Asymmetric Demography and Macroeconomic Interactions Across National Borders[1]

Ralph C Bryant

1. Introduction

Cross-border transmissions arising from nations' differing demographic evolutions modify macroeconomic outcomes and national welfares. Asymmetric demographic transitions have particularly important effects on exchange rates, saving-investment and current account balances and, hence, net capital flows.

This survey provides an analytical overview of these increasingly important dimensions of demographic influences in the world economy. Given the purposes of this G-20-sponsored workshop, the exposition is a general survey. Amplifications, supporting technical analyses, and references to the literature are confined to footnotes or omitted altogether.

When reading the paper, remember that its purpose is to analyse the effects of asymmetric demographic transitions in isolation from other influences. At any given time, many events and shocks occur in the world economy that have little or nothing to do with demographic trends. Such events and shocks have consequences for macroeconomic interactions among countries and regions that, especially over shorter runs, are more powerful than the impacts of demographic shocks. Demographic shocks and their effects are typically slower-moving and cumulative. Over medium and long runs, however, demographic forces can exert powerful effects.

The survey draws extensively on work carried out in the past several years as part of a research project on the global dimensions of demographic change. Early papers in the project focused on alternative research strategies and on interactions among similarly structured developed economies.[2] More recent research has focused on interactions between developed and developing economies.[3]

---

1. This paper is part of a joint project studying the global dimensions of demographic change coordinated by Ralph C Bryant at the Brookings Institution and Warwick J McKibbin at the Australian National University (ANU). The views expressed in this paper are those of the author alone and should not be attributed to other project researchers or the trustees and officers of the Brookings Institution. Anthony Liu provided skilful research assistance

2. Bryant and McKibbin (1998), Bryant (2004b, 2004c), Bryant *et al* (2004), Bryant and McKibbin (2004), and Bryant and de Fleurieu (2005). Bryant (2004b) gives references to related work carried out by other researchers.

3. Bryant (2005, 2006) were first efforts in the Brookings Institution's components of the project to study the interactions between developed and developing economies. McKibbin and Nguyen (2004), McKibbin (2005a, 2005b) and Batini, Callen and McKibbin (2006) have addressed these issues in the ANU components of the project.

2. A Perspective on Today's Partially Integrated World Economy

For background, it will be helpful to start with generalisations about the world economy and its evolution in recent decades. To have an analytical benchmark, moreover, it is useful to contrast today's reality with an economic system within which all economic activity is highly integrated.

2.1 Geographical flows of savings, goods and people within a highly integrated economy

In a closed (self-contained) economy, all transactions occur between residents. When any borrower has a liability on its balance sheet, a lender elsewhere in the economy has a matching asset. The savings generated in such a closed economy are like a pervasive fluid. The economy's financial system (comprising financial intermediaries and financial markets) is like a reservoir for these funds. When the current-period income of households and other economic agents exceeds their consumption, the resulting savings flow into the reservoir. Businesses and other agents, whose current-period income falls short of their spending, draw funds out of the reservoir, borrowing to finance their excess spending. The existence of the reservoir permits the saving and investment decisions of individual economic agents to be taken independently even though, when measured after all decisions have been made and inconsistencies among them have been eliminated, the flows of aggregate saving and aggregate investment are necessarily equal for the closed system as a whole.

Suppose that the economic system is highly integrated in the sense that market imperfections (such as asymmetries in the distribution of information and in access to financial institutions) do not exist; that transaction, communication and transportation costs are low; and that no restrictions exist to inhibit the geographical movements of savings, goods and people among the regions within the system. The savings fluid in the reservoir in such a system would behave much like water: following a change in underlying circumstances in some region, the fluid in all parts of the reservoir would adjust almost instantaneously to re-establish a uniform level. Savers would move funds so adeptly from lower-return to higher-return locations, and borrowers would shift so promptly from higher-cost to lower-cost sources of financing, that market interest rates and yields on investments, adjusted for risk premiums, would speedily become equalised throughout the reservoir. Similar equalising pressures would apply to the prices of goods and to wages, adjusted for skill levels.

More realistically, suppose instead that market imperfections are numerous and that transaction costs (especially for adjusting capital stocks to new desired levels) are significant. The savings fluid in the reservoir then has to be described as viscous – more like thick molasses than water. Given sufficient time to adjust to changes in underlying circumstances, a uniform level of the viscous fluid would eventually prevail. However, if in one region of the reservoir withdrawals during any particular short-run period substantially exceed or fall short of new deposits,

the level in that region can be temporarily lower or higher than elsewhere in the reservoir. Suppose, for example, that investment opportunities become more favourable in a particular region. Before information about the new opportunities becomes widely available and all plans are correspondingly adjusted, that region would have an excess demand for savings and labour. Desired withdrawals from the reservoir by the residents of, or owners of assets in, the favoured region would temporarily exceed planned inflows. The region would attract funds from other parts of the reservoir as investors in projects with higher-than-average expected returns successfully bid funds away from investors in other regions whose projects were less promising. During the transitional period, there might be little relation between the investment and saving of the favoured region's residents. If one could calculate balance of payments accounts for the favoured region, one would observe a net savings inflow (a current account deficit). Eventually, risk-adjusted rates of return, skill-adjusted wage rates and the prices of goods adjusted for transportation and transaction costs would converge throughout all regions. But as long as perceived rates of return were unusually high in the favoured region, the financial reservoir would not have a uniform level. Financial funds and people themselves would flow from the rest of the reservoir to the favoured region.

The greater the heterogeneities across regions and the greater the extent to which access to financial institutions differs – more generally, the more viscous the flow of savings from one part of the reservoir to another – the more important would be geographical variations in the intensity of investment activity and its financing. Regional variations in financial activity would tend to be closely associated with regional variations in real economic activity. Sluggishness in the movements of goods and people across regional borders would likewise contribute to regional variations in real economic activity.

2.2 Flows of savings across national borders in today's world

The world economy as a whole is a closed system. Each liability position in the world is matched by a corresponding asset position. But of course huge political, economic and social differences exist among the world's regions and nation states. Restrictions inhibit many cross-border transactions, in particular the migration of people from one nation to another. Furthermore, even in the absence of border restrictions, economic transactions within nations are much more dense than transactions across national borders. Financial activity in the world economy is, rather than a single global reservoir, a collection of national reservoirs partially – but only partially – linked together.

During the years immediately following World War II, national financial reservoirs were separated nearly completely. Only limited scope existed for cross-border net capital flows and corresponding imbalances in current account positions. Even the cross-border shipments of goods and services – but especially the net ladling of savings from one national reservoir to another – were modest relative to the sizes of national outputs. The reconciliation between savings and investment necessarily

proceeded largely independently, individual nation by individual nation, with little scope for aggregate national investment to differ from aggregate national saving.

The financial structure of the world economy underwent a sea change in the second half of the 20th century (in part returning the world to where it had been in the first decade of the century). The economic distances between nations' financial systems shrank markedly. National savings reservoirs that had been nearly autonomous became less so. Today, to a greater extent than before, the levels in national reservoirs tend to be pulled together toward a common level.

Even so, financial activities in many parts of the world remain segmented along national lines. The notion of a unified world financial system, implying a nearly uniform level throughout a single global reservoir, remains an inappropriate metaphor. For financial sector activity, national borders have economic influences that are large, pervasive and durable.

2.3 Cross-border integration of goods markets

Movements of goods and services across national borders, like saving flows, are still subject to numerous impediments and frictions. The density of product flows within national economies is much greater than for cross-border transactions. Yet, like financial markets, national goods markets are much more integrated today than they were in the middle of the 20th century.

The increasing cross-border integration of financial and goods markets during recent decades has two underlying causes. Many government policies that traditionally inhibited cross-border flows of goods, services and transactions were relaxed or even dismantled. And technological, social and cultural changes sharply reduced the effective economic and psychic distances between nations, reducing the costs of cross-border transactions and making domestic economic behaviour gradually more sensitive to developments abroad.[4]

2.4 Migration of people across borders

Within a fully integrated economy, geographical movements of people – especially individuals of working age – could be just as important as movements of goods and financial funds. The reality in today's world, however, is that migration is severely limited. Movements of people across national borders are, with few exceptions, much more restricted than movements of goods and financial funds.

Immigration restrictions in selected parts of the world were loosened modestly in the last decade and a half, most notably for highly-skilled workers. Traditional 'settlement' countries such as Canada, Australia, New Zealand and the United States continued to authorise further controlled immigration. Restrictions on migration for political asylum were eased in some countries during the 1990s, after

4. The points summarised so far are analysed in greater detail in Bryant (2003, 2004a).

the fall of the Iron Curtain, especially to permit flows into Europe from former Communist nations.

Nonetheless, for most nations, authorised immigration – either permanent or temporary – has remained modest. Illegal (unauthorised) immigration has been significant in a few countries, notably the United States and several countries in Southern Europe. For most nations, however, government policies successfully inhibit flows of people across their borders. Policy restrictions on immigration are far more consequential than the willingness of individuals to migrate in response to economic incentives. In particular, virtually all wealthier nations are reluctant to permit immigration of low-skilled individuals from poorer countries.[5]

Governmental policies preventing migration are the primary explanation for why almost all of international economic theory and existing multi-country empirical macroeconomic models focus on the cases where goods and financial funds move across borders in response to economic incentives but workers and people do not. The working assumption of no migration has permitted researchers to focus on the more important types of international interactions. Cross-border trade in goods and services and cross-border capital flows are certainly larger fractions of activity in goods and financial markets than the fraction of labour market activity accounted for by immigration. Similarly, the forces of international economic interdependence have not reduced wage differences among similarly skilled workers nearly as much as they have reduced differences in goods prices and differences in the cost of capital.[6]

2.5 Cross-border substitutability and macroeconomic interdependence

The greater sensitivity of domestic financial market and goods market behaviour to foreign developments that has characterised recent decades has resulted, in part, from secular increases in cross-border 'substitutability'. Households and firms have manifested a gradual increase in their willingness to substitute between home and foreign goods in response to relative price changes ('goods substitutability'). Savers and investors have shown a gradual increase in their readiness to respond across borders or across currency denominations to changes in relative expected returns among financial assets and liabilities ('financial substitutability'). Because analysts have devoted less attention to these trends than is warranted, empirical evidence

5. The OECD's *International Migration Outlook* (2006) summarises data trends and identifies policy issues related to this issue.

