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## International Effects of China's Rise and Transition: Neoclassical and Keynesian Perspectives

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### Abstract

Opinion over the global implications of China's rise is divided between critics, who see it as having developed at the expense of both investment and employment in the US, Europe and Japan and proponents who emphasise improvements in the 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. The criticism implies Keynesian assumptions while proponents take a neoclassical perspective. In this paper, both are embodied in a simple global, short run, macro model that 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 policy regimes. For the US and Europe, China's successful export-oriented growth is shown to offer net benefits, though there are partially offsetting Keynesian effects that have caused considerable distributional stress. Its recent, slower, more consumption focussed growth is shown to be unambiguously beneficial in those regions and in Japan.

## **Keywords**

China, International Trade, International Finance

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# **International Effects of Chinas Rise and Transition: Neoclassical and Keynesian Perspectives**

## **Abstract**

Opinion over the global implications of China's rise is divided between critics, who see it as having developed at the expense of both investment and employment in the US, Europe and Japan and proponents who emphasise improvements in the 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. The criticism implies Keynesian assumptions while proponents take a neoclassical perspective. In this paper, both are embodied in a simple global, short run, macro model that 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 policy regimes. For the US and Europe, China's successful export-oriented growth is shown to offer net benefits, though there are partially offsetting Keynesian effects that have caused considerable distributional stress. Its recent, slower, more consumption focussed growth is shown to be unambiguously beneficial in those regions and in Japan.

## **1 Introduction**

The rise of China and other Asian, heretofore developing, economies since the 1980s has not only underwritten global economic performance but, by cheapening traded light manufactures and supplying substantial excess savings, it has conferred on the developed regions terms of trade gains in both product and financial markets.<sup>1</sup> Real interest rates on long term instruments peaked in the mid-1980s and have fallen since, in part because of this relative increase in global savings supply. Yet 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. Moreover, in the US and Europe at least, through no fault of China's, the cheap credit tended to flow into debt-financed consumption, property and government spending rather than to productive investment (Chinn et al. 2012).

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 after the GFC. It has become clear that the export-led growth model is unsustainable for China, for two 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, the demographic contraction that has already occurred in Japan is now imminent in China. It will reduce the

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<sup>1</sup> The terms of trade gain transmitted financially has been commonly referred to as the Asian "savings glut". To the extent that the glut extended beyond Asia, the major contributors were the petroleum-exporting countries. See Bernanke (2005), Chinn and Ito (2007), Choi et al. (2008) and Ito (2009).

availability of surplus agricultural workers, raising labour costs and slowing productivity growth. The more inward-focussed alternative will be slower because new growth-sustaining reforms must now venture into politically sensitive areas, including the heretofore protected heavy manufacturing and services sectors and the *hukou* system that constrains labour mobility. Moreover, political stability will dictate that more attention be paid to environmental costs and to controlling income inequality. Importantly, 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.<sup>2</sup>

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 excess saving, now offers the rest of the world shocks that are the opposites of the Asian shocks in the decades since. Where those were deflationary in the developed world, inducing substantial and continuing monetary expansions, these will be inflationary. The inflationary pressure will stem from rising real rates of return that cause private portfolios to cease hoarding money, raising liquidity and price levels. Thus, as a source of reflation, rising Chinese consumption could be one of the Keynesian stimuli required to rescue demand and reduce unemployment queues in the advanced economies. Moreover, it would increase their saving and therefore their investment. For these reasons, and because of the extraordinary scale of sovereign debt in the developed regions, there will be pressure on monetary authorities to accommodate this inflation (Rogoff 2013).<sup>3</sup>

This paper offers a brief review of both the empirical and the modelling literatures concerning the global impact of China's growth to date, along with an analysis of both its retrospective and prospective impacts that employs a simple global macroeconomic model. The model is structured so as to quantify international effects that stem, on the one hand, from purely neoclassical changes to the product and financial terms of trade and, on the other, from shifts in factor demand in the presence of Keynesian sticky wages. The results confirm that the effects of Chinese policy on the developed regions are large (Eickmeier and Kuehnlitz 2013) and they

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<sup>2</sup> Japan's long time and substantial excess savings, embodied in its current account surplus, has been trending down in recent years and it fell to zero in the fourth quarter of 2012.

<sup>3</sup> A potential downside not considered in this paper has central banks choosing to soak up the new liquidity by shedding the non-traditional assets acquired via quantitative easing (QE). Because the long instruments are extensively traded internationally and held by Asian savers, who will not be in the market for more, this will make sharper and more global the rise in underlying real interest rates. Moreover, this rise 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 now absorbs at least a tenth of government revenue (OECD Economic Outlook 89 Database).

suggest that both critics and proponents are correct in that the US, the EU and Japan did lose employment and investment as a consequence of China's rise while at the same time they enjoyed valuable terms of trade gains. With compensation for the displaced and unemployed, however, the pre-transition pattern of China's expansion yielded net real income gains in these regions. It is further suggested that the impending Chinese transition to slower, more inward-looking growth will be unambiguously beneficial to the US, the EU and Japan and of sufficient magnitude that it could help draw their economies out of stagnation.

The section to follow reviews the empirical and modelling literatures on China's global impacts. Section 3 then briefly describes the pre-GFC pattern of China's growth, the reasons for a transition toward more inward-focussed growth and the consequences of this for China's consumption and saving. The model used for quantitative analysis is then presented in Section 4 and assessments both of pre-GFC growth shocks and post-transition shocks are described in Section 5. Conclusions are offered in Section 6.

## **2. The Debate over China's Global Impact**

The modern literature on the effects in developed regions of trade with developing ones surged in the late 1980s following a deterioration in the labour market performance of low-skill US and European workers. An extensive survey, grounded in the Stolper-Samuelson Theorem, was offered early on by Wood (1994). The subsequent literature broadened and can be thought of as divided amongst labour economics, global general equilibrium analysis and the combination of applied macroeconomics and international finance.

### **Labour studies**

The early empirical studies of the links between trade and US labour market performance were by Bound and Johnson (1992), Borjas and Ramey (1994), Berman et al. (1994) and Leamer (1996). These studies apportioned the blame for low wages or low employment of production workers variously between trade with developing countries (including "outsourcing") on the one hand and labour-saving technical change on the other, with all attributing at least part of the effect to trade. After China's accession to the WTO in 2001, its growth accelerated and it became the dominant developing trading partner. The empirical literature on labour market effects was then resurgent, noting that while production worker performance in the US had been poor from the 1980s into the early 1990s, the performance of all US salary earners (bar the top one per cent) deteriorated after 2000 (Haskell et al. 2012). This new stylised fact has

motivated the emergence of labour theories that depend on new models with heterogeneous workers and heterogeneous firms (Helpmann et al 2010, Autor et al. 2013). These tend to suggest a greater role for trade with China than the earlier empirical literature. Yet this literature addresses only labour market outcomes and not whether the developed regions are overall net gainers or losers from China's expansion.

