴ It was this tightening that exposed those investors who expected short rates to remain low, precipitating the GFC. Beyond 2008, of course, US short rates bottomed out, as did those in Europe, and so both joined Japan in having rendered conventional monetary policy ineffective.

What is also notable from Figure 5 is the continuous and smooth downward trend in long bond yields. This is as clear an index as any of the Asian savings glut. After the 1980s the great majority of the world's incremental growth took place in Asia, where saving rates were, and continue to be, substantially higher than in the rest of the world. Long yields, which had risen prior to the mid-1980s, have fallen continuously since. Though it is not shown in the figure, this long run pattern is also observable in European, Canadian and Australian long bond yields. Importantly, and this is clear from the more recent data on yields represented in Figure 6, the downward trend in long yields persists beyond the GFC in all three economic regions. Yet the evidence is building that the Asian savings glut is over, led by declining net saving in both Japan and China. What, then, explains the continuing decline in long yields?

Quantitative easing

The most likely explanation is unconventional monetary policy, or “quantitative easing” (QE), whereby money expansions are achieved via the large scale purchase of long bonds, and related instruments, by central banks. For economies that have been stagnant in real terms since 2007, this has led to the substantial expansions in central bank asset holdings shown in

²³ While this is true as a rule of thumb, housing investment can be sensitive to short rates in economies where most mortgage contracts have variable rates. The assumption that investment financing depends on the long maturity market is accurate in a comparative sense and it is a useful abstraction.

²⁴ Its origins in petroleum markets are analyzed by Arora and Tyers (2011).

Figure 7.²⁵ These raise the prices of long bonds and related instruments and suppress their yields. Unlike more conventional monetary policy, the QE focus on widely traded instruments projects the domestic monetary cycle beyond national borders with immediacy, causing financial outflows as investors seek out better yields abroad. In part for this reason, the policy is being matched across the three large blocs.²⁶ So what purpose does such unconventional monetary policy serve?

The three large economic regions have, each by their own historical standards, high unemployment and governments with extraordinary sovereign debt overhangs. Further fiscal expansion seems unwise yet their liquidity traps prevent conventional monetary expansions (McKibbin and Stoeckel, 2011). QE offers an alternative stimulatory course, so long as private portfolio holders preoccupied with the prospect of deflation are prepared to hoard at least part of the money thus supplied. Under these conditions, acquisitions by central banks offer the convenience of additional leeway for further government deficit spending. Governments continue to spend beyond their revenues and central bank acquisitions mask the decline in Asian demand for their bonds. Moreover, unless the expansions are fully matched abroad, the new abundance of regional currency depreciates the exchange rate and stimulates traded sectors.

The global game

In an important sense, QE policies are part of a strategic game within the small club comprising the major economic regions, of which China is now a member. A substantial monetary expansion by one region requires a matching response from the others to avoid appreciations that would reduce competitiveness. In China, the other transitional economies and the resource exporting economies like Canada and Australia that are outside the club, the result has been accelerating inflation, or substantial nominal appreciations relative to the US.²⁷ The notable thing about movements in the major currencies since 2000, shown in Figure 8, is that the US\$ has gradually depreciated against all. Beyond that, the Yen, the Euro and the Yuan have tended to move together, particularly in the aftermath of the GFC, when they appeared to stabilise around their 2000 relativities, albeit all appreciating by a third against the

²⁵ It is notable that China's monetary base is large compared with the others, which is likely due to reduced money creation by China's commercial banks in response to such restrictions as high reserve to deposit ratios.

²⁶ Of course, one clear rationale for QE on the part of the US Federal Reserve is that the substitution will be away from US bonds to US equities. And this has happened too. Much less is said by the Fed about the international effects.

²⁷ The A\$ is the resource currency of an outsider economy that is not a default risk and that has not engaged in aggressive monetary expansion. Return-seeking financial flows from the QE economies have therefore boosted its value.

US\$. Very recently, there has been a break from this pattern with Japan's more aggressive QE causing a substantial depreciation relative to the others. Since Japan is now the smallest of the large economic regions, it is possible that its departure from equilibrium could be sustained at minimum cost to the others and that no retaliation will occur.

4. The Model

A short run comparative static approach is used in which the effects of shocks are examined over an interval that lies within the gestation period of investment and hence over which capital employment is constant. The analysis therefore addresses short run departures from the underlying long run growth path of the global economy. No initial steady state is required, so that the real net rates of return on physical capital and bond yields within and between regions are generally unequal at the outset and following shocks.

Each region supplies a single product that, so far as all consumers are concerned, is differentiated from the products of the other regions. On the supply side, there are three primary factors with "production" labour (L) a partially unemployed variable factor while the stocks of physical capital (K) and skill (S) are fixed and fully employed. Total consumption depends on current and expected future disposable income, via an extended Keynesian consumption equation, and its value is then subdivided in a single CES structure between the products of all the regions. Private savings are the residual from disposable income after consumption and these are combined with government savings and directed into asset portfolios that are fully bilateral. Allocations of saving to investment across regions depend on expected real rates of return relative to regional financing rates, which in turn depend on endogenous risk premia.

Six regions are identified: the US, the EU, Japan, China, Australia and the Rest of the World, though the focus of this paper is on the first four.²⁸ There are therefore six products and 12 financial assets: the home money of each region and bonds that finance both private investment and government spending, which are homogeneous within regions between the private sector and government but are differentiated between regions. The demand for money is driven by a cash in advance constraint applying across the whole of GDP, as embedded in a conventional demand equation for real money balances. For any one household, home money is held in a portfolio with long maturity bonds and the latter are claims over domestic government debt and

²⁸ The EU is modeled as the full 26 and it is assumed that this collective has a single central bank.

physical capital across the regions. Expectations are exogenous in the model and are formed over future values of the home price level, the rate of inflation, the real rate of return on home assets and nominal disposable income. The details are as follows.

The supply side

Output is assumed to be Cobb-Douglas in the three primary factors, so that, for regions i , local output and the marginal product of capital are:

$$(2) \quad y_i = A_i^Y L_i^{\beta_L} S_i^{\beta_S} K_i^{\beta_K}, \quad MP_i^K = \beta_i^K \frac{y_i}{K_i} = \left[A_i^Y \beta_i^K S_i^{\beta_S} K_i^{\beta_K-1} \right] L_i^{\beta_L}, \quad \beta_i^L + \beta_i^S + \beta_i^K = 1 \forall i.$$

The real volume of output, y , is distinguished from nominal GDP, $Y = P^Y y$, where P^Y is the *GDP price* level (deflator). The real production wages of unskilled and skilled workers depend conventionally on the corresponding marginal products.

$$(3) \quad w_i = \frac{W_i}{P_i^P} = \beta_i^L \frac{y_i}{L_i}, \quad w_i^S = \frac{W_i^S}{P_i^P} = \beta_i^S \frac{y_i}{S_i}$$

Here the upper case wages are nominal and the lower case real and P^P is the *producer* price level.

The demand side

Both direct and indirect tax revenues, T^D and T^I , play key roles in the formulation. GDP at factor cost (or producer prices), Y^{FC} , is the total of direct payments to the collective household in return for the use of its factors.

$$(4) \quad Y_i = Y_i^{FC} + T_i^I, \quad Y_i^{FC} = C_i + T_i^D + S_i^P$$

This is the standard disposal identity for GDP, or the collective household budget, where C is the total value of final consumption expenditure, including indirect taxes paid, and S^P is private saving.

The GDP price, P^Y , and the producer price, P^P , would be the same were it not for indirect taxes. In their presence we have:

$$(5) \quad Y_i = P_i^Y y_i = P_i^P y_i + T_i^I, \quad \text{so that} \quad P_i^Y = P_i^P + \frac{T_i^I}{y_i}.$$

Direct tax

Constant marginal direct tax rates, t^W and t^K , apply to all labour and capital income. The corresponding “powers” of these rates are $\tau^L = (1+t^L)$ and $\tau^K = (1+t^K)$.

$$(6) \quad T_i^D = t_i^L (W_i L_k + W_i^S S_i) + t_i^K P_i^P M P_i^K K_i,$$

Indirect tax revenue, T^I , depends on consumption and trade and so it will emerge later.

Consumption

Aggregate consumption expenditure, C , is a nominal sum but real consumption behaviour is motivated by real incomes and the real interest rate, so here the formulation is in terms of volumes. Real consumption, (lower case) c , depends negatively on the real after-tax return on savings (the home bond yield, r) and positively on both current and expected future real disposable income.

$$(7) \quad c_i = \frac{C_i}{P_i^C} = A_i^C \left(\frac{r_i}{\tau_i^K} \right)^{-\varepsilon_i^{CR}} \left(\frac{Y_i^D}{P_i^C} \right)^{\varepsilon_i^{CY}} \left(\frac{Y_i^{De}}{P_i^{Ce}} \right)^{\varepsilon_i^{CY}}.$$

Here an exogenous expected inflation rate of consumer prices is specified so that

$$P^{Ce} = P^C (1 + \pi^e).$$

To capture the home household’s substitution between home and foreign products, real aggregate consumption in region i is a CES composite of region i ’s consumption of all six regional products:

$$(8) \quad c_i = \left(\sum_j \alpha_{ij} c_{ij}^{-\theta_i} \right)^{-\frac{1}{\theta_i}}$$

The home household then chooses its mix of consumed products to minimise consumption expenditure in a way that accounts for home indirect tax rates, foreign export taxes and differing foreign product prices and exchange rates:

$$(9) \quad C_i = P_i^C c_i = P_i^P \tau_i^C c_{ii} + \sum_j \tau_i^C \tau_i^M \tau_j^X c_{ij} P_j^P \frac{E_j}{E_i},$$

where τ_i^C , τ_i^M and τ_j^X are, respectively, the powers of region i ’s consumption and import taxes and the region of origin, j ’s export tax. E_i is region i ’s nominal exchange rate, measured in US\$ per unit of home currency. The US\$ is the numeraire in the model.