6. Freeman (2006) suggests that migration could become relatively more significant in the future. He argues that 'aging populations and low birth rates in advanced countries coupled with huge disparities in pay around the world and increased education in developing countries are likely to lead to increased immigration in the decades ahead, even with current immigration policies. People flows will become more important in globalization and should help reduce global inequality among workers around the world' (p 166). Even so, when analysing the macroeconomic effects of demographic transitions in the near-term, however, abstracting from the cross-border movements of people is a useful first approximation.

is still sketchy. Understanding the effects of these trends, however, is central to understanding many aspects of the evolution of the world macroeconomy.

By shrinking the economic and psychic distances between nations and enhancing sensitivities to foreign developments, behavioural changes in cross-border substitutability would have progressively knitted national economies more closely together even in the absence of reductions in the separation fences of national governments. Reductions in these separation fences would have enhanced cross-border mobility and interdependence even without the increased cross-border sensitivity and without technological innovations. Together, the two sets of evolutionary changes reinforced each other and powerfully transformed the world economy over the last half-century.

It is thus a central fact of life today that macroeconomic variables are more closely linked across national borders. Somewhat larger proportions of macroeconomic adjustments required in response to shocks originating domestically now tend to be channelled through external sector transactions. Shocks originating abroad now buffet the domestic economy more strongly. Cross-border and cross-currency adjustments have risen in importance relative to purely domestic adjustments.

These generalisations apply to all sorts of macroeconomic variables, domestic and external sector. In particular, and notably, they apply to variations in the imbalance between an economy's national savings and domestic investment – by definition also its current account balance with the rest of the world. Saving-investment imbalances have been strongly influenced by the lowering of national separation fences and by heightened goods and financial substitutabilities across borders. Typically, the sizes of, and variations in, an economy's current account balance relative to gross output are now larger and exhibit larger swings than would have occurred in the middle decades of the 20th century. Changes in exchange rates may also be a relatively more important component of macroeconomic adjustments in response to all sorts of shocks – including, not least, demographic shocks.[7]

7. Feldstein and Horioka (1980) and numerous subsequent studies showed that national saving rates and domestic investment rates exhibit a high correlation in cross-section studies of country data. More recent examinations, however, have shown that the empirical correlation has fallen somewhat as cross-border integration has continued to increase in the last several decades. Note also that some part of the observed correlation could be due to the dependence of changes in both saving and domestic investment on changes in incomes. And a variety of policy and non-policy disturbances originating within a nation's economy – and some types of disturbances originating abroad – can influence national saving and domestic investment in the same direction independently of the degree of mobility of capital across a nation's borders. Cross-border goods substitutability, despite increases in recent decades, still tends to be relatively low and in any case is typically less than cross-border financial substitutability; significant barriers remain that inhibit cross-border transactions in goods and services. Those factors prevent current account imbalances from growing as large as might otherwise be observed. Accordingly, the high correlation between domestic investment and national saving may be attributable more to goods market phenomena than to a lack of integration among financial markets or a low degree of substitutability among home and foreign assets (Frankel 1986, 1991).

3. Asymmetric Demographic Transitions

3.1 Characteristic trends

Virtually every part of the world has been gradually moving from a state of short life spans and high fertility rates to one of longer lives and lower fertility rates. These demographic transitions have been dramatically altering the age structures of populations. Eventually, the entire world is expected to be characterised by few births per woman, long life expectancies, and population structures with large proportions of elderly individuals and small proportions of children.

In the early stages of a demographic transition, infant mortality falls and overall mortality declines. Children thus become more numerous and the average age of the population becomes younger. Decreases in infant mortality are often accompanied, typically with a lag, by declines in fertility rates, as mothers choose to maintain a similar expected number of surviving offspring. In later stages of the transition, the working-age population and the labour force grow faster than the population as a whole. This development is sometimes termed a 'demographic dividend'; it is associated with a sustained rise in the 'active ratio' (the proportion of the total population accounted for by adults of working age, 20–64 years) and a marked decline in the 'youth dependency ratio' (the proportion of the total population aged 0–19).[8] In the final phases of a demographic transition, further increases in longevity and a low fertility rate slow the growth of the working-age population; the 'elderly dependency ratio' (the proportion of the total population aged 65 and over) rises sharply.

Although pervasive, the timing and speed of these demographic changes have been highly asymmetric across regions. Many western European countries began their transitions at the beginning of the 19th century. Those countries, along with many other industrial countries, are now in the later stages of their transitions with elderly dependency ratios increasing rapidly. At the other extreme, the transitions in some least-developed countries have started only in recent decades. These countries are still experiencing rising youth dependency ratios and are only now beginning to enter the period of the 'demographic dividend'.

3.2 Illustrative data for individual nations

The Population Division of the United Nations publishes bi-annual statistical volumes on world and national demographic trends.[9] The data in recent editions are presented for quinquennial averages, beginning with the period 1950–1955 for historical data and ending with 2045–2050 for forward-looking projections.

---

8. When using the UN Population Division demographic data, one has the choice of defining youths as either age 0–14 years or 0–19 years. Because my analytical framework presumes children pass from youth to adult age at the end of their 18th year, I choose the 0–19 year span.

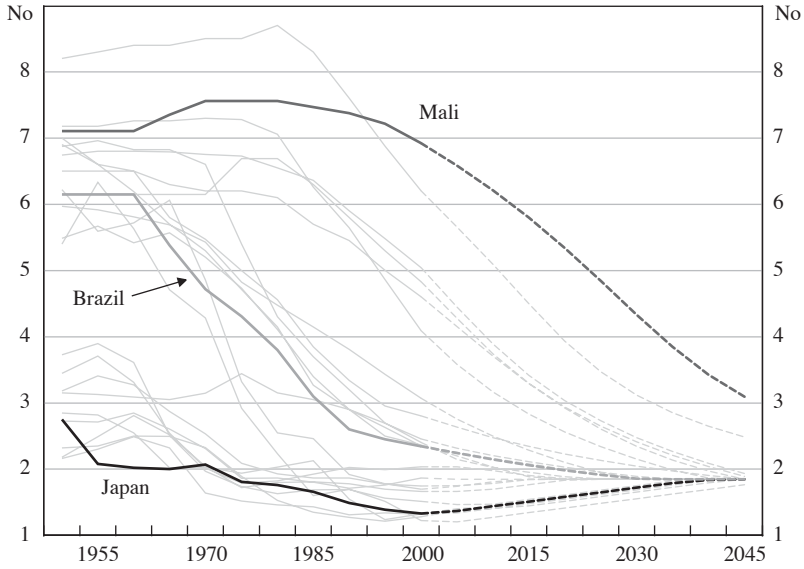
9. For example, UN Population Division (2001, 2003, 2005).

Figures 1–6 plot key demographic series from the UN data for all of the G-20 nations and several smaller developing nations. The forward-looking projections shown in the panels are the UN Population Division's 'medium' scenarios.[10] The figures immediately reveal two main facts: demographic transitions are highly heterogeneous; and common trends are pervasive. Curve labels separately identify only three of the nations – Japan, Brazil and Mali. Counterpart appendix tables at the end of the paper, however, identify the other individual countries and provide the data series (Appendix A).

Japan, Brazil and Mali exemplify the differing stages of demographic transitions. Japan is the developed country furthest along in the late stage of transitions. Other G7 nations are also in fairly late stages. Brazil is roughly representative of broad demographic trends among developing economies in the earlier to middle transition stages. Mali is an example of a smaller, least-developed country in the very early stage. (The other, earlier-stage developing nations shown in the figures are Guatemala, the Lao People's Democratic Republic, Tanzania and Yemen.)

Lifetime births per woman are much higher in developing countries than in industrialised countries (Figure 1). Yet they are falling throughout the world with

Figure 1: Fertility Rates
Births per woman



Notes: Dates refer to the beginning of the 5-year window. Data after 2005 are based on projections.
Source: UN Population Division (2005)

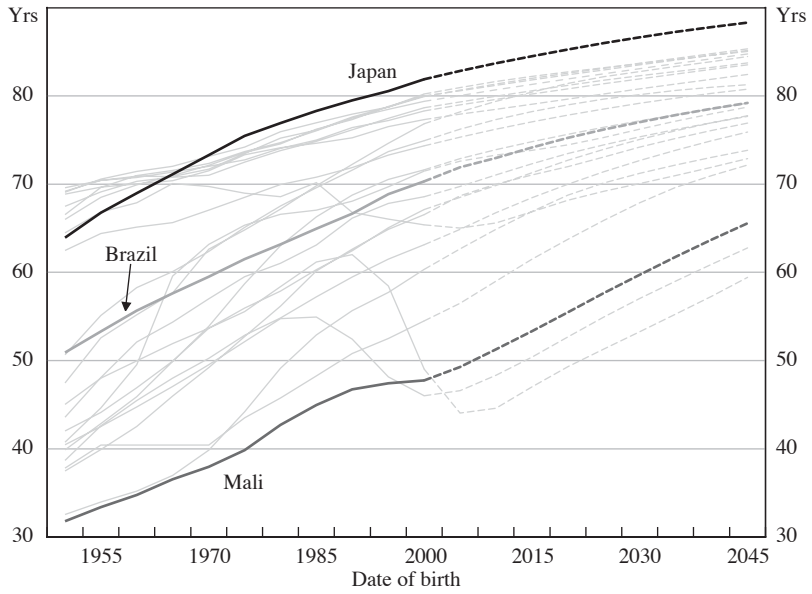
10. The UN Population Division also publishes 'low' (lower fertility and lower longevity) and 'high' (higher fertility and higher longevity) scenarios.

only a few exceptions. By the 1970s the fertility rate in Japan and several European economies had already dropped below a rate consistent with steady-state replacement of the population (about 2.1 births per woman). In contrast, in most developing countries, fertility rates today still fall into the range 3 to 5 births per woman. Countries in early transition stages, such as Mali, have even higher birth rates that have only started to decline in the last several decades.

