THE AUSTRALIAN NATIONAL UNIVERSITY

WORKING PAPERS IN ECONOMICS AND ECONOMETRICS

Projected Economic Growth in China and India: The Role of Demographic Change*

Rod Tyers, Jane Golley and Iain Bain

College of Business and Economics
Australian National University

November 2006

Working Papers in Economics and Econometrics No. 477
Australian National University

ISBN: 086831 477 3

Key words:
China, India, demographic change and economic growth

JEL codes:
C68, E27, F43, J11, O53

* Funding for the research described in this paper is from Australian Research Council Discovery Grant No. DP0557889. Thanks are due to Siew Ean Khoo and Ming Ming Chan for assistance in developing the demographic sub-model, and to Terrie Walmsley for technical help with the GTAP Database and the migration data as well as for useful discussions on the subject of baseline simulations.

Projected Economic Growth in China and India:

The Role of Demographic Change*

Abstract:

Within the next decade, China's labour force will begin to contract, while that of India will expand faster than its population. Relative labour abundance will bring higher capital returns and an increasing share of global FDI to India. Yet China may relax its One Child Policy further and India's fertility could follow the pattern elsewhere in Asia and decline faster than expected. These linkages are explored using a global demographic sub-model that is integrated with an adaptation of the *GTAP-Dynamic* global economic model in which regional households are disaggregated by age and gender. Even with a two-child-policy, China's growth is projected to slow in future with India becoming the fastest growing economy in the world on the strength of its continued population expansion. While GDP depends positively on fertility and per capita income negatively in both countries, the price of more GDP growth in terms of lost per capita income is lower in China than in India, a result that depends critically on India's initially higher fertility, its higher youth dependency and the age-gender pattern of its participation rates. India therefore has considerably more to gain, at least in per capita terms, from further reducing its fertility.

1. Introduction

As the third decade of Chinese economic reforms draws to an end, its remarkable growth performance appears almost unstoppable. Between 1995 and 2005, GDP and per capita GDP grew at average annual rates of 8.8% and 8.0% respectively. The central government's ambition to raise the level of GDP in 2020 to four times the level in 2000, which requires an annual growth rate of 7.2%, seems well within reach. India's economic reforms began in earnest in the early 1990s, and like China's, signal a systemic shift towards an increasingly market-driven economy. Despite the fact that India's average annual GDP growth performance of 6% in the last decade was enviable by virtually any standards, Indian authorities have increased their growth target to 8%, indicating some degree of disappointment with the growth rates achieved in the first decade of reforms (Ahluwalia, 2002). In both countries, there is no question that achieving high and sustainable rates of GDP growth is a major policy objective.

In China, a potential threat to GDP growth in the future is its low fertility and the associated ageing of its population. The United Nations (2005) projects a rise in the proportion of over 60s in China's population from 10% in 2000 to 20% in 2025, and further to 31% by 2050. Meanwhile, the proportion of the population of working age (15-59 years) is predicted to fall from 65% in 2000 to 62% in 2025 and 53% in 2050. By 2020, the growth of the working age population will be negative, suggesting that GDP growth will suffer as a consequence. India, by contrast, began the millennium with a much younger population than China. Its aged population was only 7.5% of the total population in 2000 and is predicted to rise to 12% in 2025 and 21% in 2050. The share of India's working age population will rise from 58% in 2000 to a peak of 64% in 2035. India's relatively youthful population and high fertility rate suggest that its "demographic dividend" could continue for another two decades at least, in stark contrast with China's.

The demographic transition to slower population growth and the associated ageing of China's population have been profoundly affected by the One Child Policy. Yet fertility rates would have declined anyway, affected as they have been in China's Asian neighbours by urbanisation, female education, increased labour force participation rates and the improved life-expectancy of new-born children. Indeed, while the associated fall in fertility has not been as spectacular as China's, India's fertility rates have also declined steadily since the 1970s. Critically, however, the different age structures of the world's two most populous countries has elicited different population policy responses: in China, with a transition to a declining and ageing population in prospect, there is now public discussion of more relaxed family planning policies, while in India, with a rapidly growing population and high youth dependency rates, the focus continues to be on fertility reduction (Xinhuanet, 2005; Padmadas et al., 2005).

In this paper the linkages between demographic change and economic growth in China and India are explored using a new global demographic sub-model that is integrated with an adaptation of the *GTAP-Dynamic* global economic model in which regional households are disaggregated by age and gender. The paper is organised as follows. Section 2 discusses the theoretical and practical links between demographic change and economic growth in China and India. In Section 3 the demographic sub-model and the *GTAP-Dynamic* economic model are described. The composite model provides a means to examine quantitatively the interactions between demographic change and economic performance. Section 4 constructs a baseline scenario for the global economy through to 2030, while Section 5 presents alternative fertility scenarios for the two nations. In China, a transition to a two-child-policy is considered, while in India, the alternative scenario explores the possibility that fertility could decline more quickly than in the baseline. Simply put, while more rapid population growth in China might ultimately ease some of the burden of an ageing population and contribute to higher rates of growth in GDP, it is shown to be contradictory to the goal of delivering improvements in real per capita income. For India, the benefits of reduced fertility, in terms of real per capita income, are shown to be substantial. Conclusions are offered in Section 6.

2. Demographic Change and Economic Growth

At a basic level, faster population growth should yield stronger GDP growth, but lower per capita income growth. This expectation stems from the standard Solow-Swan model of growth that realistically incorporates diminishing factor returns, but less realistically assumes constant labour participation rates across an ageless population. This ensures that faster population growth generates faster-growing labour forces, which yield steady states with lower levels of capital per worker and hence lower per capita income.[1] In reality, changing populations have changing age distributions, and this alters average labour force participation rates and youth and aged dependency ratios. In a developing country with large numbers of dependent children, a fall in fertility not only slows population growth, it also reduces the total dependency ratio and raises the proportion of the working aged population. Income per capita is boosted by the fall in dependency so that the basic Solow-Swan result is strengthened, giving rise to a "demographic dividend".[2] As Bloom and Canning (2005a) point out, however, the per capita income boost is not an automatic consequence of changes in the age distribution, but instead depends on economic policies as they affect labour market flexibility and education.

In addition to these supply-side effects of demographic change on growth, changes in age distributions also have demand side implications. Lower fertility raises the average age of the population, changing the scale and product composition of final consumption to more strongly reflect the preferences of adults and the aged. More importantly, the associated rise in the proportion of working aged tends to raise the share of households' disposable incomes devoted to saving. In a developing country, following a fertility decline, this tends to increase the average saving rate. If investment is also raised, the demographic dividend is further bolstered. Higgins (1998) notes that the demographic "centre of gravity" for investment demand occurs earlier in the age distribution than for savings supply, because the former is most closely related to the youth share in the population – via its connection to labour force growth – while the latter is most closely related to the share of mature adults – via their retirement needs. The divergence between these two centres of gravity means that the effect of the demographic transition on savings and investment depends on the country's openness to capital flows. The more open is the capital account the more investment and capital growth depends on the economy's comparative performance and not, narrowly, on its saving behaviour. Thus, as China and India trend toward more open capital accounts, the effects of ageing on their saving rates are likely to

---

[1] See Solow (1956) and Swan (1956), and the detailed analytical review offered by Pitchford (1974: Ch.4).

[2] See Bloom and Williamson (1998) for a generic discussion of the demographic dividend in developing countries, Bloom and Canning (2003 and 2005a) for recent reviews, Bloom et al. (2000) for a detailed examination of the implications for Asia, and Cai and Wang (2005) for implications for China.

diminish.[3] Indeed, in affecting growth performance, the supply-side effects of demographic change, acting as they do through the size of the labour force, tend to dominate demand side changes to average saving rates and to the product composition of consumption.[4]

Complexities arise, however, when the interdependence of fertility, longevity, labour force participation and saving rates are fully accounted for. In one theoretical study, Bloom et al. (2005) predict that improvements in health and longevity will result in rising natural retirement ages (increased aged labour force participation) but declining average saving rates, the latter occurring because longer working lives reduce the need to save for retirement in each successive age cohort. However, this may not be observed in practice, particularly if policy regimes prevent or discourage later retirement, in which case increased longevity will require higher average savings rates in order to finance a longer retirement period. As Alan Greenspan (2004) points out, higher payroll taxes to finance ageing-related problems exacerbate the slow-down in the growth of labour supply by diminishing the returns to work, while "policies promoting longer working life could ameliorate some of the potential demographic stresses" (p. 782).

Additional complexities include the link between labour force growth, capital returns and foreign investment. While the attraction of investment from abroad boosts GDP growth, the new capital returns are repatriated and the contribution to per capita income growth then depends on real wage changes.[5] Faster labour force growth necessarily slows real wage growth even while it attracts foreign investment. Also dependent on the growth path of real wages is the pattern of migration. Both India and China are substantial suppliers of (mainly skilled) migrants to the rest of the world. Growth due to boosted fertility, and its slower real wage growth path, would raise skilled emigration and reduce skill endowments in both. Finally, any labour-supply-driven acceleration of GDP growth tends to shift the terms of trade adversely by raising output relative to consumption and exports relative to imports.[6] This also tends to weigh down the growth of per capita income. While the integrated model of demography and economic growth to be presented in the next section does not activate all of these interactions, it offers scope to experiment with alternative assumptions about each.