Optimum consumption is consistent with an elasticity of substitution between home and foreign products of $\sigma_i = 1/(1 + \theta_i)$. The Marshallian demands are then:

$$(10) \quad c_{ii} = \alpha_{ii}^{\sigma_i} \frac{C_i}{P_i^C} \left[\frac{P_i^P \tau_i^C}{P_i^C} \right]^{-\sigma_i}, \quad c_{ij} = \alpha_{ij}^{\sigma_i} \frac{C_i}{P_i^C} \left[\frac{P_j^P E_j \tau_i^C \tau_i^M}{E_i P_i^C} \right]^{-\sigma_i}, \quad i \neq j$$

Given these consumption volumes, the composite price of all consumption, or the consumer price level, emerges from the substitution of (8) and (10) in (9) as:

$$(11) \quad P_i^C = \tau_i^C \left[\alpha_{ii}^{\sigma_i} (P_i^P)^{1-\sigma_i} + \tau_i^M \sum_{j \neq i} \alpha_{ij}^{\sigma_i} \left\{ \frac{P_j^P E_j}{E_i} \right\}^{1-\sigma_i} \right]^{\frac{1}{1-\sigma_i}}$$

The global product balance

Each region's product is differentiated from the others and so global product balance stems from a version of the expenditure identity:

$$(12) \quad y_i = \frac{I_i + G_i}{P_i^P} + \sum_j c_{ji},$$

where the final term is the sum of real consumption and real exports. Neither investors nor the government pay indirect taxes on their expenditure and so the price they face for the home product is the producer price, P^P . This equation solves indirectly for the producer prices.

Private saving

Households receive income amounting to GDP at factor cost, Y^{FC} . Their disposable nominal income is this sum less direct tax (6), and private saving is what remains after consumption expenditure (9) is further deducted.

$$(13) \quad Y_i^D = P_i^P y_i - T_i^I, \quad S_i^P = Y_i^D - C_i$$

Indirect tax revenue

This includes revenue from consumption, import and export taxes:

$$(14) \quad T_i^C = t_i^C \left(P_i^P c_{ii} + \sum_j \tau_i^M \tau_j^X c_{ij} P_j^P \frac{E_j}{E_i} \right),$$

$$(15) \quad T_i^M = t_i^M M_i, \quad M_i = \sum_{j \neq i} \tau_j^X c_{ij} P_j^P \frac{E_j}{E_i},$$

$$(16) \quad T_i^X = t_i^X X_i, \quad X_i = \sum_j c_{ji} P_i^P,$$

$$(17) \quad T_i^I = T_i^C + T_i^M + T_i^X, \quad T_i = T_i^D + T_i^I.$$

Government saving

This is government revenue less government expenditure, both measured net of direct transfers.

$$(18) \quad S^G = T^D + T^I - G.$$

To simplify the demand side, government spending is assumed to be directed only at home goods.²⁹ It pays no taxes and so faces the home producer price P^P .

Total domestic saving

This is the sum of private and government savings in the home economy, a value in home currency.

$$(19) \quad S_i^D = S_i^P + S_i^G.$$

The direction of saving to investment

The approach taken to bilateral investment flows is a simplification of the optimisation result obtained for similar use by Tyers and Cheong (2013). Data on regional saving and investment for 2011 is combined with that on international financial flows to construct an initial matrix that allocates total saving in each region to investment across all the regions. From this is derived a corresponding matrix of initial shares of region i 's saving allocated to investment in region j , s_{ij}^{S0} . When the model is shocked, the new shares are calculated so as to favour investment in regions, j , with comparatively high expected real rates of return, r^{ce} , and/or low financing interest rates, r .³⁰ Expected real rates of return depend on current real rate of return on installed capital and, via interest parity, on expected real appreciations:

$$(20) \quad r_i^{ce} = r_i^c + \hat{e}_i^e = \frac{P_i^P M P_i^K}{P_i^K} + \hat{e}_i^e = r_i^c \gamma_i^e,$$

²⁹ In the model database, direct transfers are netted from direct tax revenue, so that $T-G$ is the true fiscal surplus.

³⁰ The ratio, r^{ce}/r , is akin to Tobin's Q since current asset value depends on expected future rates of return and the replacement cost depends on the current financing rate.

where P_i^K is the price of capital goods, which is usually set equal to P_i^P in this model with single regional goods.³¹ The expectational factor, γ_i^e , is applied exogenously or solved for model consistency.

$$(21) \quad s_{ij}^S = \frac{s_{ij}^{SO} \left(\frac{r_j^{ce} \tau_i^K}{r_i \tau_j^K} \right)^{\varphi_i}}{\sum_k s_{ik}^{SO} \left(\frac{r_k^{ce} \tau_i^K}{r_i \tau_k^K} \right)^{\varphi_i}},$$

where φ_i is an elasticity that reflects the return-seeking behaviour of region i 's portfolio manager but also the differentiation of regional bonds from one another due to differences in legal structures, property rights security, price level and exchange rate stability, and sovereign risk. Note that the tax rate on capital income would not enter this relationship were investment to be financed in the destination region, since it is assumed the tax would apply to all types of financial capital earnings at the same rate. The assumption here is that it is financed in the region of origin and so, considering that tax rates differ across regions, these differences are accounted for by the added quotients. Total investment spending in region j , in local currency, is then:

$$(22) \quad I_j = \sum_i \left(s_{ij}^S S_i^D \frac{E_i}{E_j} \right).$$

This approach captures Feldstein-Horioka (1980) home preference while allowing regional redistribution of investment spending at the margin to a magnitude that depends on the return-seeking elasticity, φ_i .

Balance of payments

The sum of net inflows of payments on the current account and net inflows on the capital and financial accounts, measured in a single (home) currency is zero:

$$(23) \quad X_i - M_i + \sum_{j \neq i} \left(s_{ji}^S S_j^D \frac{E_j}{E_i} \right) - \sum_{j \neq i} \left(s_{ij}^S S_i^D \right) = 0, \quad \forall i \neq "US"$$

³¹ This relationship can be varied in practice by shocking the ratio of the two prices in (19) to reflect, for example, a comparative cheapening of capital (say IT related) goods.

Balance in the US is implied by balance in all the other regions. These equations determine the exchange rates and, since these are defined relative to the US\$, that for the US is always unity, $E_{US} = 1$.

Global financial equilibrium and real financing interest rates

The sum of investment spending worldwide must equal the sum of domestic saving worldwide.

$$(24) \quad \sum_i I_i E_i = \sum_i S_i^D E_i .$$

This condition determines a global interest rate to clear financial markets, r^W . Regional financing yields are then set relative to this rate using an interest premium factor, λ_i , that is defined relative to r_{US} , so that $\lambda_{US} = 1$, and depends on relative fiscal balance:

$$(25) \quad r_i = r^W \lambda_i, \quad \lambda_i = \lambda_i^0 \left[\frac{\left(\frac{G_i}{T_i} / \frac{G_{US}}{T_{US}} \right)}{\left(\frac{G_i^0}{T_i^0} / \frac{G_{US}^0}{T_{US}^0} \right)} \right]^{\phi_i}, \quad \forall i \neq "US",$$

where ϕ_i is an elasticity that determines the sensitivity of the dependence.³²

Regional money market equilibrium

A cash-in-advance constraint is assumed that generates transactions demand for home money across all components of GDP. The opportunity cost of holding home money is set at the nominal after-tax yield on home bonds. Real money balances are measured in terms of purchasing power over home products.

$$(26) \quad m_i^D = a_i^{MD} (y_i)^{\varepsilon_i^{MY}} \left(\frac{r_i (1 + \pi_i^e)}{\tau_i^K} \right)^{-\varepsilon_i^{MR}} = \frac{M_i^S}{P_i^V}.$$

The monetary base and the nominal money supply are linked by a standard money multiplier:

$$(27) \quad \frac{M_i^S}{M_i^B} = \frac{1 + \mu_i}{\rho_i + \mu_i},$$

where ρ_i is the reserve to deposit ratio and μ_i is the cash to deposit ratio.

³² Interest premia depend in practice not only on sovereign risk but also on relative volatility. The latter effect cannot be captured in a comparative static framework.

Real exchange rate

Each region has a real exchange rate relative to the US that is the rate of exchange between regional product bundles. With the regions specified as single product economies this measure parallels the terms of trade. Both real and nominal exchange rates are expressed according to the financial convention, so that an appreciation is a rise in value.

$$(28) \quad e_i = \frac{P_i^Y}{\left(\frac{P_{US}^Y}{E_i} \right)} = E_i \frac{P_i^Y}{P_{US}^Y} .$$

Model database, parameters and operation

The model database is built on national accounts as well as international trade and financial data for the global economy in 2011. The details are provided in Appendix 1. Solutions require a choice of shocks and closures, the latter allowing the determination of the labour market equilibrium in each region (fixed or flexible nominal wage), the fiscal policy regime (fixed nominal or real government expenditure or fixed deficit) and the monetary policy regime (whether the target is the price level, the exchange rate or the money supply itself). These are detailed in Appendix 2.

5. Simulated Effects of Chinese Growth and Saving

Two sets of experiments are conducted. The first concerns the effects of the continuation in 2011 of Chinese growth on the pattern of the past decade – export driven with comparatively low consumption growth. The second examines the transition to slower overall growth and a rising consumption share of GDP. While a variety of model closures are available and would serve the purpose, a single set is chosen, as indicated in Table 2. In labour markets, short run nominal wage rigidity is assumed in the US, EU, Japan and China with full employment in the rest of the world. Government spending is fixed in nominal terms in the US, EU and Japan but government saving is fixed in the other regions, and, for monetary policy, all central banks are assumed to target the monetary base.³³ Expectations over prices, exchange rates and rates of return are assumed myopic throughout.³⁴ The results show that the effects of changes to output

³³ This means that the monetary base is set as exogenous, though in several cases it is then subjected to shocks to represent monetary policy responses.

³⁴ Model consistent solutions have been obtained but they give rise to the same stories and patterns of results. Since the truth about expectation formation lies in between, it is more constructive to focus in the analysis on the myopic results.

and consumption preferences in China on performance in the other regions can be substantial, matching in scale the empirical findings of Eickmeier and Kuehnlenz (2013).