Life expectancy is markedly higher in Northern (developed) than in Southern (developing) economies (Figure 2). The differences in levels are striking. For example, a child born today in Japan – currently the nation with highest life expectancy at birth – can expect to live on average some 34–35 years longer than a child born in Mali. No less striking, however, is the rough similarity in mortality trends throughout the world. Life expectancy has been rising persistently almost everywhere; increases are projected to continue. The sharp fall in life expectancy over the last two decades for a few nations such as South Africa, Tanzania and Russia, interrupting their trend increases, illustrates the exceptional experience of a minority of countries. South Africa and Tanzania, for example, have been hit especially hard by the HIV/AIDS epidemic.

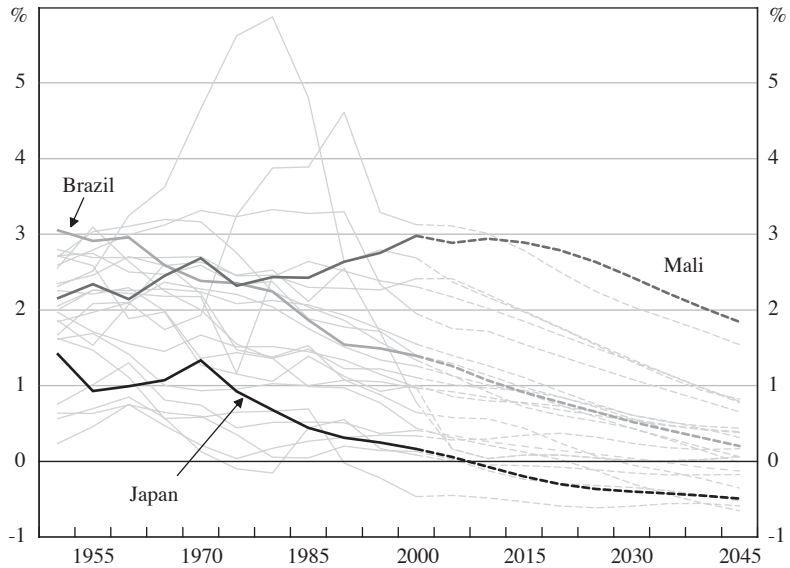
Annual growth rates of total populations have recently trended downwards (Figure 3). Broadly speaking, decreases in fertility have been quantitatively more important than increases in life expectancy; thus the net effects on population growth rates have been negative. The UN projects the trend reductions in growth rates to

Figure 2: Life Expectancy at Time of Birth



Notes: Dates refer to the beginning of the 5-year window. Data after 2005 are based on projections.
Source: UN Population Division (2005)

Figure 3: Average Annual Growth Rate of Total Population



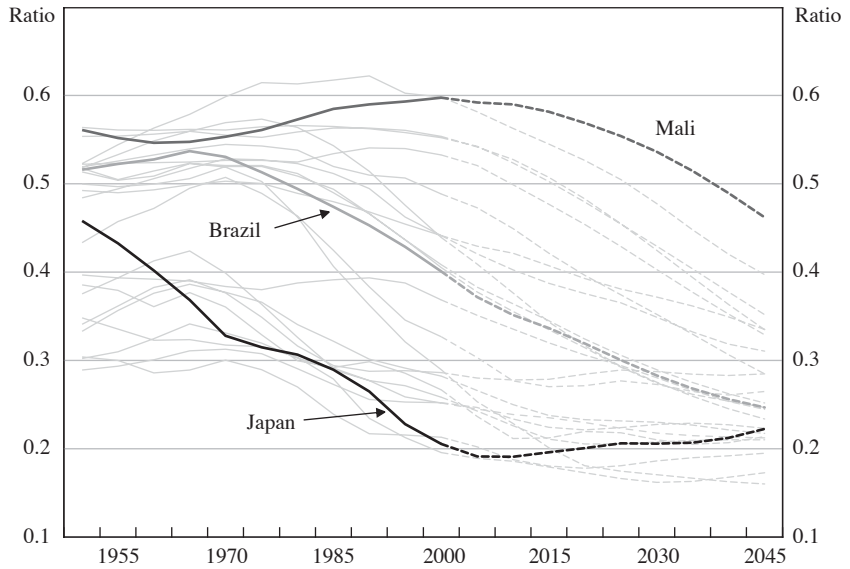
Notes: Dates refer to the beginning of the 5-year window. Data after 2005 are based on projections.
Source: UN Population Division (2005)

continue. Cross-country differences in birth rates and life expectancies, however, can continue to cause major differences in the levels of population growth rates. For developed nations such as Japan, the total population is now beginning to contract. In contrast, many developing countries still have population growth rates in the neighbourhood of 1½ per cent or higher. At the extreme, the growth rate in least-developed countries such as Mali is very high and is projected to remain high for several more decades before eventually falling.

Youth dependency ratios have fallen fastest and furthest in those Northern economies whose demographic transitions are the most advanced (Figure 4). Conversely, youth dependency ratios in early-stage developing countries are still very high; well over half of the population in many of those countries is under the age of 20. On average in middle-stage developing economies, some two-fifths of the total population are youths.

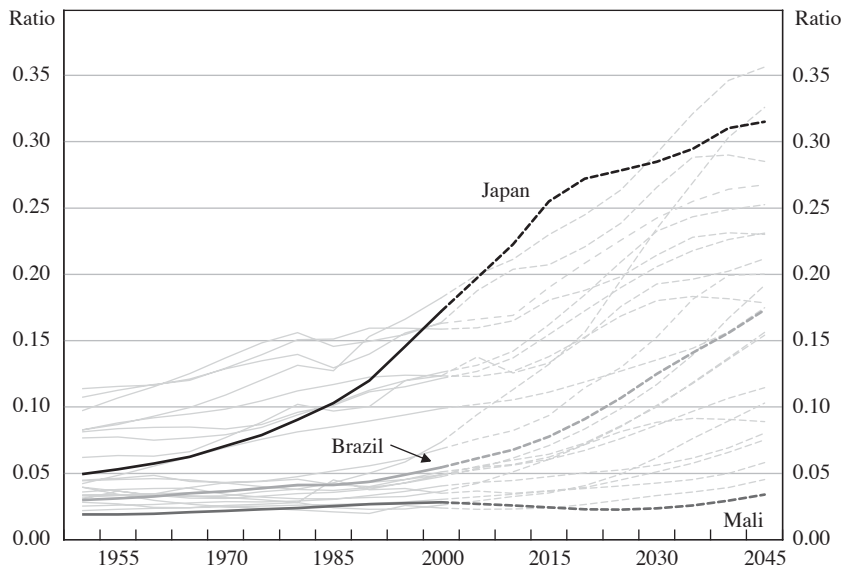
Because of their more advanced transitions, Northern economies have also experienced the greatest increases in the share of the elderly in their populations (Figure 5). In Japan, for example, already one-fifth of the population is elderly (65 years and older), with large further increases projected between now and 2050. The elderly dependency ratio is projected eventually to rise significantly throughout the South, albeit from levels today that are much lower than in Northern economies. Indeed, for early-stage developing countries, the elderly ratio may not rise at all for several more decades.

Figure 4: Ratio of Youths (Ages 0–19) to Total Population



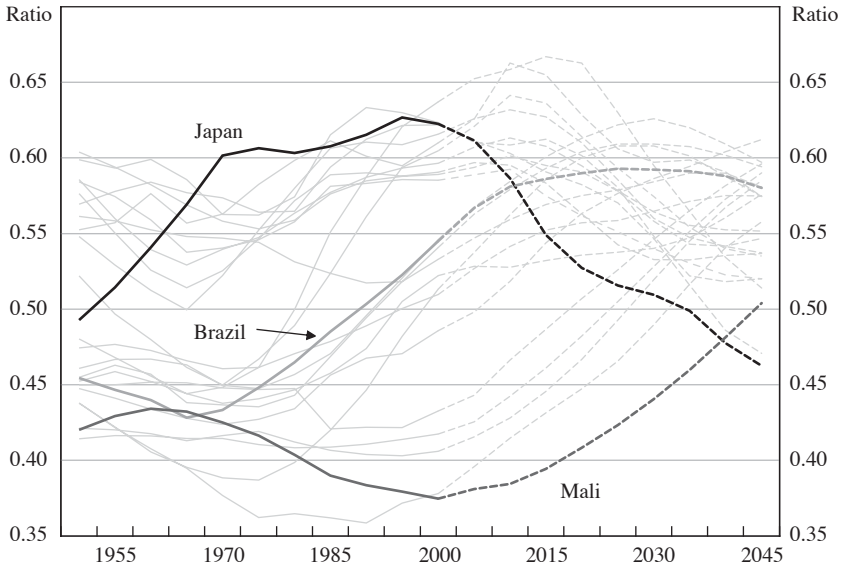
Notes: Dates refer to the beginning of the 5-year window. Data after 2005 are based on projections.
Source: UN Population Division (2005)

Figure 5: Ratio of Elderly (Ages 65+) to Total Population



Notes: Dates refer to the beginning of the 5-year window. Data after 2005 are based on projections.
Source: UN Population Division (2005)

Figure 6: Ratio of Active Adults (Ages 20–64) to Total Population



Notes: Dates refer to the beginning of the 5-year window. Data after 2005 are based on projections.
Source: UN Population Division (2005)

Active ratios are strongly influenced by the stage of demographic transition (Figure 6). Differences among nations are dramatic, both for levels at any point in time and for changes through time. In the second half of the 20th century most developing economies had significantly lower active ratios than those in industrialised economies (for example, compare Brazil and Japan). Early-stage transition economies have had especially low, and often even falling, active ratios. In contrast, the active ratios of Japan and several European economies reached their maximum values in the 1990s; the United States is currently near the peak of its active ratio. During the first half of the 21st century, broad trends in the active ratios of Northern and Southern economies will continue to be contrary, but in the opposite directions from the 1990s. The North is moving into a stage in which active ratios will persistently decline. Most Southern economies are entering decades in which active ratios will continue to rise, a period that will enable them to reap the demographic bonus associated with a plentiful supply of workers relative to dependents.