### **Global general equilibrium analysis**

The comparative narrowness of the empirical labour approach motivated general equilibrium analysts to address the issue of wage inequality as well as economy-wide net gains or losses from Asian expansion. Global numerical models were used with neoclassical structures, for the most part ignoring the nominal rigidities common in the developed regions. The literature begins with Krugman (1995) and proceeds to the decomposition analysis by Tyers and Yang (1997), which suggested that high Asian growth had been welfare improving in the developed economies and that (calibrated) technical change was more important than trade in determining labour market performance.<sup>4</sup> The labour market results proved, however, to be quite sensitive to the characterisation of technology in global models. If, for example, imports from Asia are significantly differentiated from local products and substantial non-traded service sectors are represented, terms of trade (and hence real income) gains dominate substitution effects, even for low-skill workers (Tokarick 2005). Moreover, in both the developed economies and the growing Asian developing economies wage distribution effects were shown to depend on capital-skill complementarity (Tyers and Yang 2000, Winchester and Greenaway 2007).<sup>5</sup>

Subsequent assessments include that by Dimaranan et al. (2007), which finds gains and losses across other developing regions stemming from growth in China and India, but little net effects on the developed regions. More innovative modelling is offered by Harris et al. (2011) and Harris and Robertson (2013). They incorporate endogenous skill acquisition and they focus on comparative steady state analysis. The models remain neoclassical, however, emphasising product terms of trade effects. This is not to say they neglect the loss of manufacturing jobs in the developed regions. Sectoral employment changes are very much evident in association with the Rybczynski re-allocations that facilitate net gains in response to changes in the terms of trade. But they do neglect nominal rigidities and the financial terms of trade gain enjoyed by the developed regions, as net borrowers, from Asia's excess saving. Overall, the newer

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<sup>4</sup> A similar conclusion is drawn from dynamic global modeling by McKibbin and Woo (2003).

<sup>5</sup> A useful survey of global modeling assessments to this point is by Winchester (2006).

modelling studies continue to find net welfare gains in the developed regions stemming from growth in Asia in general, and in China in particular.<sup>6</sup>

### **Applied macroeconomics and international finance**

The early applied macroeconomic assessments of China's growth are divided between those seeing a sustainable global order with export-oriented growth at the expanding "periphery" (Dooley et al. 2003, 2005) and those seeing impending problems associated with the imbalances emerging from the Asian "savings glut" (Eichengreen 2004, Bernanke 2005, Lee and McKibbin 2007, Chinn et al 2012). At the same time the critics of China's growth strategy emphasised capital market distortions, exchange rate management and myriad other interventions by the all-pervasive Chinese state to accord Chinese firms unfair advantage and to raise exports and investment at the expense of household consumption (Lardy 2006, Bergsten et al. 2008, Lardy 2012).

As Chinn et al. make clear, the result was rapid growth in China as it moved previously underemployed workers into low wage, export-oriented manufacturing while sustaining industrial and social structures that fostered high household and corporate saving. This had modest effects on the developed regions until the last decade, when the scale of China's economy began to rival their own. By then the flipside in the developed regions was high unemployment, slow wage growth but cheap credit, giving rise to asset price booms that ultimately destabilised banking systems, leaving behind an overhang of now-public debt that will be immiserizing in the medium term. This literature is akin to that on developed region labour markets in its focus on the dark side of China's emergence. It is supported by considerable empirical research but all of its elements have not as yet been addressed directly using global modelling.<sup>7</sup>

### **3. China's Domestic Transition: Slower Growth and Less Excess Saving**

Although its rate of expansion during its three decades of reform has been spectacular, it is only in the last decade that China's 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

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<sup>6</sup> This and related growth modeling work is surveyed by Robertson (2013).

<sup>7</sup> Some of these elements have been incorporated in a recent global modeling exercise by the World Bank (2013). This study emphasizes the shift in "global economic weight" toward high-saving Asian economies and suggests that this shift will more than offset life-cycle induced declines in saving rates in both Asia and the developed world. It covers many countries and does not address in detail the changes occurring in both China and Japan, where the erosion of saving will be proportionally largest and most globally significant.



dominate world trade in light manufactures.<sup>8</sup> 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).

Looking forward, there is not the scope for the rest of the world to absorb export growth from China at historical rates. Moreover, there has been an accelerated rise in Chinese labour costs, foreshadowing a Lewis "turning point"<sup>9</sup>, 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. Superficially, it would seem that a switch from export-oriented to inward-focused growth should be possible, just by sustaining high investment and substituting consumption for exports. But this simple idea is problematic because the growth to date has emphasised light manufacturing, while China's growing middle class demands quality products and services that are as yet poorly represented in its production basket. To diversify China's output toward these products requires major reform of its heavy manufacturing and services sectors and investment in associated human capital.<sup>10</sup>

Yet there is potential for substantial new growth from domestic sources. This stems, in particular, from the extension of industrial reforms into hitherto protected heavy manufacturing and services industries, where reductions in costs and prices could have major stimulatory effects 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. Oligopoly rents earned in these sectors are linked to corporate saving (Kuijs 2006, Song et al. 2011), which was 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 2012). Thus, the extension of the industrial reform process should both generate further growth and reduce corporate and hence overall saving. This trend toward reduced Chinese saving will be further reinforced by other factors, not least the ageing of China's workforce and the fact that

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<sup>8</sup> According to trade data from [data.worldbank.org](http://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.

<sup>9</sup> 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.

<sup>10</sup> 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).

an increasing proportion of Chinese retirees are leaving private sector positions and so must save for their own retirement. Moreover, although the central government is a net saver, provincial government deficits have expanded in recent years to more than offset this, leaving a trend toward increasing government net borrowing. Consider these factors in more detail.

### **Excess Saving**

National saving includes that by households, corporations and government. Savings that exceed the value of domestic private and public investment (“excess savings”) 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),  $\Delta R$  is official foreign reserve accumulation,  $CA$  is the current account balance and  $N$  is net foreign income factor income.<sup>11</sup>  $FI$  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).<sup>12</sup> 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.

#### *Household saving*

The pattern and time trend of household saving in China and other Asian economies is analysed by Horioka and Wan (2007) and 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. China, this suggests, is in the declining phase; a point with which Yang (2012) agrees, suggesting a range of mainly social and trade policy reforms that will see reduced incentives for household saving many of which are stated priorities of the new Chinese government. Moreover, recent studies question China’s official statistics on consumption expenditure, suggesting that it is larger and

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<sup>11</sup> 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  $S=S_{HH}+S_C$ .