Fertility is obviously one of the key determinants of demographic change and, according to Padmadas et al. (2005), it is *the* main driving force of population change (in absolute terms) in both China and India. They also argue that fertility rates are the most uncertain component of

[3] The problems that arise in the closed capital markets that are common in developing countries are weak intermediation and hence mal-distributed investment and a low level of embodied technical change. These are just two of the reasons for the switch to openness that is under way in China and India.
[4] See, for example, Tyers and Shi (2007).
[5] See Tyers and Golley (2006).
[6] Equivalently, lower wage costs relative to other regions tend to cause real depreciation.

population change in both countries, largely because of rising gender imbalances, changing social attitudes towards reproduction and family structure and the uncertain impacts of policy responses.[7]

In China, while debates over the extent of fertility decline continue, it is widely accepted that by the turn of the century fertility rates had fallen to well below the replacement level of 2.1 births per woman. According to the National Bureau of Statistics, the total fertility rate in 2000 was 1.22 children per woman, although even the Chinese government recognises that the true figure was more like 1.8 because of the incentive the policy creates to underreport births in surveys and censuses (Sharping, 2003). Zhang and Zhao (2006) provide an extensive survey of the literature on fertility decline in China during the last two decades and conclude that the total fertility rate probably fell to around 1.6 by the year 2000. There is no question that the One Child Policy has been fundamental in facilitating this decline. Sharping (2003) controls for numerous other factors that affect population growth – including urbanisation, female education, increases in labour force participation and improved life expectancy, all of which would have contributed to declining fertility in China, regardless of its population policy – and estimates that, in the absence of the state's birth control policies, China's population would have been 1.6 billion instead of the 1.27 billion reported at the end of the 20th century.

China's One Child Policy has always been a highly controversial topic outside of China, and is now being openly challenged within China on the grounds of related ageing and gender imbalance issues.[8] The government is certainly prepared to consider the implications of higher fertility rates, as indicated by research conducted by the Development Research Centre of the State Council of China (2000), which projects population under a variety of fertility scenarios including a "two-child policy". Of course, it is impossible to know the extent to which such a policy would impact on actual future fertility rates. According to Demeny (2003), in the past the family planning programs that have been most effective in reducing fertility rates in developing countries tended to work via "heavy-handed methods of persuasion, and, in the especially important case of China, by coercion backed by legal sanctions" (p. 14). The Chinese government is very unlikely to utilise such methods to raise fertility rates in the future, and would instead need to resort to fiscal measures (such as tax breaks and family allowances) and

[7] The gender issue is particularly critical in China, where the ratio of males to females in the 0-9 age group reached 1147 per 1000 in the year 2000. This is significantly higher than the ratio of 1092 per 1000 in the 10-19 age group, suggesting that the issue is getting worse, not better. India's ratio is also very high compared to international standards, with a ratio of 1058 males to 1000 females in the 0-9 age group in 2000, but at least this figure has fallen slightly from the ratio of 1070 to 1000 in the 10-19 age group. See Padmadas et al. (2005) for further details.

[8] A Xinhuanet (2005) news article reported that a number of Chinese scholars challenged China's family planning policy at a forum on China's population and economy at Beijing University, where the main issues were the 'expanding grey generation' and the gender issue.

policies to make motherhood and the women's labour force more compatible (through day-care services and more flexible work-hours).[9]

Like China, India has also sought to restrict population growth, although the policy mechanisms have clearly differed. India introduced a 'target' oriented family planning program in the early 1970s, using a range of incentives to promote sterilisation. The initial sterilisation target was directed towards males but was ultimately deemed unsuccessful, because of political instability and administrative failures, with female sterilisation later emerging as the predominant method of contraception among Indian couples. In 1996 the government adopted a target-free approach, relying on family planning services to promote the spacing of births, smaller families and improvements in female education and health (Padmadas et al. 2005). India has since entered a period of rapid fertility decline, particularly in the South where some states already had rates below replacement levels, which Sen (2000) cites as evidence that social policies can be more effective than administrative control measures. Leaving aside this debate, it is clear that Indian fertility rates have declined in the last three decades, from 5.4 in 1970-75, dropping to 4.2 in 1985-90 and further to 3.1 in 2000-05 (United Nations, 2005).

The question of interest here is the speed at which fertility rates will fall in the future. The key factors impacting on India's fertility rates are the age of first marriage, the uptake of family planning, especially sterilisation, and the vast discrepancies in levels across Indian states, where increases in the first two, and convergence in the latter will all contribute to future fertility declines (Padmadas et al., 2005). Different assessments of the relative importance of these factors, along with different methods and data, have given rise to a wide range of forecasts regarding Indian fertility rates in the first three decades of the twenty-first century. The "high fertility" variant of the UN (2005) population projections, for example, implies a total fertility rate that falls to 2.45 in 2025-30, while according to Dyson's (2002) "low fertility" variant it will reach 1.59 by that time.[10] Any assessment of the implications of demographic change on India's economy should therefore encompass this wide range of fertility outcomes. To do so, however, requires a model that integrates the demography with the economics. To this we now turn.

3 Modelling Demographic and Economic Change

The approach adopted follows Tyers and Shi (2007), in that it encompasses demographic and economic change. A complete demographic sub-model is integrated within a dynamic

[9] See Demeny's (2003) excellent discussion of population policy in low-fertility countries for further details.
[10] See Padmadas et al. (2005) for further details.

numerical model of the global economy. The economic model is a development of *GTAP-Dynamic*, the standard version of which has single households in each region and therefore no demographic structure.[11] The version used has regional households with endogenous saving rates that are disaggregated by age group, gender and skill level.

Demography:

The demographic sub-model tracks populations in four age groups, two genders and two skill categories: a total of 16 population groups in each of the 14 regions listed in Table 1.[12] The four age groups are the dependent young, adults of fertile and working age, older working adults and the mostly-retired over 60s. The skill subdivision is between households that provide production labour (unskilled) and those that provide professional labour (skilled).[13] Each age-gender-skill group is a homogeneous sub-population with group-specific birth and death rates and rates of both immigration and emigration, as illustrated in Figure 1.[14] If the group spans T years, the survival rate to the next age group is the fraction $1/T$ of its population, after group-specific deaths have been removed and its population has been adjusted for net migration.

The final age group (60+) has duration equal to measured life expectancy at 60, which varies across genders and regions. The key demographic parameters, then, are birth rates, sex ratios at birth, age-gender specific death, immigration and emigration rates and life expectancies at 60. Immigration and emigration are also age and gender specific. The model represents a full matrix of global migration flows for each age and gender group. Each of these flows is currently set at a constant proportion of the population of its destination group, though for skilled workers the underlying migration rates are sensitive to inter-regional real wage divergences.[15] The birth rates, life expectancy at 60 and the age specific mortality rates all trend through time asymptotically, as indicated in Tables 2-4. For each age-gender group, and region, a target rate is identified.[16] The parameters then approach these target rates with initial growth rates determined by historical observation. In particular, note the declining trend in Chinese fertility, indicated in Table 2, which extends the fall during the decade prior to the base year

---

[11] The *GTAP-Dynamic* model is a development of its comparative static progenitor, *GTAP* (Hertel, 1997). Its dynamics is described by Ianchovichina and McDougall (2000).

[12] The demographic sub-model has been used in stand alone mode for the analysis of trends in dependency ratios. For more complete documentation, see Chan and Tyers (2006).

[13] The subdivision between production and professional labour accords with the ILO's occupation-based classification and is consistent with the labour division adopted in the GTAP Database. See Liu et al. (1998).

[14] Mothers in families providing production labour are assumed to produce children who will grow up to also provide production labour, while the children of mothers in professional families are correspondingly assumed to become professional workers.

[15] See Tyers et al. (2006) for further details.

[16] In this discussion the skill index, s, is omitted because birth and death rates, and life expectancies at 60 do not vary by skill category in the version of the model used.

(1997) in an asymptotic approach toward, but not reaching, the birth rate observed in Japan in that year.[17] For India, the base year fertility rate is 3.5 and it trends asymptotically to a target of 2.56, slightly higher than the United Nation's (2005) "high" population projection for India.

A further key parameter is the rate at which each region's education and social development institutions transform production worker families into professional worker families. Each year a particular proportion of the population in each production worker age-gender group is transferred to professional (skilled) status. These proportions depend on the regions' levels of development, the associated capacities of their education systems and the relative sizes of the production and professional labour groups. The resulting rates of transformation are based on changes during the decade prior to the base year, 1997, in the composition of aggregate regional labour forces as between production and professional workers. They are constant within each region and through time.[18]

Labour Force

To evaluate the number of "full-time equivalent" workers we first construct labour force participation rates, by gender and age group for each region from ILO statistics on the "economically active population". We then investigate the proportion of workers that are part-time and the hours they work relative to each regional standard for full time work. The result is the number of full-time equivalents per worker.[19] For each age-gender group and region, a target country is identified whose participation rate is approached asymptotically. As with birth and death rates, the rate of this approach is determined by the initial rate of change. Target rates are chosen from countries considered "advanced" in terms of trends in participation rates. Where female participation rates are rising, therefore, Norway provides a commonly chosen target because its female labour force participation rates are higher than for other countries.[20]

For China, India and comparator nation, Japan, the trends in labour force participation rates are summarised in Table 5. China's aged labour force participation rises slightly to allow for the expected shortfall in pension income as more retirees leave private sector employment.[21] This,

---

[17] Since 1997 the Japanese fertility rate has fallen further, to 1.25. These projections are slightly lower than those by the Development Research Centre of the State Council of China (2000) and Sharping (2003), yet the latter two make no attempt to allow Chinese fertility to follow the declining trends observed in neighbouring countries.

[18] Note that, as regions become more advanced and populations in the production worker families become comparatively small, the skill transformation rate has a diminishing effect on the professional population. These transformation rates are held constant in this analysis but it is made endogenous to real per capita incomes and to the skilled wage premium in Tyers, Bain and Vedi (2006).

[19] See Tyers et al. (2005: Tables 11 and 12) for further details.

[20] The resulting participation rates are listed by Chan and Tyers (2006: Table 10).