4. Basic Macroeconomic Effects of Demographic Transitions

Effects on labour markets and the production sectors and production technologies of economies are the fundamental determinants of the macroeconomic outcomes resulting from demographic transitions. The rudiments of these basic forces are

summarised in this section. Important open-economy modifications are not discussed until the following section.[11]

Declines in birth rates (reductions in 'fertility') and increases in adult life expectancy (declines in adult 'mortality' rates) both alter the composition of national populations: the average age of individuals in the population rises; the ratio of elderly individuals to working adults increases; the ratio of youths to working adults declines; and the ratio of the effective labour force to the entire adult population falls.[12] The effective labour force declines relative to the output and capital stock of the economy. The marginal product of labour rises. With the effective labour force lower relative to the capital stock, the marginal product of capital falls and the capital-output and capital-labour ratios rise. Real interest rates decline over the medium run in association with declines in the marginal product of capital.

To gain intuition about the effects of demographics on macroeconomic variables such as saving, remember that when individuals first enter the labour force, they have relatively low productivity, relatively low labour incomes, and relatively low savings. Younger adults on average have lower savings in their early working years in part because of children and child-support expenses. Then as workers gain experience and seniority and have higher productivity, their effective labour input increases over time; in effect, they ascend the left side of the hump of the economy's age-earning profile. Individuals tend to reach their peak earning and high-saving years when they are in their forties, fifties and early sixties. Saving is high in these years not only because of higher labour incomes but also because of the need to save in anticipation of retirement and because older adults typically face lower payments for child support. Eventually, workers start to descend the right side of the humped age-earning profile so that their labour incomes and saving decline. During retirement, their consumption must be increasingly financed out of their privately accumulated financial wealth as supplemented by pension transfers from the government.[13]

Changes in the age composition of the population, together with the hump-shaped profile of earnings by age, influence both the supply side and the demand

---

11. The generalisations summarised here and in following sections are based on the research cited in the papers in footnotes 2 and 3 above. The two-region analytical models used in the research are general equilibrium models simultaneously determining all the main macroeconomic variables in each region. The model structures are described in detail in the research papers. The treatments of household consumption, saving and wealth accumulation build on the simplified overlapping generations framework of Yaari (1965), Blanchard (1985) and Weil (1989) as extended by, among others, Faruqee, Laxton and Symansky (1997) and Faruqee (2002). That framework is in the tradition of modified life-cycle models. Bequests (voluntary or involuntary) are not taken into account.

12. The effective labour force is the labour force adjusted for labour-augmenting technical change (so-called efficiency units of labour).

13. The hump shape of an economy's aggregate age-earnings profile reflects both of two types of effects: changes over time in the relative productivities of age cohorts (initially, increases due to rising seniority and experience and then subsequently decreases towards the end of working life as workers become less productive); and changes in the rates of participation in the labour force of different age cohorts.

side of macroeconomic behaviour. On the supply side, the age-earnings profile is an indicator of changes in a cohort's relative productivity and its supply of labour over its lifetime. The number of workers in each cohort, weighted by productivities across working cohorts, directly influences the aggregate supply of output. On the demand side, the anticipated path of labour income determines the saving plans of consumers over their lifetimes.

Incentives for investment also change in response to changes in demographics and labour productivity. As the effective labour force adjusts and the relative scarcity of labour and capital are altered, the previous relationship between the capital stock and output becomes economically inappropriate. Variables such as real interest rates are pressured to adjust to reflect the new conditions. Investment flows, occurring promptly or sluggishly depending on the size of the changed incentives and the adjustment costs to be paid, alter the capital stock and key macroeconomic variables such as the capital-output and the capital-labour ratios.

Historical demographic transitions have been a mixture of declines in fertility and increases in life expectancy, with the mixtures varying heterogeneously across countries (Figures 1–6). For most countries, fertility declines have been quantitatively more important as a driver of current and prospective population ageing. As the 21st century progresses, increases in life expectancy due to further advances in medical science may become relatively more significant.[14]

The specific cause of demographic changes, or the combination of causes, matters greatly. Notably, the macroeconomic effects of demographic change differ importantly depending on whether ageing of the population occurs predominantly because of fertility declines and hence fewer children or, alternatively, because of lower death rates and hence longer survival spans.

For fertility declines where the birth rate falls from an initial to a lower level and remains thereafter at the lower level, a fall in the effective labour force relative to the adult population and an eventual rise in the elderly dependency ratio are associated with a *fall* in the aggregate sizes of the total and adult working populations. The growth rate of population and its components *declines*. *Less* output is produced than would otherwise have been generated in the absence of the demographic changes. Other major macroeconomic aggregates – specifically including the capital stock and the aggregate consumption of the economy's residents – are also *lower*.

As with fertility declines, increases in adult life expectancy (with, for example, the adult mortality rate declining from an initial to a lower level and remaining at the lower level thereafter) lead to rises in the elderly dependency ratio, declines in the youth dependency ratio and falls in the ratio of the effective labour force to the adult population. But those similarities are overshadowed by qualitative differences. With increases in life expectancy, the total and adult working populations *increase*

14. The two categories of underlying demographic causes are interrelated in complex ways. Declines in birth rates, for example, are probably in part an endogenous response to actual and expected declines in mortality rates at all ages (especially reductions in mortality for infants and young children). A helpful recent overview of demographic behaviour is provided by Lee (2003).

and the ultimate growth rate of the population and its components moves *higher*. *More* aggregate output is produced, the economy's capital stock is *larger*, and the economy's residents have *higher* aggregate consumption than would have been the case in the absence of the demographic changes.[15]

Other similarities and differences are significant. With both fertility declines and increases in life expectancy, for example, *per-adult* human wealth rises, the ratio of savings to output rises, and the marginal propensity to consume out of lifetime wealth and per-adult consumption fall as forward-looking consumers adjust the intertemporal paths of their consumption. In contrast, absent the open-economy effects, per-adult financial wealth *declines* over the longer run with fertility declines but *rises* in the longer run with increases in life expectancy.[16]

When analysing macroeconomic effects, it is essential to carefully incorporate the implications of youth dependency and elderly dependency. The key point about youth dependency is that the consumption-saving behaviour of individual adults who provide *in vivo* transfers to children is dramatically different, in theory and in practice, from the behaviour of otherwise identical individuals without financial responsibilities for child support. If a demographic shock lowers the number of children, for example, the financial burden on child-supporting adults is reduced and resources are freed for additional adult consumption or saving. That reallocation of resources radically changes the transitional dynamics and the ultimate position of the economy compared to what it would otherwise be in an analysis that disregards children and child support. Analogously, because elderly individuals tend to be supported by pension benefits, some portion of which is provided through government-administered programs, ignoring elderly dependency suppresses the major source of macroeconomic effects stemming from the operation and financing of public pension systems.

5. Open-economy Effects of Asymmetric Demography

Open-economy interactions can critically modify the macroeconomic effects of demographic change when one part of the world economy experiences a different demographic evolution from those occurring elsewhere.

---

15. Even for demographic variables such as elderly ratios and labour-force-to-adult-population ratios that move qualitatively in the same direction, the quantitative size of changes tends to be significantly different. For example, an increase in adult life expectancy that is 'comparably sized' to a reduction in the birth rate – where comparably sized has the specific meaning that both types of shock have equivalent effects on the absolute values of changes in the ultimate steady-state growth rate of population and its components – tends to cause significantly smaller increases in elderly ratios and markedly smaller falls in the ratios of the effective labour forces to adult populations.

16. Numerous individual economies and, on average, the world as a whole have in recent years experienced an extended secular decline in real interest rates. It is interesting to speculate whether this decline is attributable partly to demographic factors. The common trends in demographic transitions, fertility declines and increases in life expectancies, both lead to reductions in the marginal product of capital and hence to declines in real interest rates.

The simplest analytical case, one that brings out key generalisations with the fewest complexities, is a world composed of two equal-sized economies (referred to hereafter as the home economy and the rest of the world, ROW) with identical domestic structures that are linked by cross-border flows of goods and capital but that have no cross-border migration.[17] The exchange rate linking the two economies adjusts to ensure that the current account balance and the net foreign asset position for the world as a whole (the algebraic sum of both economies) are always zero. Within each economy, optimising firms produce a single composite good. The goods from each country are imperfect substitutes; some production in each country is exported; import demands are a function of national incomes and relative prices. Suppose that, in the past, the two countries have had identical demographic and economic histories. For analytical shorthand, refer to an extrapolation of these identical histories as a benchmark 'baseline'.

5.1 Asymmetric fertility declines

Now imagine that the home economy is subject over an extended period to a demographic shock (departure from the past experience) that is larger or occurs sooner than demographic changes in the ROW. Fertility declines must be analysed separately from increases in life expectancy. Hence consider first the case in which the home economy experiences a rapid and large decline in its birth rate relative to baseline while the ROW has a slower, more gradual decline.[18]

In the home economy, aggregate human wealth, financial wealth, output, consumption and the capital stock all eventually decline to levels that are lower relative to baseline. Because the effective labour force declines relative to the capital stock, the marginal product of capital falls and the home real interest rate declines. Since the ROW also experiences a decline in fertility, albeit at a slower pace than in the home economy, the ROW real interest rate will also decline, but by less than in the home economy. The home capital-output ratio rises substantially in the medium and longer runs and remains at the higher level forever. The ROW experiences a smaller rise in its capital-output ratio. These different interest rate, capital stock and output evolutions in the two parts of the world are associated with major differences in saving and external sector behaviours.

Saving and financial wealth per adult in the home economy rise sharply relative to baseline in the shorter and early medium run; part of the increase is gradually

17. In this section and the ones that follow it is assumed throughout that workers, and people generally, are prohibited from moving across national borders. Neither I, nor others, have so far developed a satisfactory general equilibrium modelling of the world economy that appropriately and systematically adds cross-border migration of people to the cross-border movements of goods and financial funds. As discussed earlier, movements of people across borders are relatively less important so that the omission of migration is a defensible first approximation to a comprehensive analysis.