<sup>12</sup> The substitution between reserve accumulation, which takes the form of low-yielding foreign (mostly US) 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. This point is not considered here but is taken up by Sheng (2011) and Tyers et al. (2013).

growing more quickly than indicated.<sup>13</sup> Thus, there is much to suggest a declining path for China's household saving rate. One opposing voice is that of Wei and Zhang (2011), who identify a link between saving and entrepreneurship effort on the one hand and China's increasingly inflated sex ratio on the other. The coincidence of son preference and sexual selection technology has seen a rise in the number of unmatched men and increasingly competitive behaviour by families with sons. Debate continues about the strength of this force for higher saving against those associated with policy reforms in the education, health and retirement insurance industries.

#### *Corporate saving*

National accounts "flow of funds" data show corporate saving to be fairly stable at about a fifth of GDP through 2009. In the period since, and 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.

#### *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.<sup>14</sup> 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 in effect, debt has been underwritten centrally. The comparatively recent development in this lending is an expansion in the share directed to

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<sup>13</sup> Garner and Qiao (2013), for example, suggest that Chinese consumption expenditure is officially underestimated by US\$ 1.6 trillion and that it is now expanding rapidly.

<sup>14</sup> 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.

provincial governments to finance local public investment.<sup>15</sup> As shown in Figure 1, 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.

#### *Excess saving relative to investment*

The above discussions lead us to expect a declining trend in China's total domestic saving rate though this is not yet fully represented in the official statistics, which thus far show only a slight decline since 2010. Since then, however, total (private and public) investment has risen 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 2 and it confirms the prediction by Lee and McKibbin (2007) that investment would contribute substantially to China's "rebalancing". The result has been a contracting current account surplus in the post-GFC period, though China's surplus remained the single largest across individual countries in 2012.<sup>16</sup>

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 national post-GFC stimulus policy, the preference on the part of commercial banks to lend to protected provincial governments and SOEs and the substantial excess supply of saving, bottled up in the home market by capital controls. All three conditions should fade through time, so that the implications for future excess saving will then depend on the differences between the rates of decline of private 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, the prospect of further social and industrial reform and the mounting evidence that consumption expenditure is growing faster than officially estimated.

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

<sup>16</sup> IMF, *IFS Database*.

#### 4. Assessing Chinese Growth Shocks Pre and Post Transition

The approach taken is to estimate the effects on the developed regions of pre-transition, export oriented Chinese growth shocks and compare these with the corresponding effects of anticipated post-transition shocks that exhibit slower growth and reduced excess saving. For this purpose it is sufficient to employ short run comparative statics. The analysis therefore addresses short run departures from the underlying long run growth path of the global economy.<sup>17</sup> An elemental multi-region general equilibrium structure is used that allows the option of neoclassical and Keynesian closures.

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.<sup>18</sup> 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 physical capital across the regions.<sup>19</sup> The details are as follows.

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<sup>17</sup> The usual assumptions in comparative static macroeconomics are therefore reasonable: fixed stocks of physical capital and the absence of a steady state, allowing real net rates of return on physical capital and bond yields to differ.

<sup>18</sup> The EU is modeled as the full 26 and it is assumed that this collective has a single central bank.

<sup>19</sup> 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 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:

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

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. Region  $i$ 's nominal GDP is then

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

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:

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

### 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  $\tau^K = (1 + t^K)$  and total direct tax revenue is:

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

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. 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:

$$(7) \quad c_i = \frac{C_i}{P_i^C} = A_i^C \left( \frac{r_i}{\tau_i^K} \right)^{-\varepsilon_i^{CR}} \left( \frac{Y_i^D}{P_i^C} \right)^{\varepsilon_i^{CY}} \left( \frac{Y_i^{De}}{P_i^C [1 + \pi_i^e]} \right)^{\varepsilon_i^{CY}},$$

where the expected inflation rate of consumer prices is  $\pi^e$ . 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 products from all regions:

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

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  $\tau_i^C$ ,  $\tau_i^M$  and  $\tau_j^X$  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 as US\$ per unit of home currency.<sup>20</sup>

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:

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

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:

<sup>20</sup> US currency is the numeraire in the model.

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

### *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 in real volume terms:

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

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, spending by the government is assumed to be directed only at home goods.<sup>21</sup> 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, in home currency.

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

### *The direction of saving to investment at home and abroad*

Here the modelling departs from convention by incorporating explicit portfolios of regional assets. Data on regional saving and investment for 2011 is first combined with that on international financial flows to construct an initial matrix to allocate total domestic 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,  $r$ . Expected real rates of return depend on the current real rate of return on installed capital and, via interest parity, expected changes in real exchange rates:

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

where  $P_i^K$  is the price of capital goods, which are not distinguished from the regional good in this model. Shocks to the exogenous factor,  $\gamma_i^e$ , can represent changes in either the relative cost of capital goods or in the expected real exchange rate.

The household of region  $i$  has a portfolio manager who allocates its annual saving to new region-specific investments,  $s_{ij}^S S_i^D$ , which could be debt or equity issued in regions  $j$ , such that  $\sum_j s_{ij}^S = 1$ .<sup>22</sup> Because the newly issued equity or debt is differentiated across regions based on un-modelled and unobserved region-specific properties, their services are combined via a constant elasticity of substitution (CES) function specific to each regional portfolio manager.

<sup>21</sup> In the model database, direct transfers are netted from direct tax revenue, so that  $T-G$  is the true fiscal surplus.

<sup>22</sup> The manager does not re-optimize over *total* holdings every year. This is because the model is deterministic and risk is incorporated only via exogenous premia, so the motivations for continuous short run rebalancing, other than the arrival of new saving, are not represented.

The function covers investment by region  $i$  in region  $j$ . So region  $i$ 's household portfolio management problem is:

$$(21) \quad \max_{s_{ij}^S} U_i^F = S_i^D \left[ \sum_j \alpha_{ij} (s_{ij}^S)^{-\rho_i} \right]^{-\frac{1}{\rho_i}} \text{ such that } \sum_j s_{ij}^S = 1.$$

Here  $\alpha_{ij}$  is a parameter that indicates the significance of region  $i$ 's investment in region  $j$ . The CES parameter,  $\rho_i$ , reflects the preparedness of region  $i$ 's household to substitute between the assets it holds. To induce rebalancing in response to changes in rates of return the parameters, the  $\alpha_{ij}$  are made dependent on Tobin's Q like ratios of after-tax expected rates of return on installed capital in destination regions,  $j$ , and current market real interest rates in the region of origin,  $r_j^{ce}$  and  $r_i$ , via:<sup>23</sup>

$$(22) \quad \alpha_{ij} = \beta_{ij} \left( \frac{r_j^{ce} / \tau_j^K}{r_i / \tau_i^K} \right)^{\lambda_i} \quad \forall i, j, \quad \lambda_i > 0 \quad \forall i.$$