[21] This differs from the assumption of constant aged labour force participation rates made in Golley and Tyers (2006).

combined with the effects of ageing, raises the trend of the labour force above that of the population, as indicated in Figure 2. Both India and Japan have substantially higher aged participation rates, lacking China's central planning history. The other striking pattern is that India's female labour force participation rates are considerably lower in the 15-59 age groups than those in either China or Japan. This reduces India's recorded labour force relative to that of China.

The baseline population projections for China and India:

The baseline population and labour force projections for both China and India are illustrated in Figure 2 and the associated changes in the age and gender structure of each are summarised in Table 6. A dramatic contrast between the projections for China and India is clear from Figure 2 While the Chinese labour force falls short of a 10% increase over the three decades, and declines after 2015, the Indian labour force grows strongly with expansion continuing beyond 2030. This contrast is primarily due to the relative youth of India's population and its higher initial fertility rate. Even though the two populations are projected to reach rough parity in 2030, the Indian labour force remains smaller, due mainly to lower female participation rates. Accordingly, the projected Indian labour force has proportionally more male workers. Interestingly, the more rapid ageing of the Chinese population notwithstanding, the projected labour forces of the two nations maintain very similar proportions of older workers. Lower female participation rates notwithstanding, this is explained by India's comparatively high participation rates of 60+ workers, which are close to double China's for both men and women.

The Global Economic Model

GTAP-Dynamic is a multi-region, multi-product dynamic simulation model of the world economy. Money is not included and the prices of goods and assets are set relative to a global numeraire. In the version used, the world is subdivided, consistent with the demographic sub-model, into the 14 regions indicated in Table 1. Industries are aggregated into just three sectors, food (including processed foods), industry (mining and manufacturing) and services. To reflect composition differences between regions, these products are differentiated by region of origin, meaning that the "food" produced in one region is not the same as that produced in others. Consumers substitute imperfectly between foods from different regions.

As in other dynamic models of the global economy, in *GTAP-Dynamic* the endogenous component of simulated economic growth is physical capital accumulation. Technical change is introduced in the form of exogenous productivity growth that is sector and factor specific. Skill (or human capital) acquisition is driven by the constant transformation rates of production into skilled worker households introduced in the previous section. A consequence of its capital accumulation dynamics is the property of all dynamic models of the Solow-Swan type that incorporate diminishing returns to factor use, namely that an increase in the growth rate of the population raises the growth rate of real GDP but reduces the level of real per capita income. What distinguishes the model from this simpler progenitor is the endogeneity of saving rates and its multi-regional structure. All regional capital accounts are open and investors have adaptive expectations about real regional net rates of return on installed capital. These drive the distribution of investment across regions. In each, the level of investment is determined by a comparison of net rates of return on domestic installed capital with borrowing rates yielded by a global trust, to which each region's saving contributes, adjusted by calibrated region-specific interest premia.

To capture the full effects of demographic change, including those of ageing, the standard model has been modified to include multiple age, gender and skill groups in line with the structure of the demographic sub-model. In the complete model, these 16 groups differ in their shares of regional disposable incomes, consumption preferences, saving rates and their labour supply behaviour. While the consumption-savings choice differs for each age-gender group, it is dependent for all on group-specific real per capita disposable income and the real lending rate. Governments balance their budgets while private groups save or borrow.[22] The high initial rates for the elderly are partly due to the complication that a comparatively large proportion of consumption spending by the Chinese elderly is probably financed from the income of younger family members but it also reflects high pension payments to retirees from SOEs.[23]

4 Constructing the Baseline Economic Scenario

The baseline scenario represents a "business as usual" projection of the global economy through 2030. Although policy analysis can be sensitive to the content of this scenario, our focus is the extent of departures associated with alternative assumptions about demographic change in China and India. Nonetheless, it is instructive to describe the baseline, not only because it has some limited forecasting value but primarily because all scenarios have a

[22] Unlike the standard *GTAP* models, in which regional incomes are split between private consumption, government consumption and total saving via an upper level Cobb-Douglas utility function that implies fixed regional saving rates, this adaptation first divides regional incomes between government consumption and total private disposable income and then allows endogeneity of group saving rates depending on real disposable income levels and real interest rates.

[23] New research by Kinugasa and Mason (2005) and Feng and Mason (2005) offers useful results on the relationship between age and saving in China.

common a set of assumptions about future trends in key exogenous variables and because some exposition of the baseline makes the construction of departures from it clearer.

Shifts in consumption-saving preferences

Consumption-saving preferences are represented by age-gender specific consumption equations that relate real per capita consumption to real per capita income and the real lending rate in each region. There is no endogeneity of saving rates to longevity even though death rates decline through time and 60+ life expectancy increases in both nations, as indicated in Tables 3 and 4.[24] Consumption-saving preferences are shifted through time, however, in the few regions where changes are expected to stem from developments not represented in the model. Baselines saving rates for four regions are listed in Table 7. Aged saving rates in East Asia are projected to decline. Unlike the aged dissaving of Europe and North America, the aged of Asia are positive savers, due to high aged labour force participation rates and the mixing of incomes in extended families. In Japan, aged participation rates are the highest in the industrialised world and unlikely to increase. As Japanese family sizes fall, their aged saving rates there are likely to trend toward European levels. In the case of China, the 60+ age group has low labour force participation but high state-financed retirement incomes. Because the proportion of the aged retiring on relatively generous state pensions is declining, the 60+ groups are assumed to have underlying saving rates that fall through time. There is no *a priori* reason to think that India's underlying saving rates will rise or fall and so these are held constant.

Exogenous factor productivity growth

The model simulates growth due to the accumulation of labour, skill and physical capital. Other sources of growth, including all that passes for "technical change", are introduced via exogenous productivity growth shocks. These are applied separately for each of the model's five factors of production (land, physical capital, natural resources, production labour and professional labour). The overall rate of economic growth proves quite sensitive to these exogenous shocks since the larger these are for a particular region the larger is that region's marginal product of capital. The region therefore enjoys higher levels of investment and hence a double boost to its per capita real income growth rate.[25] Baseline agricultural productivity is assumed to grow more rapidly than that in the other sectors in China, along with Australia,

[24] This endogeneity is suggested by Bloom and Canning (2005b).

[25] The importance of productivity notwithstanding, the empirical literature is inconsistent as to whether productivity growth has been faster in agriculture, manufacturing or services and whether the gains in any sector have enhanced all primary factors or merely production labour. The factor productivity growth rates assumed in all scenarios are drawn from (Tyers et al. 2005).

Indonesia, Other East Asia, India and Other South Asia. This allows continued shedding of labour to the other sectors.[26] In the other industrialised regions, the process of labour relocation has slowed down and labour productivity growth is slower in agriculture. In the other developing regions, the relocation of workers from agriculture has tended not to be so rapid. Labour productivity in services is particularly difficult to measure. In general, baseline productivity growth rates in services are assumed to be slower than in the tradable goods sectors in all regions. The baseline values of each productivity growth rate for China and India are given in Table 8.

Interest premia

The standard *GTAP-Dynamic* model takes no explicit account of financial market maturity or investment risk and so tends to allocate investment to regions that have growing marginal products of physical capital. These tend to be labour-abundant developing countries with still rapidly expanding labour forces. Although the raw model finds these regions attractive prospects for this reason, we know that considerations of financial market segmentation, depth and risk limit the flow of foreign investment at present and that these are likely to remain important in the future. To account for this we have constructed a "pre-base" simulation in which we set the relative growth rates of investment across regions as exogenous. This allows us to capture the implied investment premium changes between the base year, 1997, and 2005, for which we have data on actual investment patterns. Thereafter, of course, while the pre-base path of investment in each region remains exogenous values are judgemental. Global investment rises and falls depending on the level of global savings, but its allocation between regions is thus controlled. To do this the interest premium variable (*GTAP Dynamic* variable *SDRORT*) is made endogenous. This creates wedges between international and regional borrowing rates. The results from the pre-baseline simulation show high interest premia for the populous developing regions of Indonesia, India, South America and Sub-Saharan Africa. In regions where labour forces are falling or growing more slowly premia fall through time.

Most significant is a secular fall in the Chinese premium. This is because the pre-base simulation incorporates the extraordinary rise in Chinese investment of the 2000-2005 period and allows it to continue growing in real terms, albeit at declining rates thereafter notwithstanding the eventual decline in China's labour force. On average, Chinese investment

[26] Wang and Ding (2006) have recently estimated that there are 40 million surplus workers in China's agricultural sector. While underemployment is not explicit in our model, the assumption of high labour productivity growth in agriculture implies that agriculture is capable of shedding labour more quickly than in other sectors. This essentially mimics the surplus labour problem, which is thereby accounted for implicitly.

is financed at an initial rate substantially above the Chinese government's long term bond rate (which exceeds the corresponding US rate by 40 per cent). The pre-base path of China's domestic interest rate declines initially, wiping out most of the initial Chinese premium.[27] This has the important consequence that the rental price of physical capital in China declines in the early years of the pre-base simulation. In the case of India, the pre-base domestic interest rate is stable through time. Since the global interest rate rises gradually, this implies a decline in its interest premium, though one that is less spectacular than for China. India's capital rental rate is nonetheless stable through time while those of the industrial economies, with more open capital markets, are rising with the global interest rate. Relatively competitive capital costs are therefore factors leading both economies to have advantageously depreciating real exchange rates.[28]

Once the regional interest premia are calibrated, they are rendered exogenous while actual investment in each region is made endogenous. The baseline simulation is then constructed, yielding results that are identical with the pre-baseline simulation but which then form the basis for comparison with subsequent simulations in which Chinese and Indian fertility levels are altered.

The baseline projection

Overall baseline economic performance is suggested by Table 9, which details the average GDP and real per capita income growth performance of each region from 1997 to 2030. In part because of its comparatively young population and hence its continuing rapid labour force growth, India attracts substantial new investment and, as shown in Figure 3, is projected to take over from China as the world's most rapidly expanding region. Rapid population growth detracts from India's long term real per capita income performance, however. By this criterion, China is the strongest performing region through the three decades. "Other East Asia" is also a strong performer, while the older industrial economies continue to grow more slowly. The emphasis hereafter is on quantifying the departures from this baseline projection due to changes in Chinese and Indian fertility.