Effects of continued export led growth beyond 2011

Two experiments are constructed around a stylised representation of the comparative growth enjoyed by the Chinese economy in the last two decades. The particular shocks implemented are listed in Table 3. In the first experiment, shocks are applied only to China and these are to productivity, consumption behaviour and the stock of capital and skill. The nominal wage, which is set as exogenous in China, is raised and a monetary response is allowed by the Chinese central bank. The shock to consumption is set so as to reflect China's heretofore declining consumption share of GDP and a continued high level of corporate saving. Two simple stories dominate the results, which are summarised in Table 4. First, with fixed money supplies everywhere outside China, the shocks advance global supply and so are deflationary. In the simulation presented, China's own monetary expansion virtually eliminates this deflation so employment in China's modern sector continues to grow rapidly, as does its real GDP. The deflation in the other large economic regions, however, reduces private revenues relative to labour costs and so employment and output fall there. The second story is that increased Chinese excess saving reduces global long term interest rates quite substantially. This induces a substitution toward money in portfolios, adding a further deflationary force in the other regions.³⁵ The reduced interest rates also increase consumption and reduce saving in these regions and hence their levels of investment decline, with negative consequences for future growth.

Turning to China's exchange rate, that these shocks deliver a nominal depreciation relative to the other major currencies is not surprising given the fixed money supplies abroad. The real depreciation is more complex, however. In this model there are two main forces affecting its level. First, more Chinese output lowers the relative value of Chinese products in global markets and so favours the real depreciation. This is the oft-referenced terms of trade gain conferred on the other regions. The second concerns financial flows on the balance of payments. China's consumption is comparatively small relative to its GDP and its trade dependence, including its import penetration, is comparatively high. At the same time, the presence of outward capital controls means that, notwithstanding a growing outflow of

³⁵ This would be exacerbated by the formation of deflationary expectations, though expectation shocks are not included here. Simulation results that incorporate expectation shocks confirm this and are available from the author.

officially sanctioned foreign investment, the share of its saving that is directed abroad is comparatively small. Indeed, despite the inclusion of return-chasing behaviour, the dominant Feldstein-Horioka association of home investment with home saving tends to constrain the free movement of saving from all regions. This means that Chinese growth with high saving tends to have a demand switching effect; to limit globally open consumption and concentrate expenditure on mainly domestic investment, and hence to *appreciate* the real exchange rate.³⁶ This tendency, while accurate as a characterisation of China's comparative structure, is accentuated by the lack of multiple products and input-output behaviour in this model.³⁷ In the end, the results show that this second, less intuitive, force is dominated by the first when output growth is strong and that the net terms of trade gain for the other regions is supported.

When monetary responses are allowed abroad, directed at mitigating the deflationary effects of China's growth, the real effects in the other regions are greatly reduced. The monetary expansions required are large, however, considering that there is no real growth in these economies. And the declines in real interest rates that stem originally from higher Chinese saving are greatly accentuated by the surge in demand for bonds by central banks that is required to bring them about. This drop in interest rates in the other regions sustains the earlier tendency for consumption to rise at the expense of saving there and hence for investment to fall. The monetary expansions also eliminate the nominal exchange rate effects. Again, however, the real exchange rate tends to be depreciated by the change in relative production of Chinese goods, which is smaller in this case because employment is not lost in the other regions, and appreciated by the rise in Chinese saving relative to consumption. As before, the relative abundance of Chinese goods is the dominant force. Thus, even with their monetary responses and the robust terms of trade gain, the other regions are unlikely to be net gainers from Chinese growth since investment that would otherwise occur there is diverted to China.

³⁶ The opposite pattern emerges from the simulation analysis of Tyers, Golley, Bu and Bain (2008), who use an adaptation of the GTAP-Dynamic model to analyse the real exchange rate effects of a variety of shocks. In that model a substantial proportion of each region's excess saving is free to be attracted to investment in other regions based narrowly on relative rates of return. The embedded Feldstein-Horioka behaviour is therefore weaker than in this case.

³⁷ This second force is biased upward as a consequence of one of the model's key abstractions. Unlike the behaviour embedded in the model of Tyers, Golley, Bu and Bain (2008), each region supplies a single good, so imports of intermediates are not properly accounted for. Government and investment expenditure are assumed to be directed to home goods and, in China, consumption expenditure is comparatively low, not very much larger than expenditure on imports (45% compared with 29% of GDP; see Appendix 1). This means that the share of consumption expenditure directed abroad is biased upward. Indeed, the share of consumption directed abroad is larger than the share of saving directed abroad.

Effects of slower Chinese growth and higher consumption beyond 2011

This analysis begins with a single shock to Chinese preferences, boosting consumption and reducing saving. It might be thought of as stemming from the combination of life cycle changes and industrial reforms discussed in earlier sections and is set sufficient to raise the consumption share of GDP by about a tenth (from 45 to near 50 per cent). As the summary in Table 5 suggests, even without associated shocks representing China's comparative growth, this change has marked effects on economic performance abroad. The two stories of the previous growth discussion now emerge in reverse. The Chinese consumption surge is a significant Keynesian stimulus in the other regions. Reduced Chinese saving causes a substantial real rise in interest rates in all the other regions, causing portfolio rebalancing away from money and raising liquidity. With fixed money supplies this causes inflation, which in turn draws workers out of unemployment as labour costs fall relative to production revenues. The higher interest rates also reduce consumption in the other regions and therefore raise both saving and investment.³⁸ The real exchange rate effects, however, are not a simple reversal of the growth results. Changes in relative product abundance now favour the other regions, and so are appreciating for China. Yet, this time, these are more than offset by the domestic demand switching effects of increased Chinese consumption (much of which is from abroad) and reduced (domestically focussed) saving, causing a small net Chinese real depreciation and hence a further terms of trade gain in the other regions.

In the final simulation the behavioural switch toward consumption is combined with relative growth shocks that are slower than before, along with a modest accommodating Chinese monetary expansion. The latter avoids any deflation of producer prices in China and ensures slow but positive employment growth. The results offer a more realistic context in which the change in consumption behaviour might take place. Yet the pattern of the results is the same. The Chinese consumption surge is again a significant Keynesian stimulus in the other regions. The interest rate rise and portfolio rebalancing again cause inflation that draws workers out of unemployment and raises real GDP by a per cent or so. Saving and investment in the other regions rise only slightly more modestly.³⁹ The exchange rate effects are similar, though the addition of the (albeit modest) relative growth shocks sees a continuation of the net rise in the

³⁸ The interest rate rise is small in China because its interest premium falls. This is because China is relatively dependent on indirect taxes and these bear mainly on consumption. So when consumption is raised relative to saving, government revenue increases substantially relative to expenditure.

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relative abundance of Chinese products, reduced unemployment in the other regions notwithstanding. This reinforces the demand switching effects to yield a modest Chinese real depreciation and so the other regions continue to enjoy a modest terms of trade gain.

When the results from the final simulation are compared directly with those of the second (in Table 4), the shift from continued export-led, low-consumption growth to more inward-focussed growth in China is seen to cause Chinese growth to slow by 4.5 percentage points while that in the larger regions is faster by one percentage point. The differences in real consumption and investment are starker. In China, real consumption growth is faster by eight percentage points while that in the US is slower by six. But investment in China is slower by 12 percentage points, while that in the US is faster by 28. This suggests a significant shift in the global centre of gravity of production and growth, away from China and toward the other large regions. To make the comparison even more clear it is instructive to convert the labour use effects in Tables 4 and 5 to production worker numbers in employment. This difference amounts to a relative gain of 17 million employees across the US, the EU and Japan and a relative loss of 16 million modern sector employees in China.

6. Conclusion

Because the economic performance of its main trading partners has been poor since the GFC, and because relative costs have risen more quickly in its domestic markets, China has undertaken a turn “inward” in search of sources of sustained growth and continued transformation. This turn inward has begun to reduce China’s excess saving, even if the initial stages have relied mainly upon a surge in public investment to achieve it. Eventually, the extension of financial and industrial reforms into hitherto protected sectors will see reduced corporate saving and life cycle changes associated with its impending demographic contraction will see household saving decline as well. Indeed, the most likely pattern is one of slower GDP growth though very likely faster consumption growth. The consequences of this for the other large economies with which China trades might be viewed from two perspectives.

First, China, and as it happens also Japan, will soon cease to be net purchasers of US sovereign debt. This will raise bond yields and hence financing costs in the US particularly, but also globally, and it will come at a time when global portfolios will seem heavy with cash as the seeds of real recovery emerge in the US and Japan. When rebalancing occurs in favour of higher yielding instruments there will be a surge in liquidity that will see the US Federal

Reserve scaling back or reversing its QE, and hence its own bond acquisitions. The coincidence of these effects could cause a sharp tightening of global financial markets, a prospect that is already causing the US Federal reserve to hesitate as to its timing. From this perspective, China's turn inward is sensible given its export environment but its timing could be unfortunate. Those excess savings would come in especially handy when the inevitable return to conventional monetary policy occurs in the other regions. The loss of these savings might therefore be seen as a key negative global shock that is only temporarily disguised by QE in the larger economic regions.

An alternative perspective is offered by the modelling presented in this paper. Its results suggest that the combination of slower growth in China with a resurgence of Chinese consumption will result in a demand shift so large that it will provide a Keynesian stimulus in the other large regions, causing a return to inflation there and raising employment sufficiently to deliver a percentage point in additional real GDP growth. Moreover, while the loss of excess saving will raise interest rates globally, this will encourage a switch from consumption to saving in the financially open Western economies. And considering the strong association of domestic saving with domestic investment, this, in turn, will raise investment in physical capital and reinforce the resurgence of growth. Of course, there is a zero-sum aspect to this, since the simulation results suggest that the annual shocks associated with such a switch would return 17 million production workers to employment in the US, the EU and Japan but prevent 16 million semi-redundant workers in rural China from making their transition to its modern sector.

In the interpretation of these results two particular caveats, which are the subject of on-going research, should be borne in mind. The model assumes a single homogeneous good in each region. This means that the dependence of China's export-oriented manufacturing sector on imported components is not captured and nor is the comparatively rapid recent growth of its largely non-traded services sector. Consistency with national accounts data, which shows that China has a comparatively small consumption share of GDP and imports a comparatively high import share, requires that Chinese consumption be represented as excessively foreign product intensive. This enlarges the role of Chinese consumption as a source of foreign stimulus. Moreover, it distorts the simulated real exchange rate effects, not only because the Balassa-Samuelson link between productivity growth and the real exchange rate is missed but also because China's consumption expenditure is directed abroad to a greater extent than its saving, causing a surge in consumption expenditure to be somewhat counter-intuitively associated with

a real depreciation of its currency. At minimum, these aspects of the results require validation empirically and via simulations using a more detailed model.