This relationship indicates the responsiveness of portfolio preferences to rates of return, via the (return chasing) elasticity  $\lambda_i$ . The augmented allocation problem becomes:

$$(23) \quad \max_{s_{ij}^S} U_i^F = S_i^D \left[ \sum_j \beta_{ij} \left( \frac{r_j^{ce} / \tau_j^K}{r_i / \tau_i^K} \right)^{\lambda_i} (s_{ij}^S)^{-\rho_i} \right]^{-\frac{1}{\rho_i}} \text{ such that } \sum_j s_{ij}^S = 1.$$

Solving for the first order conditions we have, for region  $i$ 's investments in regions  $j$  and  $k$ :

$$(24) \quad \frac{s_{ij}^S}{s_{ik}^S} = \left( \frac{\beta_{ij}}{\beta_{ik}} \right)^{\frac{1}{1+\rho_i}} \left( \frac{r_j^{ce} / \tau_j^K}{r_k^{ce} / \tau_k^K} \right)^{\frac{\lambda_i}{1+\rho_i}}.$$

This reveals that region  $i$ 's elasticity of substitution between the bonds of different regions is  $\sigma_i^l = \lambda_i / (1 + \rho_i) > 0$ . This elasticity has two elements. The return-chasing behaviour of region  $i$ 's household is captured by  $\lambda_i$  and the imperfect substitutability of regional bonds, and therefore the sluggishness of portfolio rebalancing, is represented by the CES parameter  $\rho_i$ .

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<sup>23</sup> Note that region  $i$ 's market bond yield,  $r_i$ , is determined concurrently and indicates the replacement cost of capital in region  $i$  and therefore the opportunity cost for region  $i$ 's household of investment in region  $j$ .

The optimal share of the saving of region  $i$  that is allocated to equity or bonds in region  $j$  then follows from (24) and the normalisation condition, that  $\sum_k s_{ik}^S = 1$ :

$$(25) \quad s_{ij}^S = \frac{1}{\sum_k \left( \frac{\beta_{ik}}{\beta_{ij}} \right)^{\lambda_i} \left( \frac{r_k^{ce}/\tau_k^K}{r_j^{ce}/\tau_j^K} \right)^{\sigma_i^I}} .$$

The key matrix for calibration is  $[\beta_{ij}]$ . These elements are readily available, first, by noting that only relative values are required and hence, for each region of origin,  $i$ , one value can be set to unity, and second, by making the assumption that the initial database has the steady state property that the net rates of return in regions  $j$  are initially the same as the market bond yield,  $r_j$ . Then, since in the base data  $r_{ij}^{e0} = r_j^0$ ,  $r_{ik}^{e0} = r_k^0$ , the  $\beta_{ij}$ s are available from a modified (24):

$$(26) \quad \frac{\beta_{ij}}{\beta_{ik}} = \left( \frac{s_{ij}^{S0}}{s_{ik}^{S0}} \right)^{\frac{\lambda_i}{\sigma_i^I}} \left( \frac{r_j^0/\tau_j^K}{r_k^0/\tau_k^K} \right)^{\lambda_i} .$$

Note that the tax rate on capital income would not enter this relationship if investment were financed in the destination region, since it is assumed the tax would apply to all types of financial capital earnings incurred in that region, at the same rate. The assumption here, however, 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  $j$ 's 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 elasticities  $\lambda_i$  and  $\sigma_i^I$ .

### *Global financial equilibrium and real financing interest rates*

The sum of investment spending worldwide must equal the sum of domestic saving worldwide, each valued in US\$.

$$(23) \quad \sum_i I_i E_i = \sum_i S_i^D E_i .$$

This condition determines a global interest rate to clear financial markets,  $r^W$ .<sup>24</sup> Regional financing yields are then set relative to this rate using an interest premium factor,  $\varphi_i$ , that is defined relative to  $r_{US}$  ( $\varphi_{US} = 1$ ), and the effects of varying sovereign risk are incorporated via dependence on the fiscal balance:

$$(24) \quad r_i = r^W \varphi_i, \quad \varphi_i = \varphi_i^0 \left[ \frac{\left( \frac{G_i}{T_i} / \frac{G_{US}}{T_{US}} \right)}{\left( \frac{G_i^0}{T_i^0} / \frac{G_{US}^0}{T_{US}^0} \right)} \right]^{\phi_i}, \quad \forall i \neq "US",$$

where the quotient is unity in the initial data and  $\varphi^0$  represents the initial interest premium factor relative to the US.  $\phi_i$  is an elasticity indicating sensitivity to sovereign risk.

### *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:

$$(25) \quad X_i - M_i + \sum_{j \neq i} \left( s_{ji}^S S_j^D \frac{E_j}{E_i} \right) - \sum_{j \neq i} \left( s_{ij}^S S_i^D \right) = 0, \quad \forall i \neq "US"$$

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

### *Regional money market equilibrium*

A cash-in-advance constraint is assumed to generate 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.

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

<sup>24</sup> Since investment in this model is simply allocated saving, equations (22) and (23), combined with the normalisation condition on the shares, might be thought of as forming a tautology (global saving = global saving), and this would be the case in a real model with a single numeraire. Here the key condition is that the global financial market must clear in a single currency. In this case, when there are more than two regions, the equations are not tautological and meaningful results emerge for the global market clearing interest rate.

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  $\rho_i$  is the reserve to deposit ratio and  $\mu_i$  is the cash to deposit ratio.

### *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.

$$(27) \quad e_i = \frac{P_i^Y}{\left( \frac{P_{US}^Y}{E_i} \right)} = E_i \frac{P_i^Y}{P_{US}^Y}.$$

### **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. 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. This analysis is undertaken using two different closures, as indicated in Table 2. The first is neoclassical, with nominal wages sufficiently flexible in all regions to clear labour markets and no changes to nominal government saving, the latter implying that any changes in revenue from taxes at exogenous rates is committed to government expenditure. The second is Keynesian, with rigid nominal wages of production

workers in the US, EU, Japan and China and 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. While closures with price level and other targets are available, in the results presented monetary policy responses are introduced via exogenous shocks.

Expectations over prices, exchange rates and rates of return are assumed myopic throughout. Solutions with model-consistent expectations over price levels, exchange rates and private disposable incomes tend to give rise to the same stories and patterns of results. Since, in any case, the truth about expectation formation lies in between the myopic and the model-consistent, the discussion focusses on the myopic. The results show that the effects of changes to output and consumption preferences in China on performance in the other regions can be substantial. Conventional and post-transition Chinese growth patterns are considered in turn.