5. Alternative Fertility Policies

The alternative scenario considered for China is a path toward a two-child policy. That for India is a fertility decline which is faster than our baseline assumption. The effect of each is

[27] See Tyers and Golley (2006) for further details.
[28] For an analysis using the same model of real exchange rates and their determinants, see Tyers et al. (2006).

described in turn and, for the economic bottom line, a set of elasticities is constructed that enable the two scenarios to be compared.

A Two-Child Policy for China

Following Sharping (2003) and the Development Research Centre of the State Council of China (2000), a higher-fertility scenario is constructed that, unlike the baseline, which has declining Chinese fertility, offers an asymptotic trend toward a fertility rate of 2.3. It is similar to the State Council's "two-child policy" and to Sharping's "delayed two-child policy". The implications for China's total population are indicated in Table 10. The correspondence between our model simulations and State Council projections is close. A transition to a two-child policy would raise the 2030 population by 19% relative to the baseline. The implications for population and labour force growth are displayed graphically in Figure 4. Critically, the path of China's labour force shifts up by substantially less than that of its population. By 2030, the labour force is larger by 13% and the population by 21%. This is because higher fertility first enlarges the youth population, which does not contribute to the labour force. The Chinese population continues to age, however, though more slowly with the higher fertility rate. This can be seen from the non-working-aged dependency ratio in Figure 5. After 2015 there are discernable differences, with the two-child policy yielding a 2030 ratio that is lower by four percentage points than the low-fertility baseline. As the diagram shows clearly, however, rising youth dependency dominates declining aged dependency, ensuring that the total dependency rate is higher throughout the period.

The economic effects of this change bear out the generalisations of Section 2, above. In particular, the supply side labour force effects are dominant. The anticipated supply side story is that he labour force expands, increasing capital productivity and therefore the return on Chinese investment. This attracts more of the world's savings into China so that its capital stock grows more rapidly. China's GDP might therefore be expected to be boosted substantially by increased fertility, through its direct and indirect influence over the supply of the two main factors of production, labour and capital.[29] In per capita terms, however, three forces would conspire to ensure that the average Chinese bears an economic cost. First, the Solow-Swan predisposition, due to diminishing marginal returns, toward slower real wage growth would tend to slow the growth of income per capita. Second, the associated shift in the age distribution would cause a rise in dependency (a loss of "demographic dividend") and hence a further

[29] This result could have a number of economic implications that are not captured in our model, including that higher fertility might reduce pressure on fiscal policy and so the growth-retarding effects of tax distortions might be reduced. Our scenarios maintain constant tax rates and fiscal deficits.

slowing of per capita income growth. Finally, because much of the new capital stems from foreign investment, there is the need to reward its foreign owners.

These expectations are indeed borne out in our simulations, as indicated in Table 11. The labour force increase is associated with a small decline in the skill intensity, due in part to the emigration of more internationally mobile skilled workers, which is boosted by lower skilled wages relative to destination regions.[30] The rate of return on installed capital in China is raised and so, therefore, is the level of investment and the growth in the physical capital stock. Yet, because the original stimulus is labour force expansion, this is insufficient to prevent a decline in labour productivity and hence in real wages. The terms of trade deteriorates slightly due to the expansion in China's core factors of production and the associated rise in the volume of exports more than imports. Alternatively, it can be seen as a real depreciation, brought about a lower time path of labour costs.

In the end, China's 2030 GDP is higher by 11% compared with the baseline, as is also shown in Figure 6. Yet the faster growth this represents is still not sufficient to keep pace with India's baseline growth rates.[31] And the rise in dependency, the slowdown in real wage growth, the repatriation abroad of an increased proportion of the income accruing to capital, the small addition to skilled emigration and the terms of trade deterioration all conspire to slow the rate of growth in real per capita income. By 2030 it is smaller than the baseline by 10%. This represents a significant cost of "pushing the fertility button" in order to achieve higher GDP growth.[32]

Lower Fertility in India

The low fertility scenario for India embodies a fall in the total fertility rate to 1.55 by 2030, compared with 2.55 in the baseline simulation. It reduces fertility by 1 child per woman. The simulation is therefore similar to Dyson's (2002) "low fertility" variant cited in Section 2. As shown in Figure 4, it offers substantial slowdowns in both the population and the labour force, with both tending to stabilise by around 2030. As in the fertility shock to China, above, the effect on the labour force is proportionally smaller than that on the population. As then, this is because fertility changes first affect the youth population and not those of working age. In

[30] This effect is too small to give it more space here. More details about the migration behaviour embodied in the model are provided by Tyers et al. (2006).
[31] Even with the 2 child policy in China and lower fertility in China, India's 2030 growth rate is faster by 1.2 %/yr.
[32] Empirical evidence for such terms of trade effects from growth is variable. In many cases, developing country expansions have not caused adverse shifts in their terms of trade because their trade has embraced new products and quality ladders in ways not captured by our model. See the literature on the developing country exports fallacy of composition argument, that includes Lewis (1952), Grilli and Yang (1988), Martin (1993), Singer (1998) and Mayer (2003).

contrast with China, however, in India the difference is made larger by its young population, its large population of women of fertile age and its high aged labour force participation rates. The diminished slowing impact on the labour force results in a substantial decline in the total dependency ratio, which is the combination of a minimal rise in non-working aged dependency combined with a dramatic decline in youth dependency, as shown in Figure 5.

The economic implications of this are indicated in Figure 6 and Table 12. Slower labour force growth yields slower capital productivity growth and therefore slower investment and capital accumulation. With slower primary factor accumulation comes slower GDP growth - real GDP reaches a 2030 level that is 7% lower than the baseline. By contrast with China's fertility increase, however, the forces influencing real per capita income are all positive. Dependency is substantially lower, the Solow-Swan effect sees real wages grow faster, the repatriation of capital income to foreign owners is less, there is less skilled emigration and the terms of trade improves. The latter improvement is due to increased consumption relative to GDP and therefore increased imports relative to exports. Alternatively, it is due to higher wage costs and a slight real appreciation relative to the baseline. In per capita terms, then, the Solow-Swan predisposition toward inverse proportionality between population and per capita income growth is amplified here. Even though aged dependency rises slightly, overall dependency falls substantially and slower population growth makes the average Indian better off. By 2030, the cost in GDP is 7% relative to the baseline but the gain in real per capita income is 15%.

Comparing the Implications of Fertility Change in China and India

A glance at Figure 6 reveals that, by 2030, the cost of 10% more GDP is about the same in real per capita income. In India, by contrast, 15% more real per capita income can be gained through fertility decline at the expense of only 7% of GDP. To clarify this asymmetry, we extract the elasticities of GDP and per capita income to the target fertility rate – that rate toward which fertility is assumed to trend asymptotically.[33] This yields unitless measures that are independent of the directions of the fertility shocks. As shown in Figure 7, these elasticities change through time, because, following a shock to the target fertility rate, the economic implications enlarge with departures from the baseline population and labour force. While the effects of fertility change on GDP are found to be very similar for the two countries, those on income per capita are widely divergent. The cost in per capita terms of raising fertility in India is more than twice as large is in China. This stems primarily from India's comparatively young

[33] Virtually the same result emerges when the contemporaneous fertility rate is used.

population and the more considerable demographic dividend it can therefore derive from fertility decline.

6. Conclusion

Within the next decade, China's labour force will begin to contract, while that of India will expand faster than its population. A straight-forward consideration of this in a neoclassical model with diminishing factor returns leads to the expectation that the impact of these changes will be lower GDP and higher per capita income growth in China, and the reverse in India, and this general pattern does emerge from the analysis provided above. However, the story is considerably more complex than this. In particular, population structure plays a critical role in determining the relative magnitudes of labour force growth to total population growth and the consequent change in dependency ratios, which in turn impact significantly on per capita GDP growth. Moreover, real wage trends influence skilled emigration from these regions and therefore the skill composition of their labour forces. With increasingly open capital accounts, other things equal, both countries stand to attract more foreign investment the faster their labour forces grow. This complements the positive association between fertility and GDP but the necessity to compensate foreign capital owners detracts from the per capita income result. Finally, faster GDP growth tends to shift the terms of trade adversely, which also detracts from per capita performance. Our integrated model of global demography and economic growth offers some insight into all of these complexities.

A relaxation of the One Child Policy has been proposed by some as a way of combating the negative impact that the slowdown and ageing of China's population will have on GDP growth in the future. Our simulations indicate that a 2-child policy would indeed achieve the twin goals of increasing GDP and reducing the proportion of the aged population (from 21% to 18%) and by similar proportion, the aged dependency ratio. They also imply, however, that per capita income by 2030 would be reduced by almost as much as GDP would rise, a result that stems primarily from an associated large rise in the youth dependency ratio as well as from adverse changes in skilled emigration, capital income repatriation and the terms of trade. If higher fertility rates are considered desirable for China to achieve its GDP growth and other (libertarian) objectives, policy efforts will need to be directed towards mitigating the negative impact of higher population growth on per capita income by raising labour market participation rates and increasing retirement ages.

With India set to become the world's most populous country by around 2030, its population policy continues to be directed towards promoting fertility decline. While our simulations demonstrated that faster fertility decline would necessarily lead to lower GDP growth, they also indicate that the benefits in terms of per capita income could be substantial. While lower fertility reduces GDP and increases per capita income in both countries, India gains substantially more per capita income than China per unit change in fertility, a result that depends critically on India's higher youth dependency. India therefore has considerably more to gain, at least in per capita terms, from further reducing its fertility.