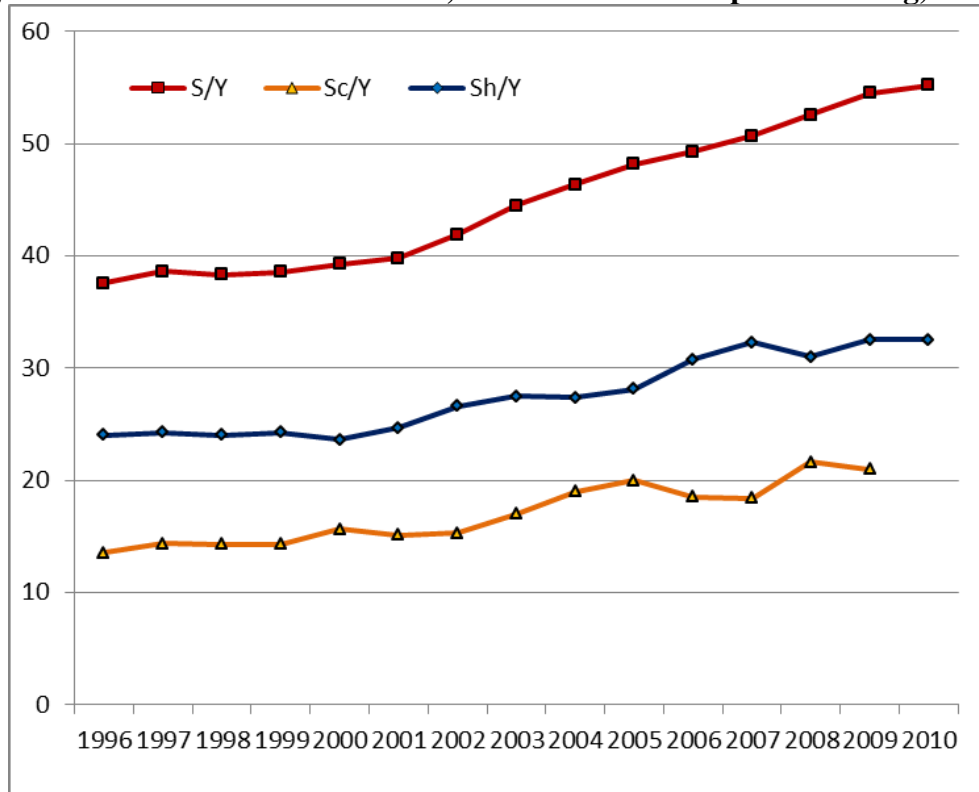
References

- Arora, V. and R. Tyers (2011), "Asset arbitrage and the price of oil", *Economic Modelling*, 29(2): 142-150, March.
- Athukorala, P. (2011), "Production Networks and Trade Patterns in East Asia: Regionalization or Globalization?" *Asian Economic Papers*, MIT Press, 10(1): 65-95, January.
- Autor, D.H., D. Dorn and G.H.Hanson (2013), "The China syndrome: local labor market effects of competition in the United States", *American Economic Review*, forthcoming.
- Bergsten, C.F., C. Freeman, N.R. Lardy and D.J. Mitchell (2008), *China's Rise: Challenges and Opportunities*, Washington DC: Peterson Institute for International Economics.
- Bernanke, B.S. (2005), "Remarks by the Governor", Sandridge Lecture, Virginia Association of Economists, Richmond Virginia, March, Federal Reserve Board.
- Bernanke, B.S. (2009), "The crisis and the policy response", Stamp Lecture, London School of Economics, London, England, January 13.
- Cai, F. (2010), "Demographic transition, demographic dividend and Lewis turning point in China", *China Economic Journal*, 3(2): 107-119, September.
- Chinn, M.D., B. Eichengreen and H. Ito (2012), "Rebalancing global growth", in O. Canuto and D. Leipziger (eds), *Ascent after Descent: Regrowing Economic Growth after the Great Recession*, Washington DC: World Bank: 35-86.
- Chinn, M.D. and H. Ito (2007), "Current account balances, financial development and institutions: assaying the world 'saving glut'", *Journal of International Money and Finance*, 26: 546-569.
- Choi, H., N.C. Mark and D. Sul (2008), "Endogenous discounting, the world saving glut and the US current account", *Journal of International Economics*, 75: 30-53.
- Deer, L. and L. Song (2012), "China's approach to rebalancing: a conceptual and policy framework", *China & World Economy*, 20(1): 1-26.
- Economist, The* (2013), "ODI-lay hee-ho: the expanding scale and scope of China's outward direct investment", 19 January: <http://www.economist.com/news/china/21569775-expanding-scale-and-scope-chinas-outward-direct-investment-odi-lay-hee-ho>.
- Eickmeier, S. and M. Kuehnlenz (2013), "China's role in global inflation dynamics", Discussion Paper 7-2013, Deutsche Bundesbank.
- Feldstein, M. and C.Y. Horioka (1980), "Domestic Saving and International Capital Flows," *Economic Journal*, Royal Economic Society, 90(358): 314-29, June.
- Fleming, J.M. (1962), "Domestic financial policies under fixed and under flexible exchange rates", *International Monetary Fund Staff Papers*, 9: 369-379.
- Garnaut, R. (2010), "Macroeconomic implications of the turning point", *China Economic Journal*, 3(2): 181-190, September.

- Garner, J. and H. Qiao (2013), "China – household consumption most likely US1.6 trillion larger than officially stated", *Asian Insight*, Morgan Stanley Research, 28 February 2013, <http://www.morganstanleychina.com/views/121217.html>.
- Golley, J. and Meng, X. (2011), "Has China run out of surplus labour?", *Chinese Economic Review*, 22(4): 555-572.
- Harris, R.G, P.E. Robertson and J. Xu (2011), "The International Effects of China's Trade and Education Booms", *The World Economy*, 34(10): 1703-1725.
- Haskel, J., R.Z. Lawrence, E.E. Leamer and M.J. Slaughter (2012), "Globalization and U.S. Wages: Modifying Classic Theory to Explain Recent Facts," *Journal of Economic Perspectives*, American Economic Association, 26(2): 119-40, Spring.
- Horioka, C.Y. and A. Terada-Hagiwara (2012), "The determinants and long term projections of saving rates in developing Asia", *Japan and the World Economy*, 24: 128-137.
- IMF (2013), *Fiscal Monitor: Fiscal Adjustment in an Uncertain World*, World Economic and Financial Surveys, Washington DC: The International Monetary Fund, April.
- Ito, H. (2009), "US current account debate with Japan then, and China now", *Journal of Asian Economics*, 20: 294-313.
- Knell, M. and H. Stix (2006), "Three decades of money demand studies: differences and similarities," *Applied Economics*, 38(7): 805-818.
- Kuijs, L. (2006), "How will China's saving-investment balance evolve?" World Bank Policy Research Working Paper 3958, Beijing, July.
- Lardy, N.R. (2006), "Toward a consumption-driven growth path" *Policy Brief 06-6*, Washington DC: Peterson Institute for International Economics.
- Lardy, N.R. (2012), *Sustaining China's Growth after the Global Financial Crisis*, Washington DC: Peterson Institute for International Economics, January.
- Leamer, E.E (1996), "Wage Inequality from International Competition and Technological Change: Theory and Country Experience," *American Economic Review*, American Economic Association, 86(2): 309-14, May.
- Lee, J.W. and W.J. McKibbin (2007), "Domestic investment and external imbalances in East Asia", CAMA Working Paper 4-2007, Canberra: Australian National University.
- Ma, G. and R.N. McCauley (2007), "How effective are China's capital controls?", Chapter 14 in R. Garnaut and L. Song (eds), *China: Linking Markets for Growth*, Asia-Pacific Press, July: 267-289.
- Ma, G. and W. Yi (2010), "China's high saving rate: myth and reality", *International Economics*, 122: 5-40.
- McKibbin, W.J. and A.B. Stoeckel (2011), 'Global Fiscal Consolidation', *Lowy Institute for International Policy, Working Papers in International Economics*, vol. 1, no. 11.
- McKibbin, W.J. and P. Wilcoxon (1995), "The theoretical and empirical structure of the G-Cubed model", *Economic Modelling*, Elsevier, 16(1): 123-148, January.
- Riedel, J. (2011), "The slowing down of long term growth in Asia: natural causes, the middle income trap and politics", School of Advanced International Studies, Johns Hopkins University.