### **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. They are roughly representative of the observed changes in China in the pre-transition period, with substantial contributions from productivity and capital accumulation.<sup>25</sup> The shock to consumption captures the observed decline in the share of consumption expenditure and the rise in the share of private savings in GDP. In the first experiment, shocks are applied only to China and these are to productivity, consumption behaviour and the stock of capital and skill. In addition, there is a Chinese monetary expansion that allows for domestic inflation at a rate that is roughly representative of the pre-transition period. In the second simulation, monetary responses are also allowed in the large developed regions, even though these regions enjoy no comparative growth shocks. The magnitude of these expansions is set to arrest the deflation in the US and EU and to reduce but not eliminate it in Japan, where active deflation (mainly of producer prices and the GDP deflator) continued throughout the pre-transition period.

#### *Implications of Chinese growth under neoclassical assumptions*

Two simple stories dominate the results, which are summarised in Table 4. First, with no shocks to the economies outside China, including to money supplies, the Chinese comparative

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<sup>25</sup> The capital accumulation and productivity shares of China's recent growth are controversial (Krugman 1994). The numbers used here are broadly consistent with the meta-analysis by Wu (2011).

growth shocks advance global supply and so are deflationary abroad. China's expansion arises purely from the increases in productivity and factor endowments. In the US and EU the terms of trade improves substantially, as indicated by its real appreciation against China, and this contributes to their "bottom line" increases in real income. The same is not true of Japan, which does not enjoy a terms of trade gain relative to China. The second story is that increased Chinese excess saving reduces global and regional long term interest rates, also quite substantially. This induces a substitution toward money in portfolios, causing deflation in the other regions.<sup>26</sup> The lower interest rates also increase consumption and reduce saving in these regions and hence their levels of investment decline, with negative consequences for future growth that are not modelled here.

Returning to China's real exchange rates, while it is true that they indicate the change in the terms of trade, their role is yet more subtle. The growth shocks and monetary expansion in China deliver a nominal depreciation relative to the other major currencies, which is not surprising given the fixed money supplies abroad. But the terms of trade is just one of two main forces affecting China's real exchange rate, reflecting the fact that more Chinese output lowers the relative value of Chinese products in global markets. 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 substantial outflow of reserves and 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.<sup>27</sup> In the end, the results show that the second force is dominated by the first when output growth is strong.

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<sup>26</sup> 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.

<sup>27</sup> The opposite pattern emerges from the simulation analysis of financial capital flows by Tyers, Golley, Bu and Bain (2008). 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. The characterization of China's consumption spending as more internationally open than its saving is accurate as a characterisation of China's comparative structure, though it is accentuated in the model used here by the lack of multiple products and input-output behaviour and hence by the absence of China's "value chain" links with other developing economies.

When monetary responses are allowed in the large developed regions bond-buying by central banks further reduces real interest rates. The monetary expansions required are large, considering that there is no real growth in these economies. With mitigated deflation their real consumption growth rises less and so the losses in real saving and investment are smaller. Nominal incomes rise in the US and the EU with their monetary expansions and the real purchasing power of these incomes over their home consumption bundles rises, albeit more modestly.

#### *Implications of Chinese growth under Keynesian assumptions*

Here the nominal wage is set as exogenous in China and the developed regions. In China, allowance is made for representative growth in the nominal wage of production workers as part of the growth shocks.<sup>28</sup> Again, two simple stories dominate the results, which are summarised in Table 5. First, with no shocks to the economies outside China, including to money supplies, the Chinese comparative growth shocks advance global supply and so are deflationary abroad. This deflation reduces private revenues relative to labour costs and so employment and output fall there. The second story is as for the neoclassical case: increased Chinese excess saving reduces global long term interest rates, inducing a substitution toward money in portfolios and therefore adding a further deflationary force in the other regions. 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. The immediate impact on their economies is a substantial negative employment shock and reduced real GDP. Yet the terms of trade gain is so large that the purchasing power over their home consumption bundle is still expanded, at least for the US and the EU. Thus, these regions are net gainers from pre-transition Chinese growth, but the impacts are domestically unequal.

When monetary responses are introduced in the large developed regions, the real contractions in those regions are eliminated or greatly reduced. With smaller employment losses the neoclassical effects are more dominant and the net real income gains more substantial. Of course, this is excepting the Japan, where, as observed, the monetary expansion is insufficient to eliminate all deflation. As before, the relative abundance of Chinese goods is the dominant force. In the long run, however, the net short run gains from the terms of trade change might be expected to be offset by the effective diversion of investment to China.

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<sup>28</sup> The nominal wage shock indicated in Table 3 is smaller than the recorded growth in Chinese average wages. In this model, production workers are homogeneous and the skilled wage is endogenous and is lifted substantially by the growth shocks.



## **Effects of slower Chinese growth and higher consumption beyond 2011**

This analysis combines slower productivity and factor accumulation changes with a single shock to Chinese preferences that boosts consumption and reduces saving (Table 3).<sup>29</sup> The preference shock might be thought of as stemming from the combination of life cycle changes and the social 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). An accompanying monetary expansion is introduced that is just sufficient to deliver modest growth in the real production wage of unskilled workers (or, in the Keynesian analysis, modest increases in production employment).

### *Implications of Chinese post-transition growth under neoclassical assumptions*

As the summary in the third block of Table 4 suggests, the shift to faster consumption growth, in particular, has marked effects on economic performance abroad. The two stories of the previous growth discussion now emerge in reverse. 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 nominal money supplies this causes modest but positive inflation which boosts firm revenues and nominal wage costs equally. The higher interest rates also induce private agents in the other regions to reduce consumption and this raises both saving and investment.<sup>30</sup> The opposite occurs in China, so there is a significant relocation of economic activity from China to the developed regions even though, under the neoclassical closure, the volume of output is unaltered everywhere. 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, albeit modest, terms of trade gain in the other regions.

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<sup>29</sup> If a major contributor to China's recent productivity growth is the conversion of rural workers into urban employees, and if the conversion rate is to slow substantially, so also will overall productivity growth. The slowdown assumed here is consistent with the analysis by Feng and Yang (2013), though this is not to deny that considerable potential remains for further productivity growth, even in China's manufacturing sector (Hsieh and Klenow 2009)..

<sup>30</sup> 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.

### *Implications of Chinese post-transition growth under Keynesian assumptions*

These results, presented in the third block of Table 5, offer a more realistic context in which the change in Chinese consumption behaviour might take place. Yet, for the developed regions at least, the pattern of the results is the same as in the neoclassical case. The Chinese consumption surge is a significant Keynesian stimulus in the other regions. The interest rate rise and portfolio rebalancing again cause modest inflation that is, by assumption, not resisted by central banks. This time, workers are drawn out of unemployment, raising real output by up to a per cent and employment by substantially more. Saving and investment in the developed regions rise more substantially.<sup>31</sup> For China, however, the results differ in that the home interest rate actually falls and this induces much less Chinese inflation, thus avoiding the substantial nominal depreciation observed in the neoclassical case. This occurs because China's interest premium falls due the departure from the neoclassical assumption of fiscal balance. China is comparatively dependent on indirect taxes and these bear mainly on consumption. So when consumption is raised relative to other forms of expenditure on GDP, government revenue increases substantially. With fixed nominal government spending this yields a substantial surplus that reduces the premium.