18. For analytical clarity, it is assumed that both the home and ROW economies ultimately reach new steady-state evolutions that, as with their past histories, are identical in rates of growth. The home economy, however, reaches its new steady-state evolution much sooner and, of course, experiences a permanent change in the size of its economy relative to the ROW economy.

reversed in the longer run. In contrast, ROW saving and financial wealth per adult rise less. The relatively higher increases in home financial wealth are explained partly by higher disposable incomes and savings reflecting the reduced support of consumption of the smaller numbers of children. The differences in saving behaviour, and hence in financial wealth, between the home and ROW economies are attributable not merely to their different-sized demographic shocks but also to modifying effects working through the exchange rate and external sector transactions.

As the interest rate falls more in the home economy than in the ROW, an interest differential in favour of the ROW opens up. That interest differential needs to be offset by an expected depreciation of the ROW currency. So as fertility continues to decline faster in the home economy, the home currency begins a sustained appreciation, first in nominal then with a lag in real terms. In the medium and long runs, the nominal and the real exchange value of the home currency settle at appreciated levels significantly higher relative to baseline.

To understand why the asymmetric demography results in a permanent appreciation of the home currency, it is necessary to focus on changes in the *relative* size of home and ROW outputs, which in turn depend on changes in the *relative* sizes of the populations and effective labour forces. The asymmetric fertility declines cause transitory differences between the home and ROW demographic rates of growth but permanently change the relative levels of demographic and macroeconomic variables. The home effective labour force falls substantially relative to the ROW's by the time both parts of the world eventually settle down to identical long-run rates of growth. Correspondingly, home macroeconomic aggregates such as the capital stock and goods output become smaller relative to the ROW. The quantity of home-produced goods available for sale and consumption in the world thus falls relative to the quantity of ROW-produced goods. In the absence of changes in the preferences of each region's consumers for the two types of goods, relative prices in the world economy have to change to reflect the now relatively less abundant home-produced goods. A permanent real appreciation of the home currency, representing an improvement in the home economy's real terms of trade, is an integral part of the required change in relative prices. The size of the required appreciation depends – as will be discussed further below – on the degree of price sensitivities in the home and ROW economies, in particular on the price elasticities of import demands.

Changes in the exchange rate create incentives for expenditure switching between the two economies. Thus the home economy begins to import substantially more of the now relatively cheaper goods produced in the ROW. Home exports to the ROW are inhibited. These expenditure-switching effects eventually cause the home economy to run a progressively larger *deficit* on its real trade account. This net import of real resources from abroad provides a cushion of support to the home economy that permits it to sustain a significantly higher level of consumption than would otherwise be possible. The ROW economy experiences the opposite effect: it must make net exports of real resources and correspondingly curtail its consumption.

The home trade deficit is *not* associated with a deficit on current account. The home economy not only imports more from abroad. It also saves more and its financial

wealth *rises*. A fraction of the higher home financial wealth is invested abroad at the relatively higher interest rates available abroad. Hence the home economy over the medium and long runs earns a higher flow of investment income from abroad. The net investment income received is more than enough to offset the deficit on trade account so that the home economy experiences a significant current account *surplus*. The home net foreign asset position, the integral over time of its current account imbalances, becomes increasingly positive.

It is instructive to analyse the outcome from the perspective of the home and ROW saving-investment balances. Saving rises relative to investment in the home economy. In the ROW, saving falls relative to investment. The opposite side of the coin of the home current account surplus is a *net outflow* of financial capital. Thus, the home economy – despite its relatively larger demographic shock, which causes sizable declines in home output and aggregate consumption relative to output and consumption abroad – nonetheless becomes a net capital exporter. The sizable net positive return earned on the home net foreign asset position helps to cushion the home economy from its larger demographic changes. Conversely, the ROW economy is adversely buffeted; it must, in effect, share some of the consequences of the larger demographic shock occurring abroad.

Careful analysis should differentiate between *aggregate* levels of macroeconomic variables and their *per-capita* and *per-adult* values. Home aggregate real consumption falls further below baseline than does ROW aggregate real consumption. Yet the path for home aggregate real consumption is significantly *above* the path that would be experienced in the hypothetical case in which the home economy is unable to cushion its larger shock through transactions with the ROW. When the per-adult or per-capita values of consumption in the home economy are considered, the cushioning effects of openness appear even more consequential. Notwithstanding the fact that the home demographic shock is larger than the ROW's shock, home per-adult consumption is *higher* than ROW per-adult consumption. The difference between the two economies is sizable in the initial decades of the asymmetric shocks and is even more marked in the long run. The cushioning effects are so substantial when measured in per-adult terms that home adults can be better off *not only relative to ROW adults*, *but also better off absolutely relative to the no-shock baseline*. Conversely, ROW per-adult consumption is *lower* than in the no-shock baseline even though the ROW's population, aggregate real GDP and aggregate consumption are all at higher-than-baseline levels.

5.2 Asymmetric increases in life expectancy

Continue to posit a world composed of two equal-sized economies having identical domestic structures and linked by cross-border flows of goods and capital. But now assume that the home economy experiences a larger and faster increase in life expectancy than the ROW. The capital stock, aggregate output and aggregate consumption of the home economy will *expand* relative to the counterpart ROW aggregate variables (instead of shrinking as with an asymmetrically larger home fertility decline). Increased longevity, however, also leads to a relatively larger

increase in the size of the home labour force. In both economies the capital-labour ratios decline and the capital-output ratios rise over the long run. But the decline in the home capital-labour ratio is relatively larger and the rise in the home capital-output ratio is relatively smaller. Declines in home real and nominal interest rates will thus be *smaller* than the declines abroad. The resulting interest differential in favour of the home economy, which other things equal needs to be offset by an expected incipient depreciation of the home currency, encourages an actual depreciation. Because the aggregate supply of home-produced goods is *increasing* relative to the aggregate supply of goods produced in the ROW, a medium- and long-run depreciation of the home currency – a deterioration in the home economy's real terms of trade – is needed as a component of the required change in the relative prices of goods and services produced in the two economies. The size of the required depreciation depends, in part, on the price sensitivities of home and ROW import demands.

The consequences of asymmetric increases in life expectancy for the home economy's net external sector transactions – the balances on trade, investment income, the current account and net capital flows – differ in important ways from, but also have similarities with, the effects of asymmetric fertility declines. Shorter-run effects from increased longevity also differ from the long-run effects. The home real trade balance in the shorter run is in deficit; yet over the longer run, reflecting the expenditure switching associated with the depreciation of the home currency, the trade balance moves toward a surplus. The home investment-output ratio rises fairly sharply over the short and medium runs, but the saving-output ratio rises even more. The ratio of the home current account to nominal GDP thus changes positively. The home economy is a net exporter of capital. Net investment income rises enough to more than offset the trade deficit. The home net foreign asset position modestly and gradually becomes more positive over the short and medium runs.

Over the longer run, however, the home saving-investment balance changes sign, the current account moves into deficit, and the net foreign asset position begins a protracted decline. After the medium run, the home economy's real terms of trade continue to deteriorate gradually. In the longest of runs, the home net foreign asset position actually turns into a net liability position.

The evolution of external sector transactions in the shorter and medium runs might at first seem paradoxical. Why do the home current account and net foreign asset positions improve for the asymmetric increase in life expectancy as well as for an asymmetric decline in fertility even though the exchange rate in the two cases moves in opposite directions? The apparent paradox is explained when it is seen that improvements in the current account and net foreign asset positions of the home economy occur sooner and faster for the asymmetrically larger home increases in life expectancy but then begin to be reversed sooner and faster. The evolutions of external sector outcomes over time become progressively different when asymmetric increases in life expectancy are compared with asymmetric declines in fertility.

Welfare comparisons between parts of the world economy also depend sensitively on whether the demographic changes take the form of increases in life expectancy or declines in fertility. When life expectancy in the home economy increases faster

than in the ROW, home per-adult and per-capita consumption fall below the no-shock baseline even though the home population, aggregate home real GDP and aggregate home consumption are all above their baseline levels. ROW per-adult and per-capita consumption also fall below baseline, but proportionately *less* than in the home economy. The effects on individuals at home stemming from the openness of the economy can be adverse – 'exacerbating' rather than 'cushioning' the impact of demographic change – if the dominant cause of a faster and larger home demographic transition is an increase in life expectancy instead of a fertility decline.

5.3 Qualifications

The preceding cases abstract from several relevant considerations. The underlying analytical framework uses simplifying assumptions. The generalisations are a sound place to begin the analysis of demographic and macroeconomic interactions across borders. Nonetheless, one should be cautious when applying that analysis to actual economies.

One question to ask is whether the generalisations are significantly affected by the assumption of equal-sized economies. For example, would the qualitative conclusions differ much if the home population and economy were assumed to be much smaller than the population and economy of the ROW? Limited explorations in varying the relative sizes of the economies in my analytical framework suggest some expected differences in results, but typically only of second-order importance. One presumes that a small open economy will be substantially influenced by shocks originating in the rest of the world and, correspondingly, that shocks originating in a small economy will have relatively modest effects abroad. But by itself, the relative size of regions that experience asymmetric demographic evolutions does not appear to overturn the qualitative conclusions summarised above.

To illustrate, consider a smaller home economy experiencing a faster fertility decline relative to the ROW. The home currency will appreciate somewhat less than when the home economy is large relative to the ROW. Given the smallness of the economy relative to the ROW, home per-adult and per-capita consumption will perform somewhat more favourably as the asymmetric demographic evolutions occur. But the qualitative outcomes do not show a first-order difference.

Possible qualifications are more significant when nations or regions of the world vary greatly in structure and initial conditions, as of course they do in real life. The next section discusses the case of demographic differences between two regions representing developing and developed economies. The focus is on how such differences influence the regions' aggregate saving-investment imbalances and the resulting net capital flows between the regions. That example assumes large differences in the structures and sizes of the two regions and allows for quite different initial conditions (the configuration of the economies at the start of the analysis). As shown in the example, the underlying analytical framework described above can be successfully applied in circumstances where regional or country differences are more realistically taken into account.