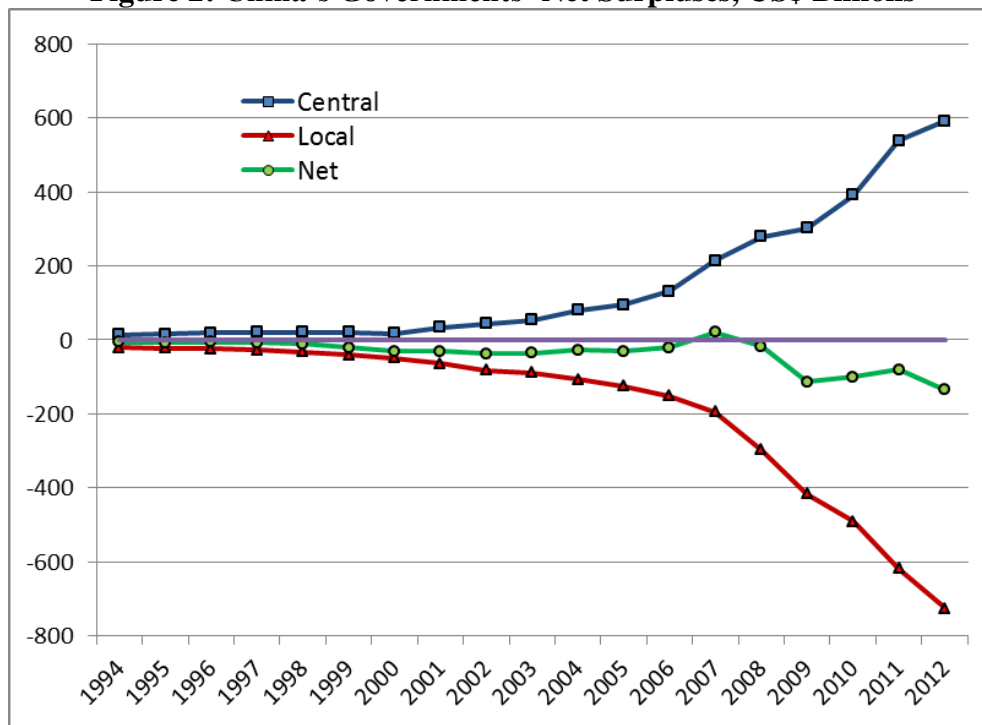
- Song, L., J. Yang and Y Zhang (2011), "State-owned enterprises' outward investment and the structural reform in China", *China and the World Economy*, 19(4): 38-53.
- Teles, P. and R. Zhou (2005), "A stable money demand: Looking for the right monetary aggregate", *Economic Perspectives*, Federal Reserve Bank of Chicago, Q I:50-63.
- Tseng, W., H.E. Khor, K. Kochhar, D. Mihaljek and D. Burton.(1994), "Economic reforms in China: a new phase", IMF Occasional Paper No. 114, Washington DC.
- Tyers, R. (2012), "Looking inward for transformative growth in China", CAMA Working Paper No. 15/2012, Centre for Applied Macroeconomics, Australian National University, Canberra, March.
- Tyers, R., Y. Bu and I. Bain (2008). "China's Equilibrium Real Exchange Rate: A Counterfactual Analysis." *Pacific Economic Review* 13: 17-39.
- Tyers, R. and T.C. Cheong (2013), "A Dynamic Global Model for Macroeconomic Analysis: Government debt, Reserves, Bilateral Asset Holdings and Sector Specificity", for presentation at the 16th Conference on Global Economic Analysis, Shanghai 12-14 June 2013, and CAMA Working Paper, February.
- Tyers, R., J. Golley, Y. Bu and I. Bain (2008), "China's economic growth and its real exchange rate", *China Economic Journal*, 1(2): 123 - 145, July.
- Tyers, R. and F. Lu (2008), "Competition policy, corporate saving and China's current account surplus", Working Papers in Economics and Econometrics No. 496, College of Business and Economics, Australian National University, July.
- Tyers, R. and Y. Zhang (2011), "Appreciating the *renminbi*", *The World Economy*, 34(2): 265-297, February.
- Tyers, R., Y. Zhang and T.S. Cheong (2013), "China's saving and global economic performance", Ch 6 in Garnaut, R., F. Cai and L. Song (eds,) *China: A New Model for Growth and Development*, Canberra: ANU E Press.
- Wen Jiabao (2007), *The Conditions for China to be able to Continue to Guarantee Stable and Rapid Economic Development*, www.npc.gov.cn, 16 March, accessed 28 October 2011.
- _____, (2011), *Report on Work of the Government*, www.npc.gov.cn, 5 March, accessed 24 March 2011.
- Wood, A. (1994), *North-South Trade, Employment and Inequality*, Oxford: Clarendon Press.

Figure 1: Trends in Chinese Private, Household and Corporate Saving, % GDP



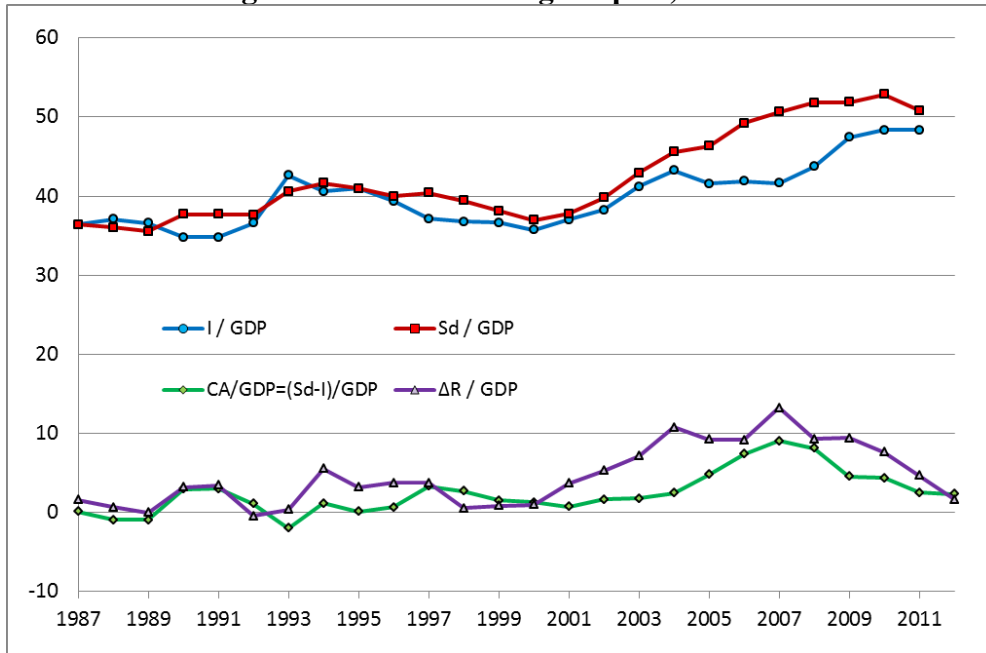
Sources: From national accounts statistics private saving is $S = Y_N - C - T$ and $S_H = S - S_C$, where Corporate saving, S_C , is from “flow of funds” data. These data are inconsistent, as noted by Ma and Yi (2010), though the latter is the only source for corporate saving. Flow of funds data on household saving suggests its value in 2009 was about 25% GDP.

Figure 2: China’s Governments’ Net Surpluses, US\$ Billions



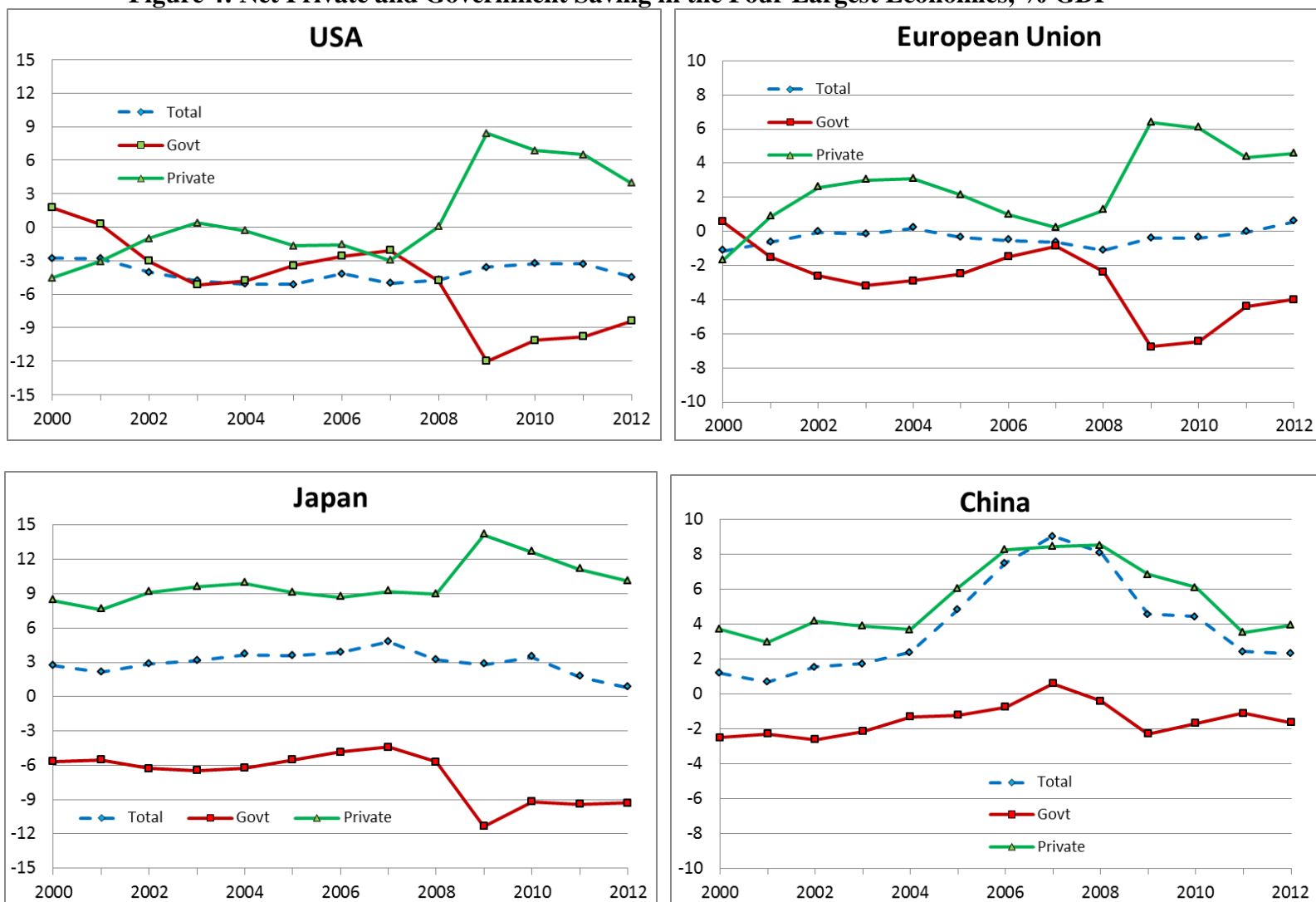
Sources: Government debt and general government gross debt position, IMF Fiscal monitor; External debt outstanding, Chinese statistical yearbook 2012