The real exchange rate changes are similar, with the relative growth shocks ensuring continued relative abundance of Chinese products reinforcing the demand switching effects to yield a modest Chinese real depreciation, conferring on the other regions a modest terms of trade gain. When the results from the final simulation are compared directly with those of the second (in Table 5), the shift from continued export-led, low-consumption growth to more inward-focussed growth in China is seen to cause Chinese real GDP 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 Table 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. This large gain notwithstanding, the effects of China's

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slowdown on the real purchasing power of incomes is very positive for Japan but the US and the EU did better under employment-robbing pre-transition growth. What this suggests is that net real income gains to the US and EU from economic change in China will continue, but with added benefits in the post-transition period from growing employment and hence less distributional stress.

### **Contrasting neoclassical and Keynesian Assumptions**

A summary of the results under neoclassical and Keynesian closures is offered in Table 6. The omission of Keynesian employment effects does not significantly distort the estimated net real income gains from pre-transition Chinese growth, at least as to direction. It does, however, reverse the sign of net effects on real income in the US and EU from post-transition Chinese growth. If, under Keynesian assumptions, central banks in the US, the EU and Japan allow the projected inflation there, then the employment gains are sufficient to more than offset the terms of trade losses. Both model formulations agree as to the direction of the effects due to the Chinese transition, at least when measured in terms of real incomes. The employment gains in the US, the EU and Japan, along with the increases in saving and investment indicated in Tables 4 and 5, suggest that the outlook beyond China's transition will be positive for all the developed regions.

On the other hand, China's modern sector will add fewer workers each year and enjoy significantly slower yet still positive output growth, with the real purchasing power of national income over the home consumption bundle stagnating. Indeed, though not shown in the tables, the comparative rise of consumer price inflation in China would erode gains in the real consumption wage there, even though the unit cost of low-skill labour to firms rises. Clearly, in the new era the distributional stress will fall on China rather than the older developed regions.

## **6. Conclusion**

A substantial literature has developed on the effects of China's growth on other regions the labour and macroeconomics components of which suggest pessimism as to foreign gains. The global modelling component of this literature has been neoclassical in orientation and so focussed on terms of trade gains that have stemmed from China's cheap light manufacturing exports and its excess saving. It has therefore been comparatively sanguine about the global benefits from China's rise. In this paper the Keynesian or "job stealing" aspect of Chinese

growth is incorporated in a simple short run global model to shed light on the comparative effects of terms of trade and employment changes.

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). The simulation results show that the effects of China's growth on the terms of trade and employment in the developed regions are indeed in conflict, yet at least for the US and the EU, there are positive net gains in real income, irrespective of the monetary responses of these regions. The key effect of China's growth is to confront these regions with distributional stress and therefore major policy challenges.

Because the economic performance of its main trading partners has been poor in the decade since its accession to the WTO, and particularly 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. 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 combined with faster consumption growth. The consequences of this for the other large economies with which China trades have both neoclassical and Keynesian elements.

Since China (and, indeed, the collective of China and Japan) will soon cease to be net purchasers of foreign sovereign debt, bond yields will rise globally, coming 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 and a tendency to inflation which, if allowed by central banks, could deliver a significant stimulus in the languid economies of the developed regions, sufficient to raise real GDP growth by a percentage point. 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. In the unlikely event

that Chinese semi-redundant rural workers are still available in sufficient numbers this would imply that the flow to modern sector employment slows by 16 million.

While these effects appear to be dominated by Keynesian employment redistribution, the same analysis with a neoclassical closure delivers a largely consistent bottom line, at least when welfare is measured by the purchasing power of national incomes over home consumption bundles. The post-transition growth pattern in China tends to resolve the earlier conflict of forces abroad so that the US, the EU and Japan are projected to enjoy increases in both employment and real national incomes.

In the interpretation of these results a number of issues arise that are the subject of on-going research. First, the distribution of government revenue burdens over direct and indirect taxes, and amongst the forms of indirect tax, is quite important in determining the projected behaviour of consumer, producer and GDP price levels. The abstraction adopted here, that indirect taxes fall on consumption and imports only, may prove to be a strong one as it affects the behaviour of both firms and households in important ways. Second, the model assumes a single homogeneous good in each region, side-stepping the popular issue of “value chain” effects in China’s trade behaviour. In association with this, there is some enlargement of the role of Chinese consumption in providing foreign stimulus. These aspects of the results require validation empirically and via simulations using a more detailed model, though they do not discount the main message, that the neoclassical global modelling work on the impacts of Chinese growth cannot be discounted and that post-transition Chinese growth should offer the rest of the world further stimulus in a mix that is less inclined to create distributional conflict.