References

Ahluwalia, Montek, S. (2002), 'Economic reforms in India since 1991: Has gradualism worked?', *The Journal of Economic Perspectives*, Vol. 16, No. 3, 68-88.

Attanasio, O.P., J. Banks and C. Meghir, G. Weber (1999), "Humps and bumps in lifetime consumption", *Journal of Business and Economic Statistics* 17(1): 22-35, January.

________ and M. Szekely (1998), "Household savings and income distribution in Mexico", Inter-American Development Bank, Office of the Chief Economist, Documento de Trabajo No.390, December.

Bloom David E. and David Canning (2005a), "Global Demographic Change: Dimensions and Economic Significance," in *Global Demographic Change: Economic Impacts and Policy Challenges*, Federal Reserve Bank of Kansas City.

_______ (2005b), "The effect of improvements in health and longevity on optimal retirement and saving", NBER Working Paper No.10919, Cambridge, MA: National Bureau of Economic Research, April.

_______ (2003), "How Demographic Change can Bolster Economic Performance in Developing Countries", *World Economics*, 4(4): 1-14.

_______ and P. Malaney (2000), "Demographic change and economic growth in Asia", *Population and Development Review* 26:257-290.

Bloom, D.E. and J.G. Williamson (1998), "Demographic transitions and economic miracles in emerging Asia", *World Bank Economic Review* 12(3): 419-455.

Cai Fang and Dewen Wang (2005) 'Demographic Transition: implications for growth' in Garnaut and Song, eds, *The China Boom and its Discontents*, Asia-Pacific Press, Canberra.

Chan, M.M. and R. Tyers (2006), "Global demographic change and labour force growth: projections to 2020", Centre for Economic Policy Research Discussion Paper, Research School of Social Sciences (RSSS), Australian National University, December.

Demeny, Paul (2003), "Population Policy: A Concise Summary", Population Council, Policy Research Division Working Paper No. 173.

Development Research Centre of the State Council of China (2000), *China Development Studies: the Selected Research Report of the Development Research Centre of the State Council*, China Development Press.

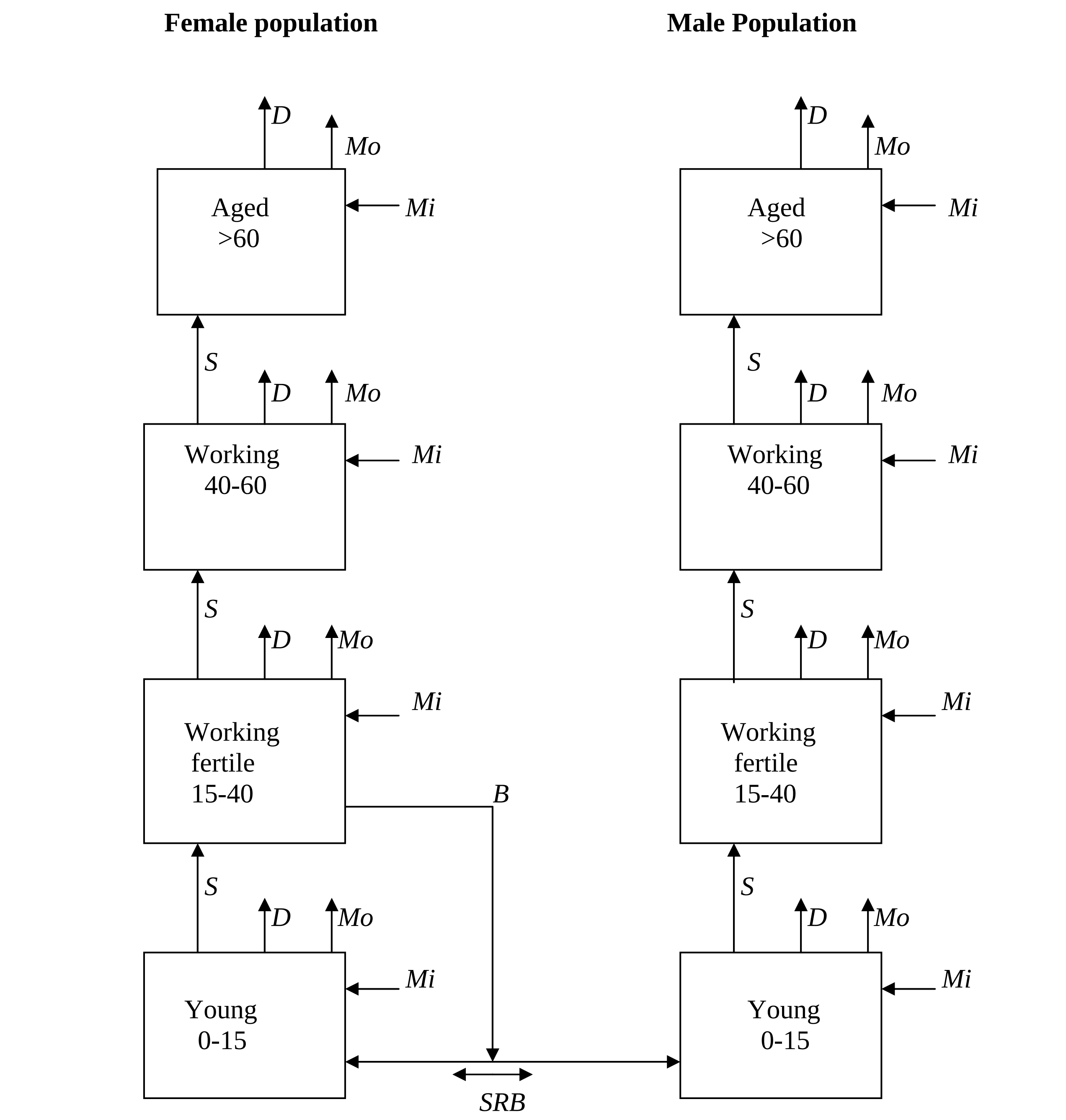
Dyson, T. (2002), "On the future of human fertility in India", Paper presented at the "Expert Group Meeting on Completing the Fertility Transition", United Nations Population Division, New York.

Feng, W. and A. Mason (2005), "Demographic Dividend and Prospects for Economic Development in China", UN Expert Group Meeting on Social and Economic Implications of Changing Population Age Structures, Mexico City, August 21-September 2.

Gibson, J. and G. Scobie (2001), “A cohort analysis of household income, consumption and savings”, *New Zealand Economic Papers* 35(2): 196-216, December.
Golley, J. and R. Tyers (2006), “China's Growth to 2030: Demographic Change and the Labour Supply Constraint”, Chapter 8 in Garnaut, R. and L. Song (eds.), *The Turning Point in China’s Economic Development*, Asia-Pacific Press, September.
Greenspan, Alan (2004), “Alan Greenspan on the Economic Implications of Aging”, *Population and Development Review* 30(4), December: 779-82.
Grilli, E. and M.C.Yang (1988), “Primary Commodity Prices, Manufactured Goods Prices and the Terms of Trade of Developing Countries: What the Long Run Shows”, *World Bank Economic Review*, 2(1), January.
Hertel, T.W. (ed.) (1997), *Global Trade Analysis Using the GTAP Model*, New York: Cambridge University Press (http://www.agecon.purdue.edu/gtap).
Higgins, Matthew (1998) “Demography, National Savings and International Capital Flows”, *International Economic Review*, Vol. 39, No. 2: 343-369, May.
Ianchovichina, E. and R. McDougall (2000), “Theoretical structure of Dynamic GTAP”, GTAP Technical Paper No.17, Purdue University, December (http://www.agecon.purdue.edu/gtap/GTAP-Dyn).
Kinugasa, T. and A. Mason (2005), “The effects of adult longevity on saving”, mimeo, University of Hawaii at Manoa.
Kitamura, U., N. Takayama and F. Arita (2001), “Household savings and wealth distribution in Japan”, Discussion Paper No.38, Project on Intergenerational Equity, Institute of Economic Research, Hitotsubashi University, Tokyo, September.
Lewis, W.A. (1952) “World Production, Prices and Trade, 1870- 1960”, *Manchester School of Economic and Social Sciences*, 20(2):105-38, May.
Liu, J. N. Van Leeuwen, T.T. Vo, R. Tyers, and T.W. Hertel (1998), “Disaggregating Labor Payments by Skill Level in GTAP”, Technical Paper No.11, Center for Global Trade Analysis, Department of Agricultural Economics, Purdue University, West Lafayette, September.
Martin, W. (1993), “The fallacy of composition and developing country exports of manufactures”, *The World Economy* 23: 979-1003.
Mayer, J. (2003), “The fallacy of composition: a review of the literature”, UNCTAD Discussion Paper No. 166, February.
Padmadas, Sabu, Guangzhou Wang, James Brown and Bohua Li (2005), ‘Birth planning and population prospects in China and India’, Paper presented at the IUSSP XXV International Population Conference, Tours, France, July 18-23.
Pitchford, J.D. (1974), *Population in Economic Growth*, Amsterdam: North Holland Publishing Co.
Sen, A. (2000), *Development as Freedom,* Oxford University Press, New Delhi.
Sharping, Thomas (2003) *Birth Control in China 1949-2000: Population policy and demographic development,* RoutledgeCurzon, London.
Singer, H.W. (1998), “Beyond terms of trade: convergence/divergence and creative destruction”, *Zagreb International Review of Economics and Business* 1(1): 13-25, May.
Solow, R.M. (1956), “A Contribution to the Theory of Economic Growth”, *Quarterly Journal of Economics*, 70 (1): 65-94.
Swan, T.W. (1956), “Economic Growth and Capital Accumulation”, *Economic Record*, 32 (2): 334-61.
Tyers, R., I. Bain and J. Vedi (2006), “The global implications of freer skilled migration”; Working Papers in Economics and Econometrics No. 468, Australian National University, Canberra, July.