Figure 3: China's Saving Surplus, % GDP



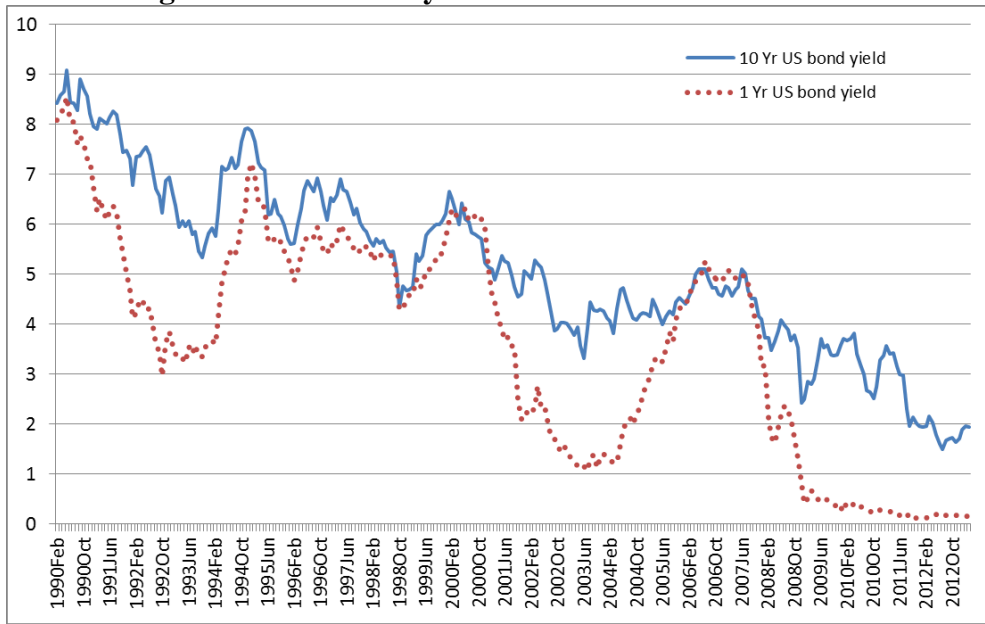
Sources: National Bureau of Statistics yearbook 2009-2012; IMF IFS data base. The value for the current account in 2012 is based on the trade balance and the authors' estimate of net factor income from abroad in that year.

Figure 4: Net Private and Government Saving in the Four Largest Economies, % GDP



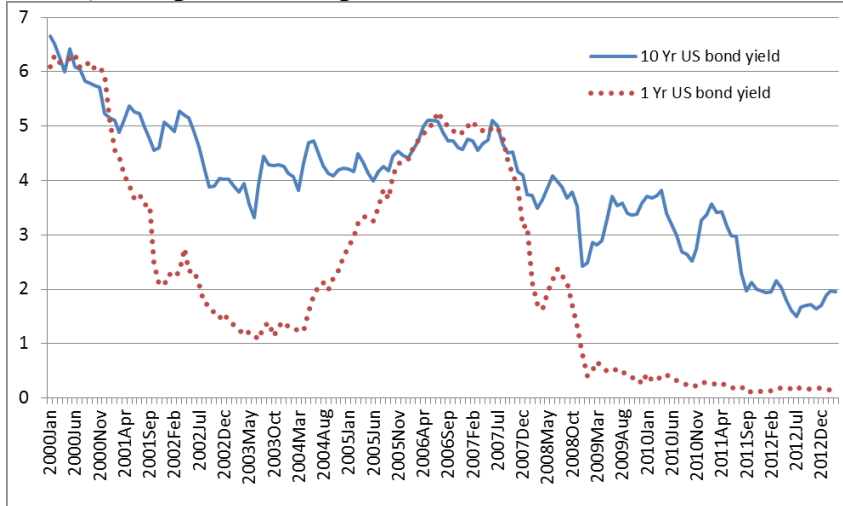
Sources: IMF IFS data base; Australia, ABS; China (Mainland, for 2012 authors' estimate is used for net factor income), NBS; USA, Bureau of Economic Analysis; Japan, BOJ; EU, Eurostat.

Figure 5: US Treasury Bond Yields over Two Decades

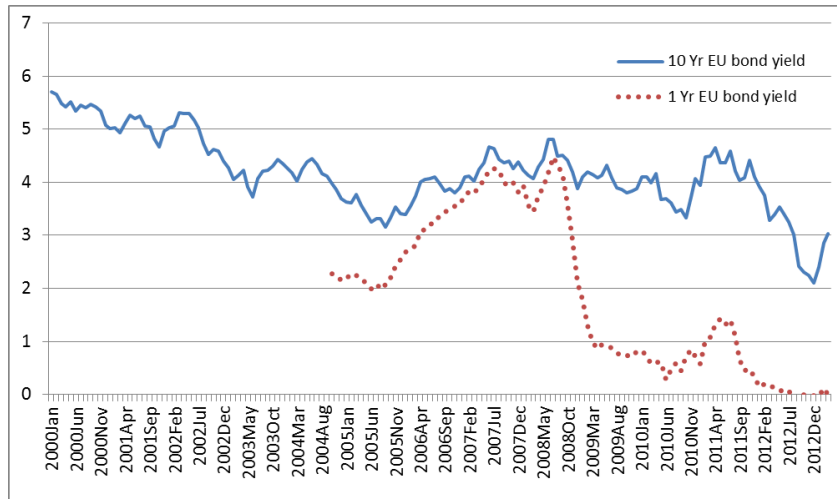


Source: US Treasury.

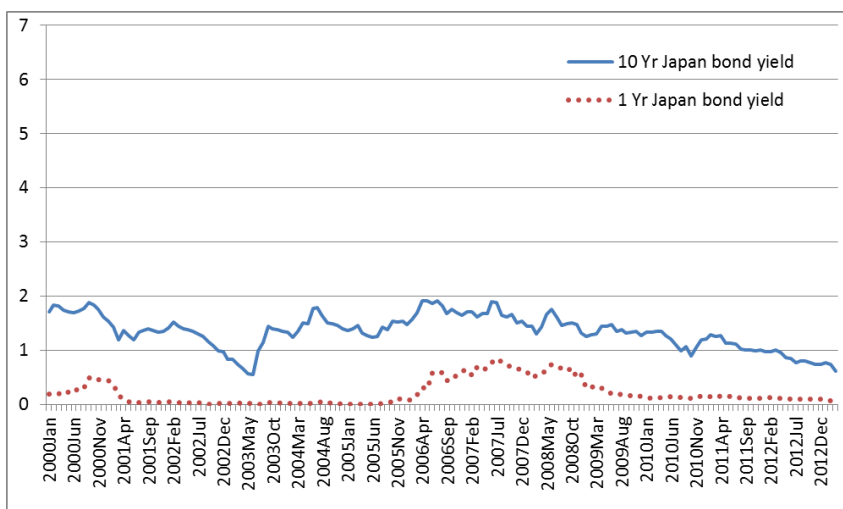
Figure 6: US, European and Japanese Government Bond Yields Since 2000



Source: US Treasury.

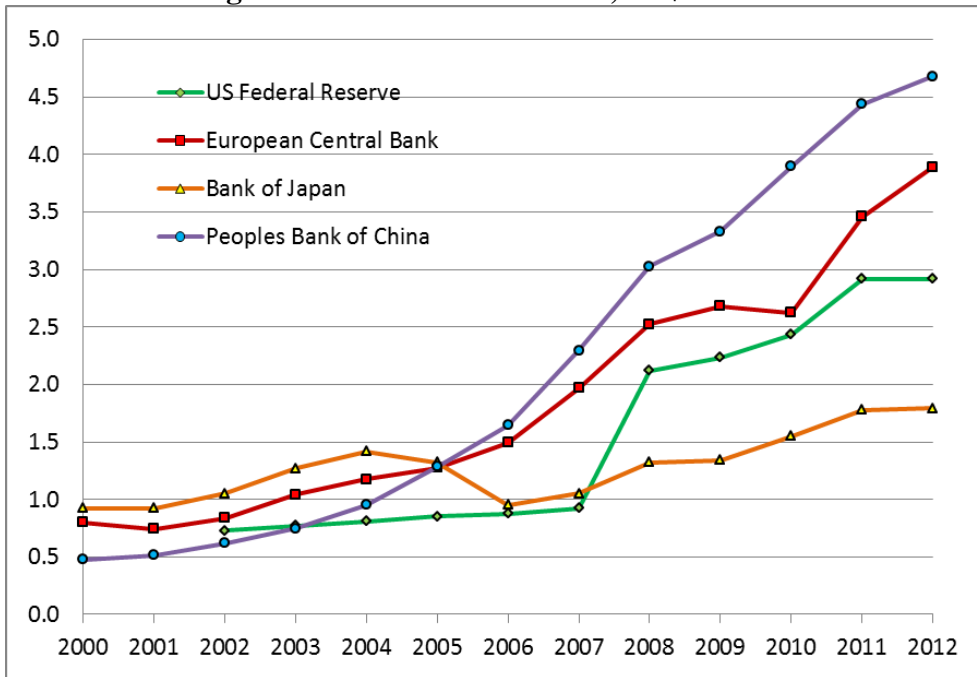


Source: European Central Bank.



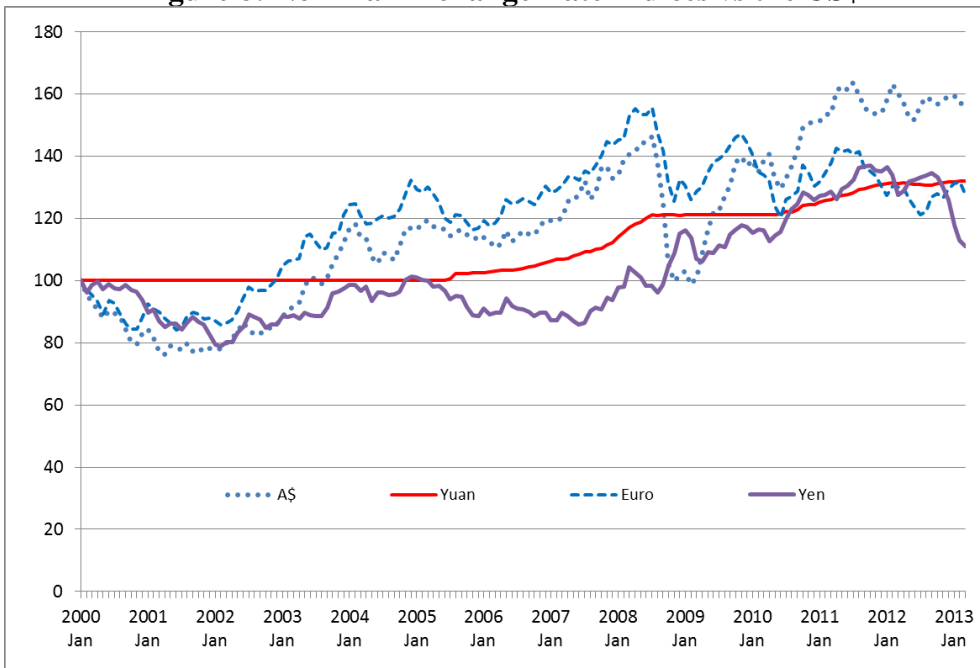
Source: European Central Bank, Reuters.