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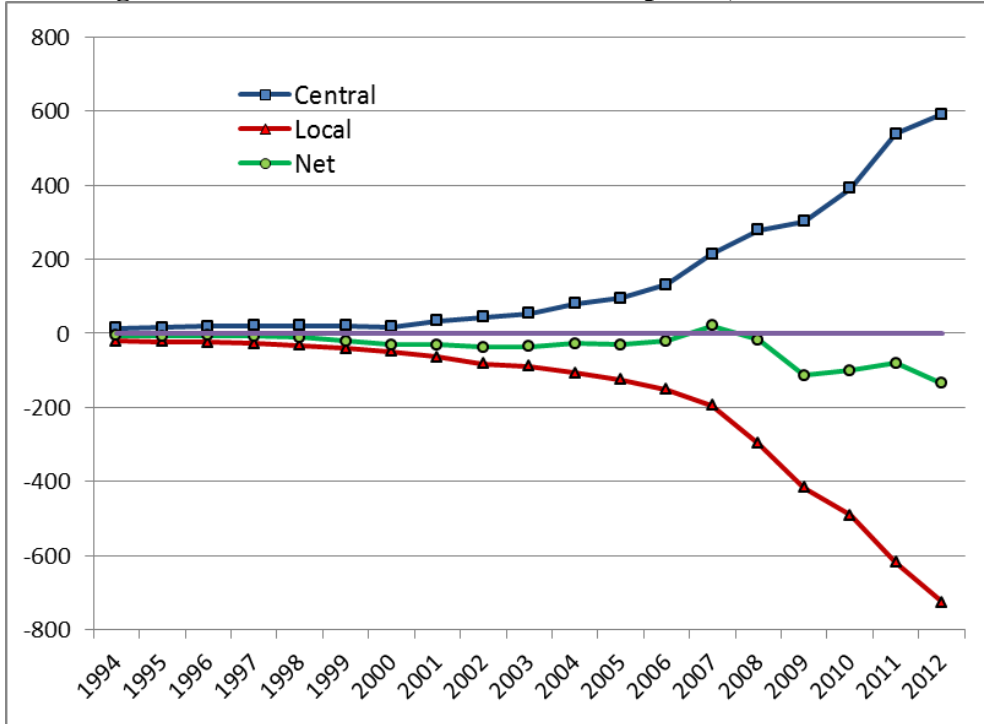
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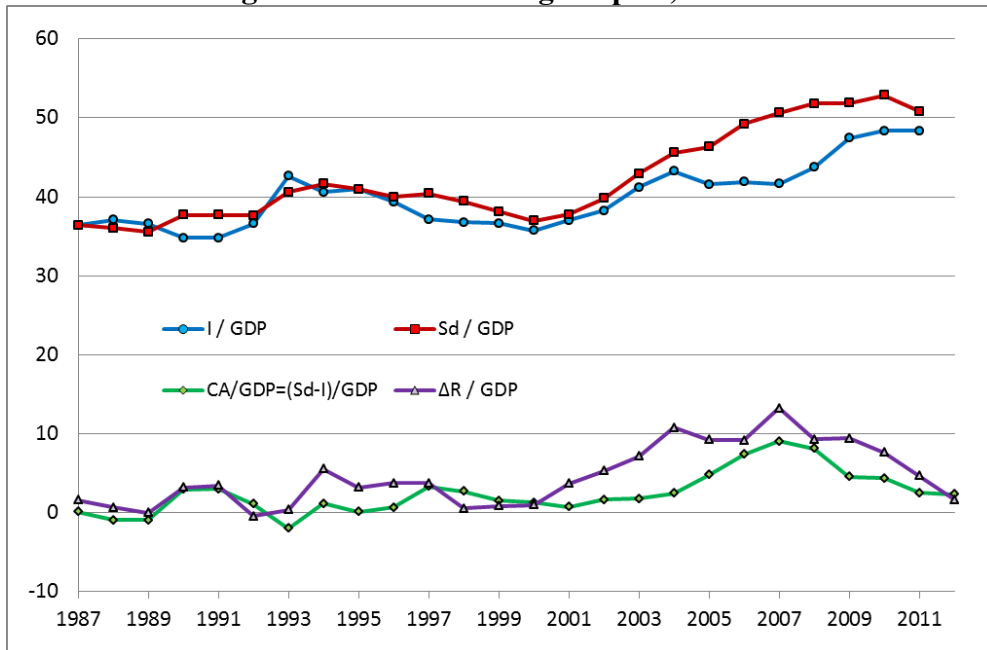
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**Figure 1: China's Governments' Net Surpluses, US\$ Billions**



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

**Figure 2: 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.

**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<sup>a</sup>**

Closure	
<b>Labour market:</b>	
<b>Keynesian</b>	Exogenous nominal wage in the US, EU, Japan and China
<b>Neoclassical</b>	Full employment of all factors everywhere
<b>Fiscal policy closure:</b>	
<b>Keynesian</b>	Exogenous nominal government spending in US, EU and Japan
<b>Neoclassical</b>	Exogenous government saving everywhere
<b>Monetary policy targets:<sup>b</sup></b>	Exogenous monetary base in every region <sup>c</sup>

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.

b Money is neutral in the neoclassical closure.

c Money supplies can be set to target price levels, nominal exchange rates or nominal GDP levels. Indeed, for the three large developed regions monetary policy could be set to the usual inflation target (a CPI expanding by 2-3%) but those regions, and particularly Japan, failed to meet this target during China's pre-GFC growth phase and so the money supply is set exogenous and subjected to idiosyncratic shocks.

**Table 3: Experimental Shocks**

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

<sup>a</sup> Nominal wages are endogenous in the neoclassical closure and so are not shocked. The Chinese nominal wage is shocked with the Keynesian closure only to allow for observe increases.

**Table 4: Chinese Growth Shocks with Neoclassical Closure: Simulation Results**

% changes	US	EU(26)	Japan	China
<i>1. China relative growth with monetary response in China but none abroad</i>				
Real bond yield, $r$	-9.4	-9.4	-8.7	-8.3
Consumer price level, $P^C$	-6.6	-6.6	-4.7	3.5
Producer price level, $P^P$	-6.3	-7.1	-5.2	4.6
GDP price level, $P^Y$	-5.3	-5.3	-5.0	3.3
Nominal exchange rate v US, $E$	0.0	-0.5	-3.4	-10.3
Real exchange rate v US, $e$	0.0	-0.5	-3.1	-2.1
Saving/GDP, $S^D/Y$	-46.5	-23.7	-16.7	10.2
Real consumption, $C/P^C$	7.8	7.7	4.4	-2.9
Real investment, $I/P^P$	-29.1	-23.1	-18.5	10.8
Production employment, $L$	0.0	0.0	0.0	0.0
<b>Real output (GDP), <math>Y/P^Y</math></b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>6.3</b>
<b>Nominal income (GDP), <math>Y</math></b>	<b>-5.3</b>	<b>-5.3</b>	<b>-5.0</b>	<b>9.8</b>
<b>Real income <math>Y/P^C</math></b>	<b>1.4</b>	<b>1.4</b>	<b>-0.3</b>	<b>6.1</b>
<i>2. China relative growth with monetary response in China and in US, EU, Japan</i>				
Real bond yield, $r$	-16.0	-15.6	-15.6	-15.3
Consumer price level, $P^C$	-0.3	-0.8	-3.3	-0.1
Producer price level, $P^P$	0.1	0.0	-3.3	0.3
GDP price level, $P^Y$	0.4	0.6	-3.1	-0.4
Nominal exchange rate v US, $E$	0.0	0.2	2.4	-0.8
Real exchange rate v US, $e$	0.0	0.4	-1.2	-1.6
Saving/GDP, $S^D/Y$	-10.2	-7.0	-14.0	6.0
Real consumption, $C/P^C$	2.0	3.1	4.2	0.6
Real investment, $I/P^P$	-8.7	-8.1	-13.6	9.1
Production employment, $L$	0.0	0.0	0.0	0.0
<b>Real output (GDP), <math>Y/P^Y</math></b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>6.3</b>
<b>Nominal income (GDP), <math>Y</math></b>	<b>0.4</b>	<b>0.6</b>	<b>-3.1</b>	<b>5.8</b>
<b>Real income <math>Y/P^C</math></b>	<b>0.6</b>	<b>1.4</b>	<b>0.2</b>	<b>6.0</b>
<i>3. Post transition China relative growth with strong consumption and a Chinese monetary response</i>				
Real bond yield, $r$	4.1	4.2	3.8	9.2
Consumer price level, $P^C$	3.0	2.9	2.1	10.0
Producer price level, $P^P$	3.0	3.3	2.4	7.8
GDP price level, $P^Y$	2.5	2.6	2.3	8.3
Nominal exchange rate v US, $E$	0.0	0.3	1.6	-6.3
Real exchange rate v US, $e$	0.0	0.3	1.4	-1.1
Saving/GDP, $S^D/Y$	19.3	9.4	6.9	-5.9
Real consumption, $C/P^C$	-3.1	-2.8	-1.7	4.7
Real investment, $I/P^P$	11.9	9.0	7.3	-0.4
Production employment, $L$	0.0	0.0	0.0	0.0
<b>Real output (GDP), <math>Y/P^Y</math></b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>2.5</b>
<b>Nominal income (GDP), <math>Y</math></b>	<b>2.5</b>	<b>2.6</b>	<b>2.3</b>	<b>11.0</b>
<b>Real income <math>Y/P^C</math></b>	<b>-0.5</b>	<b>-0.3</b>	<b>0.3</b>	<b>0.9</b>

a These results are from the model described in the text and the closures and shocks listed in Tables 2 and 3.