Much further research, however, remains to be done before one can generalise with confidence about individual countries and regions. Analytical frameworks differ in the details of their structures and simplifications (as can be seen by a comparison of several papers for this workshop). What is most needed is further refinement of multi-country models that provide for a general equilibrium determination of interest rates, exchange rates, saving-investment imbalances and external sector transactions.

My inferences about the effects of asymmetric changes in life expectancy may be especially subject to modification. It is a strength of my modelling framework that it delivers an endogenous determination of interest rates and exchange rates that keeps careful track of general equilibrium interactions across borders. But the tractability of my general equilibrium approach comes with a cost: the model uses a theoretical shortcut that assumes adult mortality rates are age-invariant across all adults and youth mortality rates are age-invariant across all children. The assumption that mortality rates (the inverse of life expectancies) are age-invariant rather than age-specific departs seriously from reality.[19]

6. North-South Capital Flows

The largest demographic asymmetries in the world today, dramatically evident in Figures 1–6, exist between lower-income, less-developed countries (the 'South') and higher-income developed countries (the 'North'). Although many factors other than demography influence net capital flows between the North and South, asymmetric demographic transitions are important in determining whether and how transfers of savings take place. Focusing on North-South capital flows is thus another revealing way to study the issues on this workshop's agenda.

In principle, demographic influences can have either facilitating or restraining effects on net transfers of savings. Toward one end of the range of views, the presumption is that asymmetric demographic evolutions will increase the extent to which the South collectively runs a current account deficit, thus importing a fraction of Northern savings into Southern economies. This view is relatively optimistic:

19. The theoretical shortcut is attributable to Yaari (1965), Blanchard (1985) and Weil (1989). Advantages and disadvantages are discussed in Bryant and McKibbin (2004), Bryant (2004c) and Bryant *et al* (2004). Blanchard himself pointed out that the evidence on mortality rates suggests low and approximately constant probabilities of death from, say, ages 20 through 40; thereafter mortality rates rise with age (sometimes modelled by 'Gompertz's Law' suggesting that mortality rates after puberty rise in geometric progression as in Wetterstrand 1981), reaching (annual) rates in the United States in the neighbourhood of 16 per cent by age 80 and 67 per cent by age 100. The generalisations about changes in life expectancies in the text stem from analytical experiments that asymmetrically change the average (age-invariant) life expectancies for adults in the model's regions. In real life, macroeconomic effects presumably depend sensitively on the specific age cohorts for which life expectancy increases. Declines in mortality rates for elderly adults, for example, presumably have different macroeconomic effects than declines in mortality rates for young adults or for children. When simulation experiments in my underlying model for reductions in youth mortality are contrasted with the results for reductions in adult mortality, notable differences are evident.

it presumes North-South macroeconomic interactions will be mutually beneficial, permitting asset owners in the North to earn higher returns on their savings than would otherwise be possible and simultaneously permitting investment within the South to be higher, thereby promoting Southern economic development. Views toward the opposite end of the range are sceptical. Demographic influences could, according to those views, move saving-investment imbalances in the North and the South in the 'wrong' direction, *reducing* the degree to which Southern economies can run a current account deficit and sustain a higher level of domestic investment relative to Southern savings.

Quite apart from demographic trends, impediments and frictions in Southern economies and politics suggest a non-optimistic view about their ability to absorb saving from the rest of the world. Southern economies can provide substantially larger investment opportunities at the margin for Northern investors only if the constraints that inhibit faster Southern growth can be eased. In practice, the South might not be able to absorb enough Northern savings to alter significantly the saving-investment balance for the North. Most analysts agree that investments in the South by Northern owners of financial capital, if feasible, could bring advantages to both the North and South through enhanced diversification of risk and higher rates of return. For Southern economies to capture those potential gains, however, the economic, political and legal impediments that inhibit Northern investment in the South must not be too severe.[20]

To isolate the effects of asymmetric North-South demography from other influences, I use an analytical framework similar to that underlying the analysis above. Developing and developed economies are aggregated into a two-region world – a Southern economy and a Northern economy – and the demographic and macroeconomic interactions between them are simulated. The analysis, however, differentiates many aspects of the behaviour of the regions, trying to capture some of the salient differences between developing and developed economies. The calibration of the regions' structures, for example, reflects the facts that the South has some 80–85 per cent of the world's population but only about one-fifth to one-quarter of world GDP measured at market prices and at market exchange rates. The regions have very different levels and growth rates of total factor productivity. The investment climate in the South is less favourable than in the North (adjustment costs for changing capital stocks and risk-premium wedges are higher). A smaller fraction of Southern than of Northern households is assumed to be able to smooth consumption intertemporally in a manner consistent with the life-cycle hypothesis. At the outset of the analysis, the South is running a sizable current account deficit in relation to its GDP and has a large net foreign *liability* position. Because of the global identities enforced in the model, the North has a correspondingly large net foreign asset position *vis-à-vis* the South. In the 1950 initial conditions with which

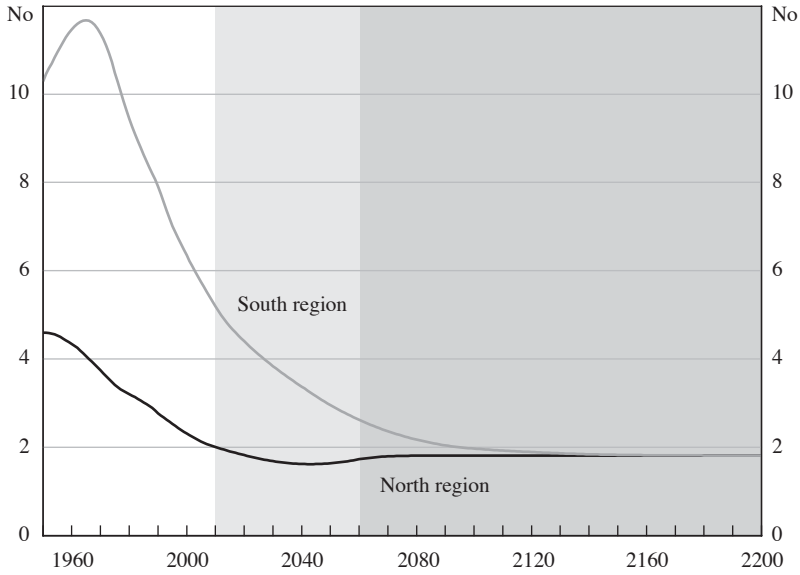
20. Discussion of the issues can be found in, for example, the World Bank's (2002, 2004) *World Development Report* for the years 2002 and 2005, Gertler and Rogoff (1990), Temple (1999), Hall and Jones (1999), Holzmann (2000) and Bosworth and Collins (2003). See also the early pages of Bryant (2006).

simulations begin, therefore, the South has domestic investment that is higher than national saving while national saving in the North is higher than domestic investment, with a part of Northern gross saving exported to the South through net capital outflows.[21]

Figure 7 shows aggregated birth-rate series for the Southern and Northern regions that are derived from the UN Population Division's data for life expectancies and the growth rates of adult populations. Figure 8 plots the related series of the active ratios of working-age adults to the total population. Each of these charts (as well as the others that follow) begins with the historical data for 1950–2005; the UN projection data for 2005–2050 are lightly shaded; the darkly shaded parts for years after 2050 indicate how the UN projections can be analytically extended to produce eventual convergence to a steady state with stationary populations in all parts of the world.

The changes over time in birth rates shown in Figure 7 and counterpart series for changes in life expectancies indicate that, from today until the middle of the 21st century, demographic transitions on average in Northern economies are beginning to slow down while transitions in Southern economies are picking up speed. The effects of asymmetric demography depend not only on differences across

Figure 7: Fertility Rates
Births per woman

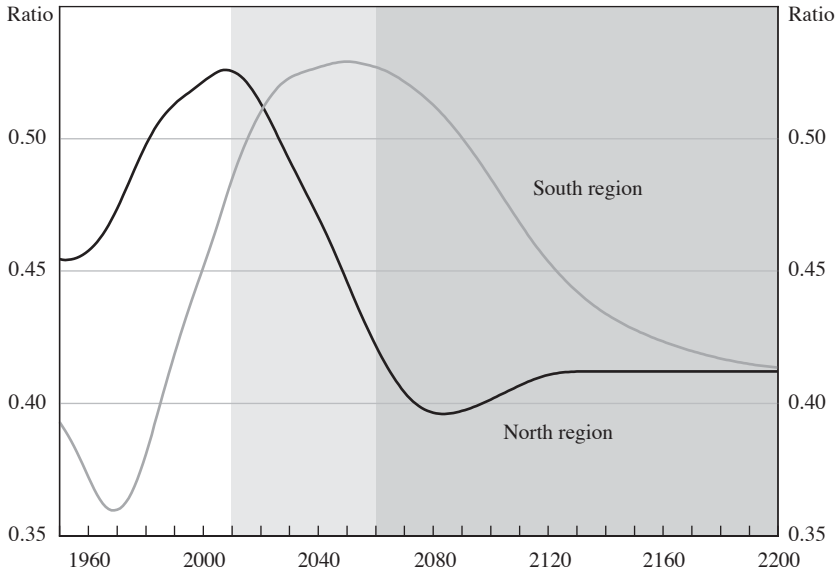


Note: Data from 2005 to 2050 are based on UN Population Division projections and thereafter analytical extensions to produce eventual convergence to a stationary population steady state.

Sources: Bryant (2006); UN Population Division (2005)

21. Details are given in Bryant (2006).

Figure 8: Ratio of Active Adults (Ages 20–64) to Total Population



Note: Data from 2005 to 2050 are based on UN Population Division projections and thereafter analytical extensions to produce eventual convergence to a stationary population steady state.