Figure 7: Central Bank Assets, US\$ trillions



Sources: EU, ECB; United States, Japan: St. Louis Federal Reserve Database; China, National Bureau of Statistics.

Figure 8: Nominal Exchange Rate Indices vs the US\$



Source: IMF IFS and Eurostat.

Table 1: Relative Economic Sizes of China and the Other Large Regions, ca 2011:

| % of world | China | US | EU(26) | Japan |
|------------------------------|-------|----|--------|-------|
| GDP | 11 | 22 | 26 | 9 |
| Consumption, C | 8 | 27 | 26 | 9 |
| Investment, I | 20 | 15 | 22 | 8 |
| Government spending, G | 7 | 20 | 30 | 10 |
| Exports, X | 17 | 17 | 25 | 7 |
| Imports, M | 15 | 21 | 23 | 8 |
| Total domestic saving, S^D | 19 | 13 | 20 | 9 |

Sources: National accounts data supply most of the elements though adjustments have been required to ensure that current accounts sum to zero globally, as do capital/financial accounts. The IMF-IFS database is the major source but there is frequent resort to national statistical databases.

Table 2: Simulation Closures^a

| Closure | |
|---------------------------------|--|
| Labour market closure: | Exogenous nominal wage in the US, EU, Japan and China, full employment elsewhere. |
| Fiscal policy closure: | Exogenous nominal government spending in US, EU and Japan and exogenous government <i>saving</i> elsewhere including China |
| Monetary policy targets: | Exogenous monetary base in every region, though price level and nominal GDP targets are possible. |

^a Since the model is a system of non-linear simultaneous equations and more variables are specified than equations in the system, there is flexibility as to the choice of those to make exogenous and this choice mirrors assumptions about the behaviour of labour markets, fiscal deficits and monetary policy targets.

Table 3: Experimental Shocks

| Scenario | Shocks, % | |
|--|-----------------------------|----|
| 1. Continued export led relative growth in 2011 with no policy response abroad | <i>All shocks to China</i> | |
| | Productivity, A^Y | 3 |
| | Consumption constant, A^C | -7 |
| | Capital stock, K | 5 |
| | Skill stock, S | 3 |
| | Nominal wage, W | 3 |
| | Monetary base, M^B | 15 |
| 2. Continued export led relative growth in 2011 with monetary expansions at home and in the US, EU and Japan | <i>Shocks to China</i> | |
| | Productivity, A^Y | 3 |
| | Consumption constant, A^C | -7 |
| | Capital stock, K | 5 |
| | Skill stock, S | 3 |
| | Nominal wage, W | 3 |
| | Monetary base, M^B | 15 |
| | <i>Other shocks</i> | |
| | US monetary base, M^B | 10 |
| | EU monetary base, M^B | 10 |
| Japan monetary base, M^B | 6 | |
| 3. China higher consumption only, no relative growth or policy response at home or abroad | <i>Shocks to China</i> | |
| | Consumption constant, A^C | 15 |
| 4. China slower relative growth with higher consumption share and home monetary response, no policy response abroad | <i>Shocks to China</i> | |
| | Productivity, A^Y | 1 |
| | Consumption constant, A^C | 15 |
| | Capital stock, K | 2 |
| | Skill stock, S | 2 |
| | Monetary base, M^B | 5 |

Table 4: Chinese Export Led Growth, ca 2011: Simulation Results

| % changes | US | EU(26) | Japan | China |
|---|-------------|-------------|-------------|------------|
| <i>1. China relative growth with monetary response at home but none abroad</i> | | | | |
| Real bond yield, r | -9.4 | -9.4 | -7.0 | -12.5 |
| Consumer price level, P^C | -5.5 | -5.7 | -3.2 | 0.8 |
| Producer price level, P^P | -5.2 | -5.7 | -3.5 | 0.7 |
| GDP price level, P^Y | -4.3 | -4.2 | -3.3 | -0.2 |
| Nominal exchange rate v US, E | 0.0 | -0.4 | -3.5 | -6.9 |
| Real exchange rate v US, e | 0.0 | -0.3 | -2.5 | -2.9 |
| Saving/GDP, S^D/Y | -38.9 | -20.1 | -14.6 | 8.7 |
| Real consumption, C/P^C | 5.6 | 5.6 | 2.5 | 0.2 |
| Real investment, I/P^P | -27.3 | -22.3 | -18.0 | 12.4 |
| Production employment, L | -6.3 | -6.9 | -4.2 | 5.3 |
| Real GDP, Y/P^Y | -1.1 | -1.3 | -0.8 | 7.7 |
| <i>2. China relative growth with monetary response at home and in US, EU, Japan</i> | | | | |
| Real bond yield | -16.2 | -16.5 | -13.7 | -16.5 |
| Consumer price level, P^C | -0.3 | -0.9 | -1.9 | -1.0 |
| Producer price level, P^P | 0.0 | -0.4 | -1.8 | -1.1 |
| GDP price level, P^Y | 0.2 | 0.2 | -1.7 | -1.7 |
| Nominal exchange rate v US, E | 0.0 | 0.3 | 1.2 | 0.1 |
| Real exchange rate v US, e | 0.0 | 0.3 | -0.7 | -1.8 |
| Saving/GDP, S^D/Y | -8.5 | -5.1 | -10.6 | 6.0 |
| Real consumption, C/P^C | 2.0 | 2.9 | 2.5 | 1.8 |
| Real investment, I/P^P | -7.1 | -6.2 | -11.5 | 10.7 |
| Production employment, L | 0.0 | -0.5 | -2.2 | 2.8 |
| Real GDP, Y/P^Y | 0.0 | -0.1 | -0.4 | 7.1 |

a These results are generated by the Gempack software from the closures and shocks listed in Tables 2 and 3.

Table 5: Larger Chinese Consumption, ca 2011: Simulation Results

| % changes | US | EU(26) | Japan | China |
|--|------------|------------|------------|-------------|
| <i>3. Larger Chinese consumption alone, no relative growth or policy response at home or abroad, measured relative to baseline</i> | | | | |
| Real bond yield, r | 9.0 | 8.8 | 6.6 | 1.7 |
| Consumer price level, P^C | 5.4 | 5.0 | 2.9 | 3.2 |
| Producer price level, P^P | 5.3 | 5.6 | 3.5 | -0.3 |
| GDP price level, P^Y | 4.5 | 4.2 | 3.3 | 1.1 |
| Nominal exchange rate v US, E | 0.0 | 0.7 | 3.7 | 2.4 |
| Real exchange rate v US, e | 0.0 | 0.5 | 2.6 | -0.9 |
| Consumption/GDP, C/Y | -5.1 | -4.5 | -3.0 | 10.3 |
| Saving/GDP, S^D/Y | 39.0 | 18.8 | 14.0 | -10.4 |
| Real consumption, C/P^C | -4.6 | -3.8 | -1.8 | 7.9 |
| Real investment, I/P^P | 24.7 | 18.9 | 15.6 | -4.9 |
| Production employment, L | 6.5 | 6.8 | 4.2 | -0.4 |
| Real GDP, Y/P^Y | 1.1 | 1.2 | 0.7 | -0.1 |
| <i>4. Larger Chinese consumption with slow relative growth and a home monetary response</i> | | | | |
| Real bond yield | 7.9 | 7.6 | 5.8 | -1.8 |
| Consumer price level, P^C | 4.7 | 4.1 | 2.4 | 4.1 |
| Producer price level, P^P | 4.7 | 4.8 | 3.0 | -0.1 |
| GDP price level, P^Y | 3.9 | 3.7 | 2.9 | 1.3 |
| Nominal exchange rate v US, E | 0.0 | 0.7 | 3.3 | 0.6 |
| Real exchange rate v US, e | 0.0 | 0.5 | 2.3 | -2.0 |
| Consumption/GDP, C/Y | -4.4 | -3.8 | -2.6 | 10.0 |
| Saving/GDP, S^D/Y | 33.7 | 15.8 | 12.1 | -9.3 |
| Real consumption, C/P^C | -3.9 | -3.0 | -1.4 | 9.5 |
| Real investment, I/P^P | 21.4 | 16.1 | 13.4 | -1.2 |
| Production employment, L | 5.7 | 5.8 | 3.7 | 0.5 |
| Real GDP, Y/P^Y | 1.0 | 1.0 | 0.6 | 2.6 |

a These results are generated by the Gempack software from the closures and shocks listed in Tables 2 and 3.

Appendix 1: Model Database

The structures of the regional economies are indicated in Table A1. They differ in important ways. The US has a high consumption share of GDP, China a low one. Necessarily, then, the US has a low saving share while China has a high one. Some regions are more dependent on indirect taxes than others, which makes a difference to the proportion of GDP made up of factor cost and hence the size of the household budget and the gap between producer and GDP prices. The EU is relatively dependent on indirect taxes, for example. Since these taxes (at least those accounted for in the model) fall most heavily on consumption, changes in saving behaviour have strong implications for fiscal deficits and, indirectly, for interest premia. Investment is larger in some than in others, being extraordinarily high in China. And then, of course there are the fiscal deficits that are largest in the US and Japan, and the current account surpluses or capital-financial account deficits in Japan and China, at least partly funding the very substantial deficit in the US.

Interactions between these large economies through trade are captured in the consumption expenditure matrix shown in Table A2. It is derived from the combination of national accounts with a matrix of trade flows. The flows are expenditures inclusive of indirect taxes, converted into the shares of total expenditure on goods and services by each country. Implicit, and consistent with the one-good per region model, is the assumption that investment and government spending make demands on the markets for home goods only. As it turns out, this assumption has important implications for the representation of China in the model. Since its consumption is comparatively low and its investment high, home products are mostly absorbed by investment and government spending and so China's consumption is distributed more evenly across regional goods than for the other economies. This suggests a case for an import-dependent capital goods industry in the model.