**Table 5: Chinese Growth Shocks with Keynesian Closure: Simulation Results**

<i>1. China relative growth with monetary response in China 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
<b>Real output (GDP), <math>Y/P^Y</math></b>	<b>-1.1</b>	<b>-1.3</b>	<b>-0.8</b>	<b>7.7</b>
<b>Nominal income (GDP), <math>Y</math></b>	<b>-5.4</b>	<b>-5.4</b>	<b>-4.1</b>	<b>7.5</b>
<b>Real income <math>Y/P^C</math></b>	<b>0.14</b>	<b>0.27</b>	<b>-0.9</b>	<b>6.7</b>
<i>2. China relative growth with monetary response in China and in US, EU, Japan</i>				
Real bond yield, $r$	-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	-10.8	5.7
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
<b>Real output (GDP), <math>Y/P^Y</math></b>	<b>0.0</b>	<b>-0.1</b>	<b>-0.4</b>	<b>7.1</b>
<b>Nominal income (GDP), <math>Y</math></b>	<b>0.2</b>	<b>0.1</b>	<b>-2.1</b>	<b>5.3</b>
<b>Real income <math>Y/P^C</math></b>	<b>0.6</b>	<b>1.0</b>	<b>-0.2</b>	<b>6.3</b>
<i>3. Post transition China relative growth with strong consumption and a Chinese monetary response</i>				
Real bond yield, $r$	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
Saving/GDP, $S^D/Y$	32.2	15.1	11.7	-9.0
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
<b>Real output (GDP), <math>Y/P^Y</math></b>	<b>1.0</b>	<b>1.0</b>	<b>0.6</b>	<b>2.6</b>
<b>Nominal income (GDP), <math>Y</math></b>	<b>4.9</b>	<b>4.7</b>	<b>3.6</b>	<b>3.9</b>
<b>Real income <math>Y/P^C</math></b>	<b>0.3</b>	<b>0.6</b>	<b>1.2</b>	<b>-0.2</b>

a These results are from the model described in the text and the closures and shocks listed in Tables 2 and 3.

**Table 6: Employment and Real Income Effects of China's Transition**

% changes	US	EU(26)	Japan	China
<b>Neoclassical analysis only</b>				
Real income $Y/P^C$				
<i>Chinese growth, no foreign monetary response</i>	1.4	1.4	-0.3	6.1
<i>Chinese growth, foreign monetary response</i>	0.6	1.4	0.2	6.0
<i>Post-transition Chinese growth</i>	-0.5	-0.3	0.3	0.9
<i>Difference due to the transition</i>	-1.1	-1.7	0.1	-5.1
<b>Including Keynesian effects</b>				
<i>Pre-GFC Chinese growth without monetary response</i>				
Production employment, $L$	-6.3	-6.9	-4.2	5.3
Real income $Y/P^C$	0.1	0.3	-0.9	6.7
<i>Pre-GFC Chinese growth with monetary response</i>				
Production employment, $L$	0.0	-0.5	-2.2	2.8
Real income $Y/P^C$	0.6	1.0	-0.2	6.3
<i>Post-transition Chinese growth</i>				
Production employment, $L$	5.7	5.8	3.7	0.5
Real income, $Y/P^C$	0.3	0.6	1.2	-0.2
<i>Difference due to the transition</i>				
Production employment, $L$	5.7	6.3	5.9	-2.3
Real income, $Y/P^C$	-0.3	-0.4	1.3	-6.5

a These summaries are based on Tables 4 and 5.



## 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.<sup>32</sup> 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.

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<sup>32</sup> 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<sup>a</sup>**

% 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

<sup>a</sup> 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<sup>a</sup>**

% of row total saving	US	EU(26)	Japan	China	Australia	RoW
US <sup>b</sup>	68.0	13.3	6.4	6.4	1.5	4.4
EU(26) <sup>c</sup>	12.9	80.1	2.3	2.3	0.9	1.5
Japan <sup>d</sup>	14.0	3.3	72.2	6.2	0.7	3.6
China <sup>c</sup>	9.2	0.6	0.9	81.1	0.1	8.0
Australia <sup>e</sup>	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 <sup>a</sup>						
Labour, $\beta^L$	0.18	0.18	0.18	0.26	0.18	0.24
Skill, $\beta^S$	0.47	0.47	0.47	0.24	0.47	0.21
Capital, $\beta^K$	0.35	0.35	0.35	0.50	0.35	0.55
Income tax rates <sup>b</sup>						
$t^L = t^S = t^K$	0.02	0.02	0.13	0.04	0.10	0.07
Indirect tax rates <sup>c</sup>						
$t^C$	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 <sup>d</sup>						
Interest premium, $\varphi^0$	1.00	0.97	0.78	1.73	0.82	2.61
Reserve ratio, $\rho$	0.05	0.05	0.05	0.15	0.05	0.10
Cash ratio, $\mu$	0.08	0.10	0.17	0.21	0.10	0.20
Elasticities						
$C$ to $r$ , $\varepsilon^{CR}$	0.10	0.10	0.10	0.10	0.10	0.10
$C$ to $Y^D$ , $\varepsilon^{CY}$	0.94	1.03	0.82	0.93	1.25	0.88
$C_{ij}/C_{ik}$ to $P_j^C/P_k^C$ , $\sigma_i$	2.00	2.00	2.00	2.00	2.00	2.00
$s_{ij}^S/s_{ik}^S$ to $r_j^{ce}/r_k^{ce}$ , $\sigma_i^l$	2.00	2.00	2.00	2.00	2.00	2.00
Premium to $G/T$ , $\phi_i$						
$m^D$ to $y$ , $\varepsilon^{MY}$	1.00	1.00	1.00	1.00	1.00	1.00
$m^D$ to $r+\pi^e$ , $\varepsilon^{MR}$	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	$\rho$
Expectations factors	Consumer price inflation	$\pi^e$
	Real appreciation	$\gamma^e$
	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	$Y$