Sources: Bryant (2006); UN Population Division (2005)

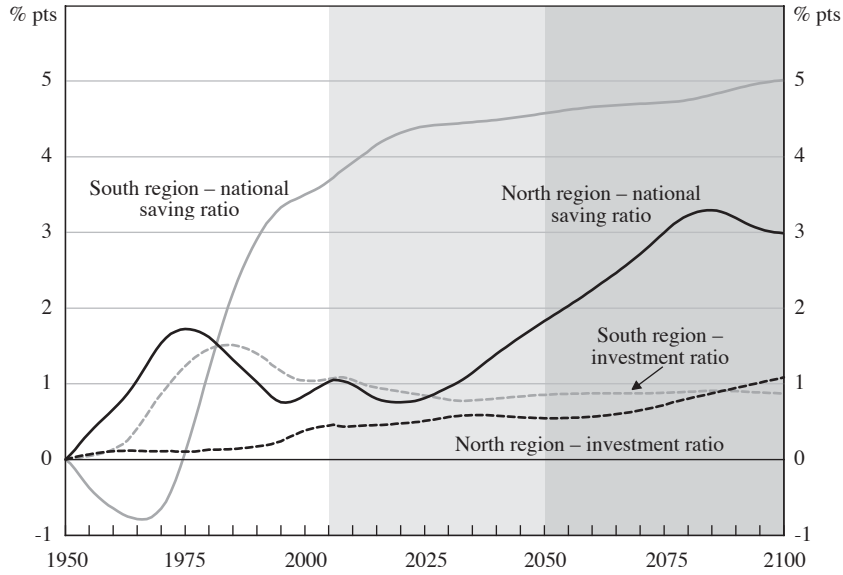
regions in the *levels* of birth rates, life expectancies and dependency ratios but also on differences in the sizes of incremental *changes* in rates and ratios. The gap in levels between Southern and Northern demographic variables will diminish through time. Alternatively stated, especially because of faster declines in Southern fertility rates, Southern economies will prospectively experience demographic change *more rapidly* – not less rapidly – than Northern economies. The very different prospective changes in active ratios (Figure 8) provide another clue about the macroeconomic interactions that lie ahead between developing and developed regions.

To illustrate the macroeconomic effects on saving, investment and saving-investment balances, Figures 9 and 10 summarise the results of a benchmark model simulation incorporating the demographic inputs shown in Figures 7 and 8. Figure 9 plots the evolutions of saving and investment relative to economic activity in the Southern and Northern regions. Each region's external imbalance in the benchmark simulation, measured as a ratio to the region's nominal GDP, is plotted in Figure 10. These current account balance ratios are implicit in Figure 9, but Figure 10 makes it easier to focus on how dramatically the saving-investment balances change over time. The variables are measured as changes from the initial-conditions values of the ratios prevailing in 1950.[22]

22. The denominators of the ratios in Figures 9 and 10 are Southern nominal GDP for the Southern ratios and Northern nominal GDP for the Northern ratios. Saving is nominal national saving, the sum of nominal private saving and nominal government saving or dissaving.

Figure 9: Ratios of Domestic Investment and National Savings to Nominal GDP

Benchmark simulation – change from 1950 value of ratios

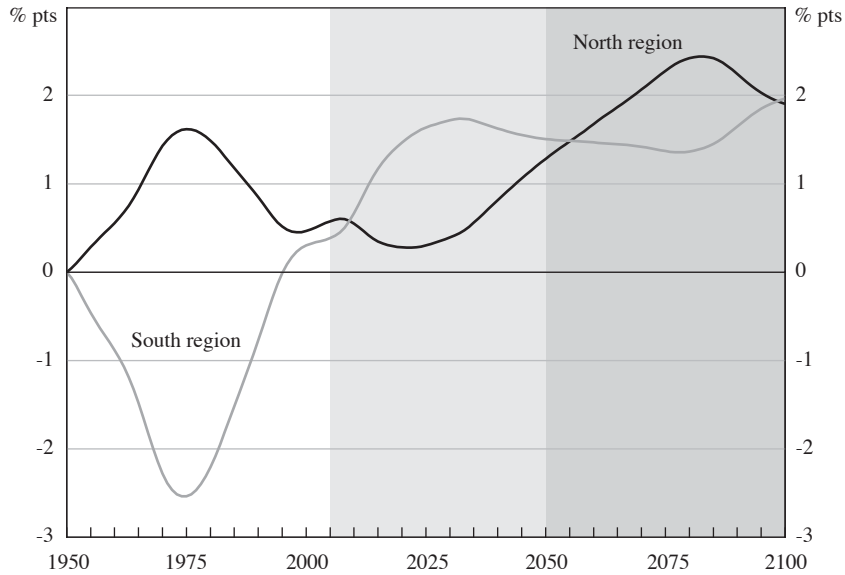


Notes: Data from 2005 to 2050 are based on UN Population Division projections and thereafter analytical extensions to produce eventual convergence to a stationary population steady state.

Source: Bryant (2006)

Figure 10: Ratio of Current Account Balance to Nominal GDP

Benchmark simulation – change from 1950 value of ratios



Notes: Data from 2005 to 2050 are based on UN Population Division projections and thereafter analytical extensions to produce eventual convergence to a stationary population steady state.

Source: Bryant (2006)

For the first few decades after 1950, the level of the active ratio is much lower in the South than the North and declines markedly (Figure 8). The decline in the Southern active ratio reflects the large number of children entering the South population in those years and the lower productivity relative to older workers of the increasingly numerous youths just entering the labour force. In association with these demographic changes, the saving-GDP ratio in the South declines significantly (by close to a percentage point of GDP) and does not begin to increase strongly until the active ratio begins rising several decades later. In contrast, the Southern investment-GDP ratio rises from the outset but then begins a gradual deceleration after the 1970s; the investment ratio falls after the mid 1980s for several decades.

Demographic influences on saving and investment in the North during the first decades after 1950 are roughly the opposite of those in the South. The North has a high and initially rising active ratio. Northern saving is buoyant and Northern investment is relatively weak during the early decades when the North active ratio is rising strongly.

The saving-investment balances move dramatically in the reverse direction, however, once the Northern active ratio peaks and begins to decline and as the Southern active ratio begins to increase strongly. The gap between the Southern and the Northern active ratios is already narrowing by the 1980s. The Southern active ratio exceeds the Northern ratio after 2020 and does not peak until 2050. The Northern active ratio continues its sharp fall. The saving ratio in the South, now influenced by the demographic bonus of a fast-increasing effective labour force, begins a persistent upsurge that continues into the middle of the 21st century. In contrast, net demographic influences in the North contribute to a peaking of its saving ratio and then a subsequent decline. The demographic evolutions of the two regions thus contribute to a progressive strengthening of Southern saving and a relative weakening of Northern saving.

As part of the adjustment to the asymmetric demographics in the benchmark simulation, the Southern currency depreciates gradually for several decades after 1950 and then depreciates more strongly over a period that continues for more than 100 years. In the very long run, the real value of the Southern currency settles at a depreciated level far below its original (initial-conditions) value. As in the earlier analyses, the changes in the real exchange rate are due to changes in the relative size of the regions' outputs, which in turn depend on changes in the relative sizes of the regions' populations and effective labour forces. The South's effective labour force is much larger than the North's by the time both regions settle down to the same rates of growth in the long run. Correspondingly, macroeconomic aggregates such as the capital stock and output become larger in the South relative to the North. The quantity of goods produced in the South available for sale and consumption in the world thus increases relative to the quantity of goods produced in the North. In the absence of changes in the preferences of each region's consumers for the two types of goods, relative prices in the world economy have to adjust to reflect the now relatively more abundant Southern-produced goods. A real depreciation of the South's currency, representing an improvement in the Northern economy's real terms of trade, facilitates the required change in relative prices.

Recall that in the benchmark initial conditions, the South in 1950 starts out as a debtor region, running a current account deficit. Thus at the outset some part of Northern saving flows to the South. This pattern of sizable capital inflows to the South in proportion to the Southern economy continues in the benchmark simulation for two and a half decades after 1950. Hence the shifts in relative demographics contribute to a major increase in the gap between the South's domestic investment and national savings ratios, and hence to a further widening in the current account deficit (Figure 10).

However, the gaps in the regional saving-investment balance ratios – the current account deficit ratio in the South and the North's current account surplus ratio – begin to move in the opposite direction around the mid 1970s. Thereafter, for the final two decades of the 20th century and the first four decades of the 21st century, the South's current account deficit as a proportion of GDP narrows steadily and persistently. By the decade of the 2030s, the South's current account deficit ratio is more than 1.5 percentage points of GDP less negative than in 1950.

The analysis summarised here thus identifies a dramatic reversal after the 1970s of saving-investment balances in relation to the sizes of the regional economies. Prior to the mid 1970s, demographic asymmetries between the Southern and Northern regions increase the net flow of capital from the North to the South. Beginning in the mid 1970s, however, the relative demographics operate in the reverse direction. As a percentage of their regional economies, Northern saving falls relative to Northern investment while Southern saving increasingly rises relative to Southern investment. Demographic influences considered by themselves progressively operate to *reduce* rather than increase the net flow of capital from the North to the South measured relative to the size of the Southern economy.[23]

The fundamental explanation for these effects is, to repeat, the shift in *relative* demographics between regions. Relative shifts in the age compositions of populations, and in particular relative shifts in the numbers of active workers in the labour forces and their efficiencies, differentially affect regions' flows of saving and investment. Aggregate savings, determined in a modified life-cycle framework, are relatively high (low) in a region in which the active labour force rises (declines) in relation to the total population. Investment relative to saving is high (low) when youth and elderly dependents constitute a large (small) fraction of the population. Both saving and investment are of course higher (lower) in a region growing strongly (sluggishly). But the balance between saving and investment for a single region – and even

23. The ratios in Figures 9 and 10 measure savings, investment, and current account balances in relation to the sizes of the regional economies and in relation to the initial conditions of 1950. In the benchmark simulation, the South – even by the 2030s – is still running a current account deficit in absolute terms; the North is still exporting a (smaller) fraction of its savings to the South. Thus the direction of net capital flows in absolute terms is still from the North to the South. The more important point analytically, stressed in the text, is that the net capital flows occurring after the mid 1970s are progressively *diminished* as a proportion of the Southern economy.

more so net changes through time in the saving-investment imbalances of regions interacting with each other – depend critically on the relative demographics.[24]

7. Cross-border Goods Substitutability

Goods substitutability and financial substitutability in the world economy have both increased over time, linking macroeconomic variables more closely across national borders. The prevailing degrees of cross-border substitutability between goods produced in different parts of the world critically determine the quantitative sizes of macroeconomic responses to policy and non-policy shocks. That point is relevant for all cross-border transmissions. It warrants emphasis here because it applies strongly to the cross-border effects of asymmetric demography.[25]

The substitutability between home-produced and foreign-produced goods – the degree of imperfect substitutability – is captured in analytical models partly by the values of the price-elasticity parameters governing each region's demand for imports. Suppose goods production in a region accounts for a rising share of world output over time. Given traditional assumptions about the determinants of imports, that region will experience a faster increase in its imports than its exports. The incipient trade imbalance will, other things equal, give rise to a real depreciation of the region's currency. With unchanged preferences for the imperfectly substitutable home-produced and foreign-produced goods, such depreciation is required to induce the world's consumers and firms to buy the now relatively less scarce output of the faster-growing region and to prevent the region's actual trade deficit from growing larger and larger. The size of the required depreciation will depend on the degree of the imperfect goods substitutability. Most other macroeconomic variables will in turn be influenced by the changes in real and nominal exchange rates.