The financial interactions between the regions are indicated by the saving-to-investment flows in Table A3.⁴⁰ These show the expected Feldstein-Horioka (1980) behaviour but also that there are substantial financial interactions between the US, the EU and Japan in particular. The share of excess saving directed to the US might be expected to change due to the recent decline in reserve accumulation by China and its substitution with outward FDI that, most recently, has not been directed to the US (Tyers et al. 2013). Finally, a complete list of the behavioural parameters used in the model is provided in Table A4.

⁴⁰ Bilateral flows represent only those associated with asset acquisitions. Factor income flows, which depend on prior foreign asset holdings and are uninteresting in this comparative static framework, are excluded.

Table A1: Regional Economic Structure, 2011:

| % of GDP | US | EU(26) | Japan | China | Australia | RoW |
|-------------------------|--------|--------|--------|-------|-----------|--------|
| C | 0.712 | 0.580 | 0.605 | 0.450 | 0.536 | 0.550 |
| I | 0.155 | 0.191 | 0.200 | 0.410 | 0.275 | 0.240 |
| G | 0.171 | 0.217 | 0.204 | 0.114 | 0.177 | 0.199 |
| X | 0.139 | 0.175 | 0.151 | 0.285 | 0.217 | 0.200 |
| M | 0.177 | 0.163 | 0.161 | 0.259 | 0.204 | 0.189 |
| Indirect tax rev, T^I | 0.144 | 0.235 | 0.047 | 0.125 | 0.070 | 0.130 |
| Direct tax rev, T^D | 0.017 | 0.015 | 0.124 | 0.035 | 0.093 | 0.061 |
| Total tax rev, T | 0.161 | 0.250 | 0.171 | 0.160 | 0.163 | 0.191 |
| Private saving, S^P | 0.127 | 0.169 | 0.224 | 0.390 | 0.301 | 0.259 |
| Govt saving, S^G | -0.010 | 0.034 | -0.034 | 0.046 | -0.013 | -0.008 |
| Total saving, S^D | 0.155 | 0.191 | 0.200 | 0.410 | 0.275 | 0.240 |
| Monetary base, M^B | 0.133 | 0.114 | 0.220 | 0.411 | 0.134 | 0.250 |
| Capital stock, K | 3.317 | 3.414 | 4.239 | 2.740 | 4.027 | 2.000 |

Sources: National accounts data supply most of the elements though adjustments have been required to ensure that current accounts sum to zero globally, as do capital/financial accounts. The IMF-IFS database is the major source but there is frequent resort to national statistical databases.

Table A2: Shares of Consumption by Region of Origin, 2011^a

| % of row consn expenditure | US | EU(26) | Japan | China | Australia | RoW |
|----------------------------------|------|--------|-------|-------|-----------|------|
| US | 65.9 | 10.3 | 2.3 | 6.1 | 0.5 | 14.9 |
| EU(26) | 12.0 | 43.9 | 2.9 | 11.2 | 0.6 | 29.4 |
| Japan | 4.7 | 5.1 | 69.1 | 6.5 | 2.3 | 12.3 |
| China | 10.4 | 18.2 | 11.2 | 17.6 | 4.5 | 38.1 |
| Australia | 8.1 | 12.8 | 3.8 | 9.2 | 53.7 | 12.5 |
| Rest of world | 14.4 | 22.0 | 3.9 | 10.6 | 1.0 | 48.1 |

^a These shares sum to 100 horizontally. They are based on the 2011 matrix of trade flows combined with consumption expenditure data in each region. The resulting matrix is inconsistent as between data sources and so a RAS algorithm is used to force consistency of bilateral elements with national accounts data.

Sources: Implied trade flows are for 2011, drawn from the World Trade Organisation database.

Table A3: Shares of Total Domestic Saving Directed to Investment in Each Region, 2011^a

| % of row total saving | US | EU(26) | Japan | China | Australia | RoW |
|------------------------|------|--------|-------|-------|-----------|------|
| US ^b | 68.0 | 13.3 | 6.4 | 6.4 | 1.5 | 4.4 |
| EU(26) ^c | 12.9 | 80.1 | 2.3 | 2.3 | 0.9 | 1.5 |
| Japan ^d | 14.0 | 3.3 | 72.2 | 6.2 | 0.7 | 3.6 |
| China ^c | 9.2 | 0.6 | 0.9 | 81.1 | 0.1 | 8.0 |
| Australia ^e | 13.0 | 4.8 | 2.3 | 2.1 | 77.3 | 0.4 |
| Rest of world | 3.4 | 3.9 | 2.6 | 2.8 | 0.1 | 87.2 |

a These shares sum to 100 horizontally. They are based on 2011 investment flows. The original flow matrix is inconsistent with data on saving and investment from national accounts and so a RAS algorithm is used to ensure that row and column sums are consistent with other data. The row sums of the flow matrix are total saving by region and the column sums are total investment by region. These sums are sourced from the IMF-IFS database and the World Bank database.

b USA: values are based on official statistics, BEA.

c EU and China: indirect information from USA, Australian and Japanese statistics.

d Japan: estimated based on FDI data, assuming investment outflow=FDI*1.6. The ratio 1.6 is that of USA reported inward investment from Japan divided by Japanese reported outward FDI to the USA.

e Australia: Australian Bureau of Statistics "International Investment Position, Australia: Supplementary Statistics, 2011".

f ROW is a residual. Its saving is inferred from national accounts estimates and its investment abroad is determined to balance the matrix of financial flows.

Table A4: Parameters

| | US | EU(26) | Japan | China | Australia | RoW |
|---|------|--------|-------|-------|-----------|------|
| Production shares ^a | | | | | | |
| Labour, β^L | 0.18 | 0.18 | 0.18 | 0.26 | 0.18 | 0.24 |
| Skill, β^S | 0.47 | 0.47 | 0.47 | 0.24 | 0.47 | 0.21 |
| Capital, β^K | 0.35 | 0.35 | 0.35 | 0.50 | 0.35 | 0.55 |
| Income tax rates ^b | | | | | | |
| $t^L = t^S = t^K$ | 0.02 | 0.02 | 0.13 | 0.04 | 0.10 | 0.07 |
| Indirect tax rates ^c | | | | | | |
| t^C | 0.20 | 0.40 | 0.05 | 0.20 | 0.10 | 0.15 |
| t^M | 0.15 | 0.43 | 0.11 | 0.19 | 0.11 | 0.31 |
| t^X | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Money parameters ^d | | | | | | |
| Interest premium, λ^0 | 1.00 | 0.97 | 0.78 | 1.73 | 0.82 | 2.61 |
| Reserve ratio, ρ | 0.05 | 0.05 | 0.05 | 0.15 | 0.05 | 0.10 |
| Cash ratio, μ | 0.08 | 0.10 | 0.17 | 0.21 | 0.10 | 0.20 |
| Elasticities | | | | | | |
| C to r , ε^{CR} | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| C to Y^D , ε^{CY} | 0.94 | 1.03 | 0.82 | 0.93 | 1.25 | 0.88 |
| C_{ij}/C_{ik} , σ_i | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| Saving s_{ij}^S to r^e/r , ϕ_i | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| Premium to G/T , ϕ_i | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| m^D to y , ε^{MY} | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| m^D to $r+\pi^e$, ε^{MR} | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 | 0.60 |

a Production shares are based on demographic and occupational data from Tyers and Bain (2006), as well as estimates of factor incomes and capital stocks from the GTAP Database.

b These income tax rates are lower than observed because direct transfers and sovereign debt service are deducted from income tax revenue so that observed fiscal balances are consistent with $T-G$, where G includes only expenditure on goods and services.

c Although export taxes appear in the modelling, no values are applied since such taxes are usually very indirect. To infer the rates for other indirect taxes, approximate rates are initially chosen for the consumption tax rate and the import tax rate is then determined for consistency with the data on indirect tax revenue. In regions where other indirect taxes are major contributors to revenue, this tends to inflate the values of t^C and t^M .

d The money parameters are crude characterisations, made on the assumption that the EU behaves as if it had a single central bank to cover all 26 members. Money demand parameters stem from a survey of estimates used in other models (including McKibbin and Wilcoxon 1995, Knell and Stix 2006, Teles and Zhou 2005 and Tseng et al. 1994).

e Consumption elasticities are consistent with a variety of estimates in use in other models, both of marginal propensities and elasticities (including McKibbin and Wilcoxon 1995 and Jin 2011).

Appendix 2: Model Operation

Comparative static analysis using the model requires that a set of shocks be applied to exogenous policy variables or behavioural parameters. These “levers” are listed in Table A5. Associated closure choices available in the model are listed in Table A6. These allow the choice of labour market equilibrium, fiscal policy regime and the target of monetary policy.

Table A5: Exogenous Variables for Experimentation

| Policy | Instrument | |
|----------------------|---|------------|
| Tax rates | Labour income tax | t_L |
| | Capital income tax | t_K |
| | Consumption tax (GST) | t_C |
| | Import tariff | t_M |
| | Export tax | t_X |
| Fiscal policy | Government spending or the fiscal surplus, <i>US\$ trillion</i> | G, S_G |
| Monetary policy | Monetary base, <i>US\$ trillion</i> | M_B |
| | Reserve ratio | ρ |
| Expectations factors | Consumer price inflation | π^e |
| | Real appreciation | γ^e |
| | Nominal disposable income | Y^{De} |
| Productivity | TFP | A^Y |
| Saving | Preference shifter | A^C |

Table A6: Closure Choices and Policy Regimes

| | In each case, holding fixed or exogenous one of: | |
|-----------------|--|-------|
| Labour market | Nominal wage | W |
| | Labour use | L |
| Government | Nominal expenditure | G |
| | Fiscal surplus | $T-G$ |
| Monetary target | Monetary base | M^B |
| | Consumer price level | P^C |
| | GDP price level | P^Y |
| | Producer price level | P^P |
| | Exchange rate | E |
| | Nominal GDP | Y |