_______ and J. Golley (2006), "China's Growth to 2030: The Roles of Demographic Change and Investment Premia", Working Papers in Economics and Econometrics No. 461, May; version in Chinese 2007 in the *Chinese Journal of Population Science*.
_______, J. Golley, Y. Bu and I. Bain (2006), "China's economic growth and its real exchange rate", Working Papers in Economics and Econometrics No. 476 Australian National University, November, November.
_______ and Q. Shi (2007) "Global demographic change, policy responses and their economic implications"; *The World Economy* 30(4), April 2007.
_______, Q. Shi and M.M. Chan (2005), "Global demographic change and economic performance: implications for the food sector"; Report for the Rural Industries Research and Development Corporation, Canberra, September.
United Nations (2000), "*1997 United Nations Demographic Yearbook*" UN Department of Economic and Social Affairs, New York.
_______ (2003), *World Population Prospects: The 2002 Revision*, UN Population Division, February (www.un.org/esa/population/publications/wpp2002).
_______ (2005) *World Population Prospects: The 2004 Revision*, UN Population Division, http://esa.un.org/unpp/
Wang Jiangui and Ding Shouhai (2006), 'A re-estimation of China's agricultural surplus labour – the demonstration and modification of three prevalent methods', *Frontiers of Economics in China*, Vol. 1, No. 2: 171-181.
WHO (2003) (from Tables 3 and 5)
Xinhuanet (2005), 'Family planning becomes controversial topic', 30 December.

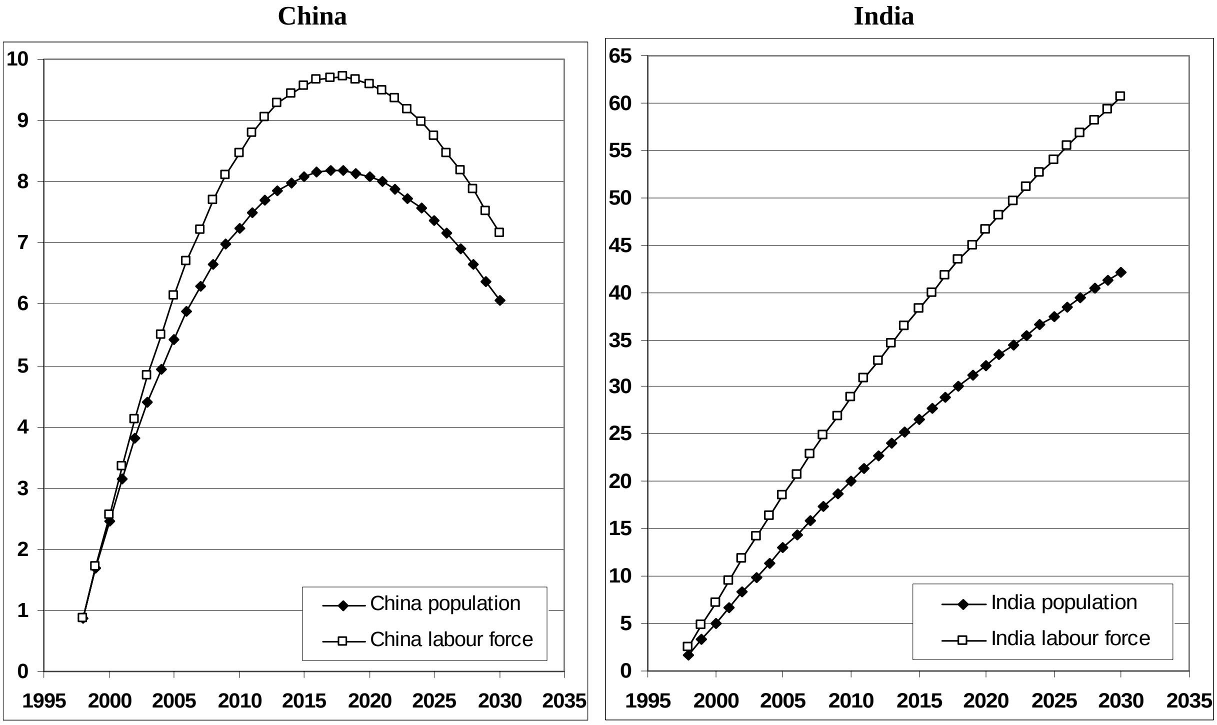
Figure 1: The Demographic Sub-Model



Glossary:

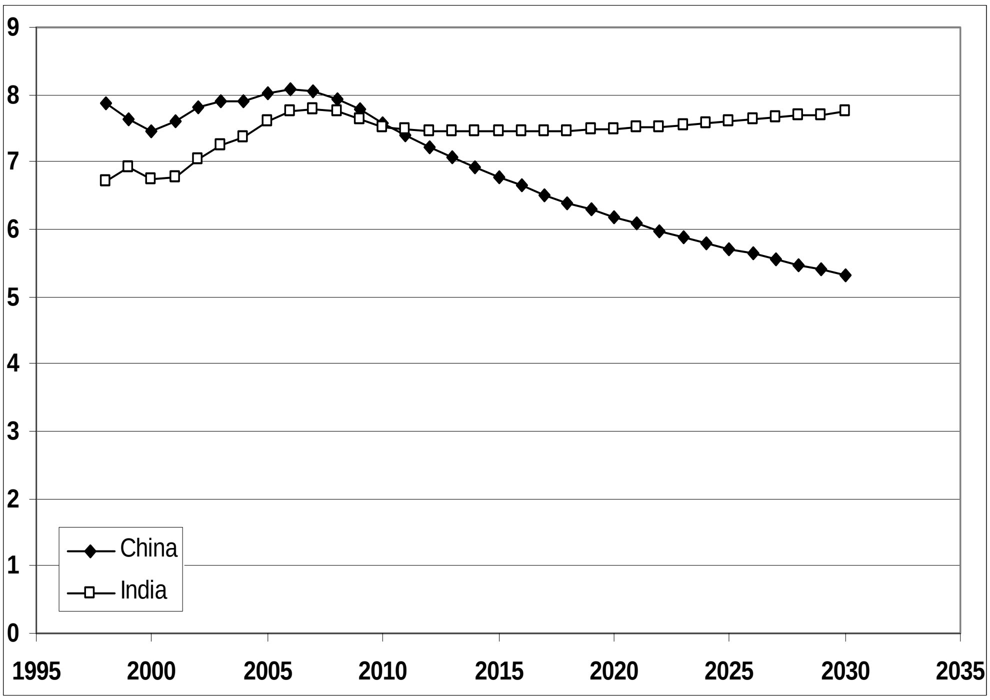
D	Deaths
S	Survival
B	Births
Mi	Immigration
Mo	Emigration
SRB	Sex ratio at birth

Figure 2: China's and India's Projected Populations and Labour Forces[a]



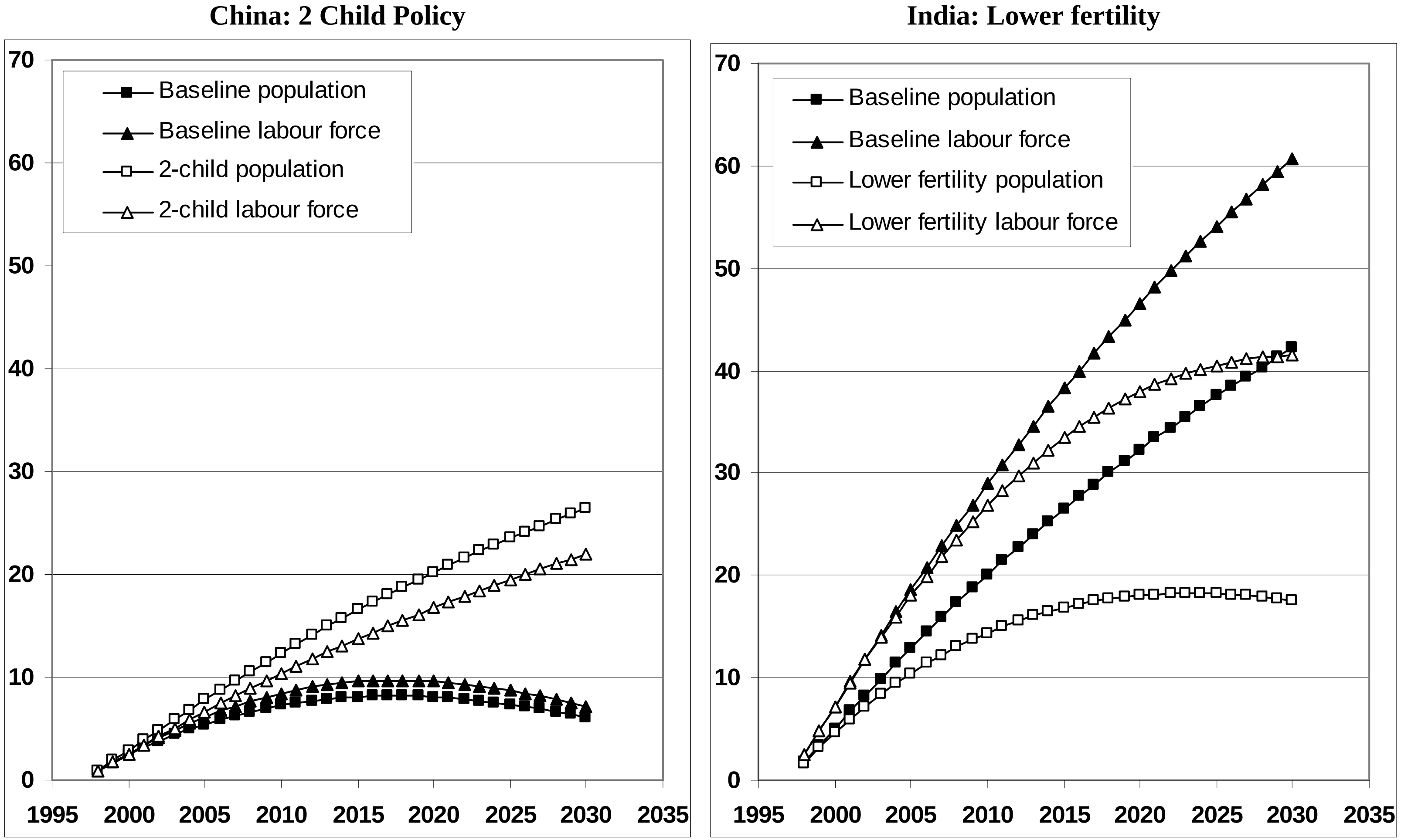
a These are cumulative % departures from the base year 1997, drawn from the baseline simulation in which China's fertility is projected to decline faster than India's and in which India commences with a much younger population.

Figure 3: Baseline Chinese and Indian GDP Growth Rates[a], %/year



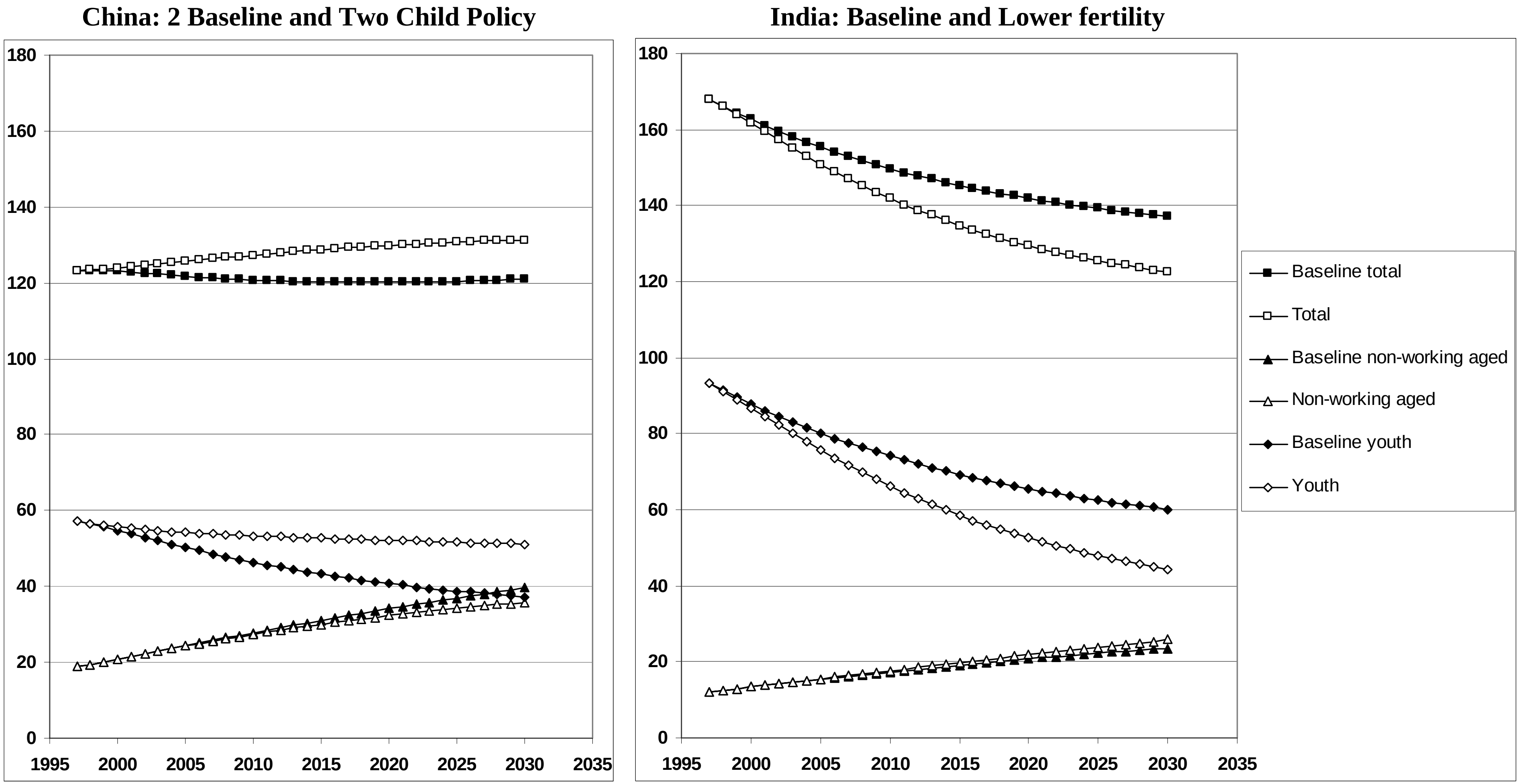
a These are annual growth rates of real GDP. They diverge in the later years due to slower labour force growth in China.

Figure 4: Population and Labour Force: Alternative Scenarios[a]



a These are *cumulative* % departures from the base year 1997.

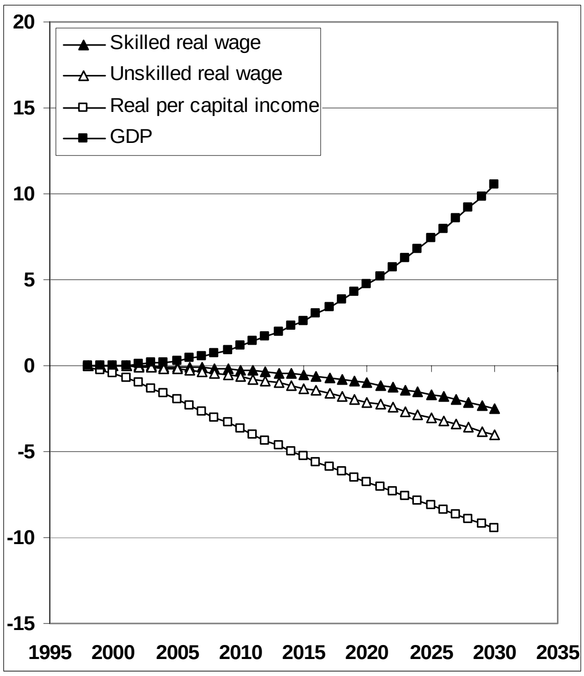
Figure 5: Total, Youth and Non-Working-Aged (60+) Dependency Ratios[a]

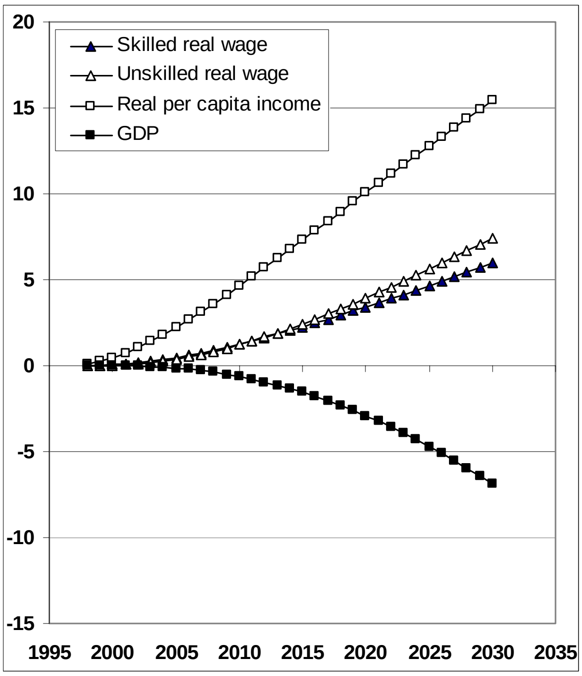


a These are the simulated ratios of the total population, the total youth population (0-15) and the non-working aged population, to the full time equivalent labour force.

Figure 6: GDP, Real Wages and Real per Capita Income Alternative Scenarios (% Departures from the Baseline)[a]

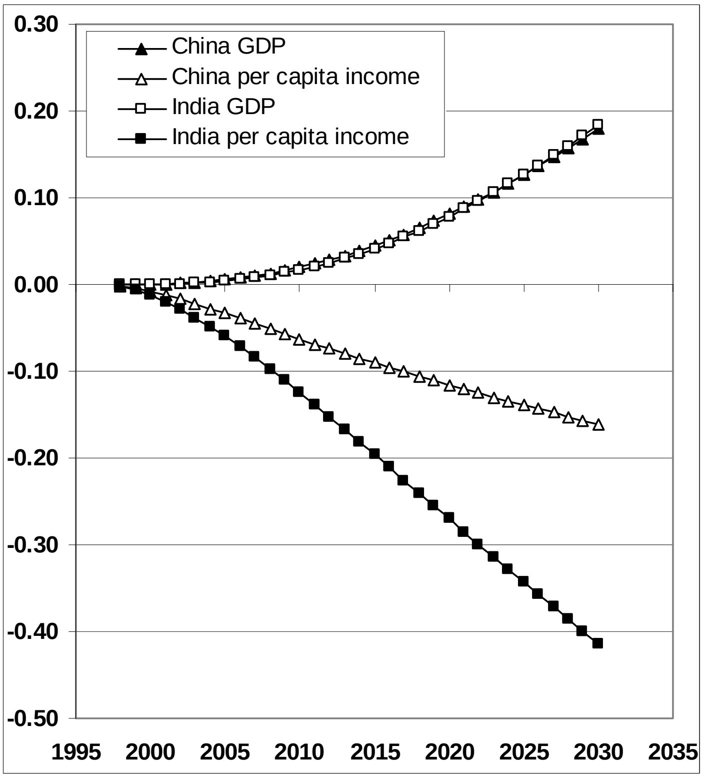
China: 2 Child Policy **India: Lower fertility**





a These are % departures from the baseline simulation for each year.

Figure 7: Elasticities of GDP and Per Capita Income to Target Fertility Rate[a]



a These are the % changes in real GDP and real per capita income for each corresponding % change in the target fertility rate, calculated from the results in Figure 6 and from target fertility rate changes of 59% for China and -37% for India.

Table 1: Regional Composition in the Global Model

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

Source: The *GTAP Global Database*, Version 5.

Table 2: Baseline Birth Rates in China, India and Japan[a]

	China		India		Japan	
Sex ratio at birth, M/Fs	1.10		1.08		1.06	
	Birth rate[b]	Fertility rate[b]	Birth rate[b]	Fertility rate[b]	Birth rate[b]	Fertility rate[c]
Base year, 1997	76	1.91	139	3.47	61	1.53
2010	62	1.56	114	2.86	59	1.48
2020	59	1.47	106	2.65	57	1.43
2030	58	1.44	102	2.56	56	1.40

a Birth rates are based on UN estimates and projections as represented by the US Bureau of the Census. The latter representation has annual changes in rates while the UN model has them stepped every five years. Initial birth rates are obtained from the UN model by dividing the number of births per year by the number of females aged 15-39. These rates change through time according to annualised projections by the US Bureau of the Census.

b Birth rates are here defined as the number of births per year per thousand women of fertile age. They are modified to allow for the modelling simplification that the fertile age group spans 15-39.

c Fertility rates are the average number of children borne by a woman throughout her life.

Source: Aggregated from United Nations (2003), US Department of Commerce- U.S. Bureau of the Census "International Data Base", as compiled by Chan and Tyers (2006).

Table 3: Age-Gender Specific Death Rates in China, India and Japan[a]

Deaths per 1000	China		India		Japan	
	Males	Females	Males	Females	Males	Females
0-14						
Initial (1997)	1.10	0.90	8.2	9.4	1.20	1.00
2030	0.54	0.49	3.8	4.5	0.72	0.66
15-39						
Initial (1997)	0.80	0.30	2.4	2.4	0.70	0.40
2030	0.57	0.19	2.0	2.1	0.55	0.77
40-59						
Initial (1997)	3.90	2.00	12.3	8.5	3.50	2.00
2030	2.81	1.78	7.6	5.7	2.60	1.39

a Projections of these parameters to 2020 assume convergence on target rates observed in comparatively "advanced" countries, as explained in the text. Only the end point values are shown here but the model uses values that change with time along the path to convergence.
Source: Values to 1997 are from United Nations (2000) and WHO (2003).

Table 4: Life Expectancy at 60 in China, India and Japan

Deaths per 1000	China		India		Japan	
	Males	Females	Males	Females	Males	Females
Initial (1997)	16	18	15	18	22	26
2030	17	21	16	19	27	33

a Projections of these parameters to 2020 assume convergence on target rates observed in comparatively "advanced" countries, as explained in the text. Only the end point values are shown here but the model uses values that change with time along the path to convergence.
Source: Values to 1997 are from United Nations (2000).

Table 5: Age-Gender Specific Participation Rates in China, India and Japan, Base Year (1997) and Projected, 2030[a]

Full time equiv	China		India		Japan	
workers per person	Males	Females	Males	Females	Males	Females
15-39						
Initial (1997)	0.79	0.60	0.81	0.35	0.77	0.55
2030	0.77	0.61	0.83	0.36	0.76	0.57
40-59						
Initial (1997)	0.91	0.43	0.95	0.38	0.97	0.67
2030	0.93	0.45	0.96	0.40	0.97	0.68
60+						
Initial (1997)	0.24	0.04	0.55	0.14	0.46	0.22
2030	0.27	0.08	0.55	0.15	0.52	0.25

a Projections of these parameters to 2020 assume convergence on target rates observed in comparatively "advanced" countries, as explained in the text. Only the end point values are shown here but the model uses values that change with time along the path to convergence.
Source: Values to 1997 are from United Nations (2000) and WHO (2003).

Table 6: Baseline Population and Labour Force Structure in China and India[a]

	China			India		
Population	**Millions**	**% Female**	**% 60+**	**Millions**	**% Female**	**% 60+**
Initial (1997)	1272	48.5	9.7	955	48.2	6.9
2010	1364	48.7	14.8	1146	48.4	10.6
2020	1375	48.8	18.4	1263	48.5	13.0
2030	1353	49.0	21.2	1349	48.5	14.8
Labour Force			**% 40+**			**% 40+**
Initial (1997)	570	37.2	33.9	356	27.4	36.3
2010	618	36.7	41.2	459	27.1	41.7
2020	624	36.4	45.4	522	27.2	45.1
2030	613	36.1	48.2	568	27.5	47.9

a The labour forces are measured in full time equivalent workers.

Source: Projection using the baseline simulation of the model described in the text. The labour forces are measured in full time equivalent workers.

Table 7: Baseline Saving Rates from Personal Disposable Income, %

Per cent		15-39		40-59		60+	
		Male	Female	Male	Female	Male	Female
North America							
	1997	14	14	19	19	-30	-30
	2030	14	14	19	19	-30	-30
Japan							
	1997	24	24	28	28	22	22
	2030	24	24	28	28	10	10
China							
	1997	35	35	40	40	31	31
	2030	53	35	40	40	10	10
India							
	1997	19	19	28	28	19	19
	2030	19	19	28	28	19	19

Source: These depend on initial values, compiled from studies of consumption behaviour on particular countries, including Mexico: Attanasio and Szekely (1998); Japan: Kitamura et al. (2001); New Zealand: Gibson and Scobie (2001); US: Attanasio et al. (1999), and on changes in real per capita disposable income and real lending rates that occur during the simulation.

Table 8: Baseline Factor Productivity Growth in China, India, Japan and North America

%/yr	Sector	Primary factor					Regional & sectoral averages
		Land	Production labour	Skilled labour	Capital	Natural resources	
China							**3.1**
	Food	1.8	5.0	7.0	1.6	0.0	3.6
	Industrial products	0.0	4.0	8.5	1.6	0.7	3.2
	Services	0.0	2.1	6.0	1.6	0.0	2.8
India							**2.3**
	Food	2.1	3.0	6.0	1.6	0.0	2.4
	Industrial products	0.0	3.5	7.0	1.6	0.7	2.5
	Services	0.0	2.0	4.0	1.6	0.0	2.0

a Productivity growth is specified by primary factor. For display, sectoral averages are weighted by factor cost shares in each sector and regional averages by sectoral value added shares in each region.
Source: Tyers et al. (2005).

Table 9: Baseline Real GDP and per Capita Income Projections to 2030

	% change 2030 over 1997		Implied *average* annual growth rate, %/yr	
	Real GDP	Real per capita income	Real GDP	Real per capita income
Australia	401	275	5.0	4.1
North America	350	255	4.7	3.9
Western Europe	227	276	3.7	4.1
Central Europe & FSU	337	331	4.6	4.5
Japan	214	313	3.5	4.4
China	**743**	**578**	**6.7**	**6.0**
Indonesia	253	243	3.9	3.8
Other East Asia	410	468	5.1	5.4
India	**892**	**435**	**7.2**	**5.2**
Other South Asia	424	157	5.1	2.9
South America	267	205	4.0	3.4
Mid East & Nth Africa	319	152	4.4	2.8
Sub-Saharan Africa	373	150	4.8	2.8
Rest of World	498	277	5.6	4.1

Source: The (low fertility) baseline projection described in the text.

Table 10: The Chinese Population: Baseline and Two Child Policy[a]

Millions	Baseline: (declining) fertility: 1.91 to 1.45	Transition to 2 child policy	
		State Council	Our model
2000	1,252	1,270	1,257
2010	1,311	1,369	1,369
2020	1,321	1,466	1,462
2030	1,296	1,518	1,536

a The base year for our simulations is 1997, when China's fertility rate was approximately 1.91.
b Our Two Child Policy simulation matches the fertility assumptions by Sharping (2003).
Source: Development Research Centre of the State Council of China (2000) and simulations using the model described in the text.

Table 11: Economic Effects of Higher Chinese Fertility, 2030

(% Departures of the 2-Child Policy from the baseline)

	Real investment	Real capital stock	Labour force	Skill intensity[a]	Real skilled wage	Real production wage	Skill premium	Rate of return on installed capital, (% points)	Terms of trade	Real GDP	Real GNP per capita
2010	1.95	0.67	1.76	-0.26	-0.25	-0.65	0.41	0.05	0.04	1.15	-3.68
2020	7.77	3.65	6.51	-0.70	-1.01	-2.10	1.11	0.09	-0.29	4.73	-6.77
2030	15.87	8.87	13.85	-1.07	-2.53	-4.02	1.56	0.11	-1.13	10.52	-9.46

a Skill intensity is the ratio of the skilled to the total labour force.

Source: The baseline and the Chinese 2-Child Policy projections from the model described in the text.

Table 12: Economic Effects of Reduced Indian Fertility, 2030[a]

(% Departures of the Indian low fertility scenario from the baseline)

	Real investment	Real capital stock	Labour force	Skill intensity[a]	Real skilled wage	Real production wage	Skill premium	Rate of return on installed capital, (% points)	Terms of trade	Real GDP	Real GNP per capita
2010	-1.06	-0.32	-1.65	0.28	1.24	1.22	0.02	-0.04	0.05	-0.63	4.63
2020	-4.62	-2.23	-5.92	0.76	3.42	3.92	-0.48	-0.08	0.67	-2.92	10.07
2030	-9.65	-6.04	-11.93	1.18	5.97	7.42	-1.35	-0.09	1.87	-6.86	15.45

a Skill intensity is the ratio of the skilled to the total labour force.

Source: The baseline and Low Indian Fertility projections from the model described in the text.