An example drawn from the analysis of asymmetric North-South demography will establish the empirical importance of the point. The benchmark simulation whose effects on saving-investment imbalances was shown in Figures 9 and 10 above was conducted with typically estimated values for substitutability parameters. Specifically, in the import equations of both regions the price elasticities had values of –1.10 (values near negative unity are commonly estimated in aggregate import demand equations) and values of zero were assigned to the so-called 'varieties

24. Bryant (2006) discusses a variety of sensitivity experiments that test the robustness of the conclusions about the likely future direction of North-South capital flows. For example, alternative assumptions were examined about the speed of the demographic transition and the evolution of total factor productivity in the South. Although the sensitivity experiments with alternative assumptions revealed quantitative differences in the simulation results, the differences were not large enough to overturn the qualitative conclusions summarised in the text.

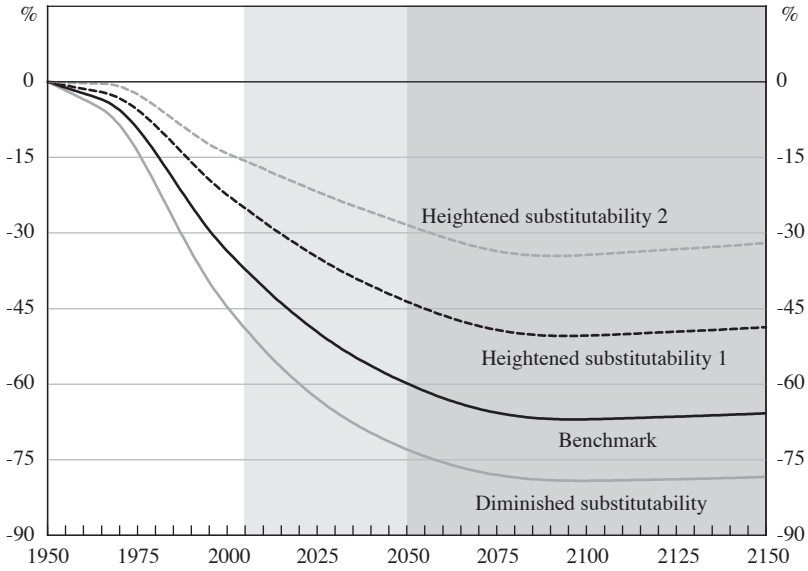
25. Bryant and de Fleurieu (2005) provide background for, and empirical illustrations of, this basic point. The degree of imperfect cross-border *financial* substitutability is probably an even more important influence on macroeconomic interactions than the degree of imperfect goods substitutability. But financial substitutability is more difficult to study empirically. Unfortunately, multi-country general equilibrium models are not yet sufficiently advanced to successfully treat assets denominated in different currencies and issued in different nations as imperfect substitutes.

effects'. For comparison, three additional simulations were prepared that were identical except for the assumed values of the substitutability parameters. For a 'diminished-substitutability' simulation, the import price elasticities were lowered by 25 per cent (to values of –0.82). A 'heightened-substitutability-1' simulation raised the import price elasticities to values two-thirds larger than the benchmark case (to –1.65) but kept varieties effects set at zero. A 'heightened-substitutability-2' simulation raised the import price elasticities by two-thirds and also assigned a positive value of 0.50 to the varieties-effect coefficient.[26]

Figure 11 contrasts the effects of the four simulations on the depreciation of the real value of the South's currency. Figure 12 contrasts the effects on the South's current account balance expressed as a proportion of nominal GDP. As the figures show, altering the substitutability parameters has major effects. Heightened substitutability dramatically cuts the size of the currency depreciation. Adding non-zero varieties effects in the heightened-substitutability-2 simulation reduces the size of the depreciation still further. Raising the substitutability parameters increases the South's current account deficit relative to GDP up until the decade of the 2030s

Figure 11: Real Exchange Value of South's Currency – Alternative Substitutability Parameters

Percentage change from 1950 value



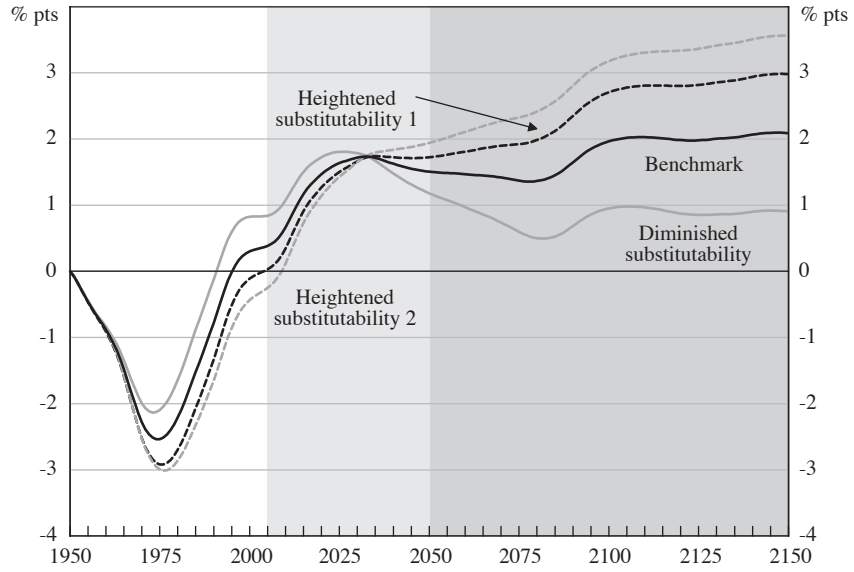
Notes: Negative values indicate a depreciation of currency. Data from 2005 to 2050 are based on UN Population Division projections and thereafter analytical extensions to produce eventual convergence to a stationary population steady state.

Source: Bryant (2006)

26. The rationale for 'varieties effects' in trade equations and the way they are incorporated in the analytical model are explained in Bryant and de Fleurieu (2005).

Figure 12: Ratio of South's Current Account Balance to Nominal GDP – Alternative Substitutability Parameters

Change from 1950 value of ratios



Notes: Data from 2005 to 2050 are based on UN Population Division projections and thereafter analytical extensions to produce eventual convergence to a stationary population steady state.

Source: Bryant (2006)

(Figure 12). If cross-border goods substitutability is diminished, the effects on the real value of the South's currency and its current account ratio go in the opposite direction. The differences in outcomes associated with different substitutability parameters have first-order importance.

The key to understanding the differences between the scenarios is to realise that changes in the degree of goods substitutability influence the relative importance of *quantity* adjustments relative to adjustments in *prices* and *price-like variables*. Heightening cross-border substitutability increases the importance of quantity adjustments relative to price adjustments. Diminishing substitutability has opposite effects: it puts even greater pressure for adjustment on prices and price-like variables. When any exogenous shocks – such as changes in fertility rates or life expectancies – are put into an analytical macroeconomic system, real quantity variables (for example, incomes, wealths, outputs and consumptions) must adjust so that regional economies and the world economy as a whole can attain a new real equilibrium. The necessary adjustments in quantity variables, although not independent of what happens to price variables, depend most crucially on the evolution of other endogenous quantity variables (with all endogenous variables ultimately driven by the exogenous shocks). If shocks are asymmetric across regions, major adjustments are typically required in both the real and the nominal values

of cross-border transactions. The greater is cross-border goods substitutability in response to changes in relative prices, the less will price variables have to adjust to achieve the necessary adjustments in real quantity variables. Greater sensitivity of behaviour to prices means that quantities, both cross-border and domestic, adjust faster and possibly more smoothly to the required new equilibrium. Conversely, if cross-border goods substitutability is weak, then price and price-like variables must adjust by much larger amounts to achieve the adjustments to quantities that are ultimately necessary. Price variables in these generalisations include of course goods prices – domestic prices as well as import and export prices. But the relevant price-like variables also include interest rates and exchange rates (both real and nominal).

Thus in the diminished-substitutability simulation shown in Figures 11 and 12, price adjustments – including, dramatically, the real exchange rate but also the real interest rate – are larger than in the benchmark case. In particular, diminished goods substitutability increases the size of the depreciation of the South's currency needed to adjust the global economy to the greater relative abundance of goods produced in the South. The lower value of the import price elasticity simultaneously *raises* the South's current account ratio (relative to the benchmark case) through the decade of the 2030s.

The opposite effects occur when the substitutability parameters are larger in absolute value. The real exchange rate and real interest rate need to change *less* relative to the benchmark case to achieve the required adjustment to the altered demographic conditions. The higher values of the substitutability parameters thus permit a *smaller* depreciation of the South's currency and produce a *deterioration* (larger negative value) of its current account ratio through the decade of the 2030s. If a non-zero varieties effect is combined with a higher value for the import price elasticities (as in the heightened-substitutability-2 simulation), the size of the necessary depreciation is still smaller and the South runs a still more negative current account ratio in the short and medium run.

The example from asymmetric North-South demography highlights another general point: the degree of cross-border goods substitutability can dramatically influence regional welfares. Heightened (diminished) cross-border substitutability with its augmented (reduced) Southern use of Northern savings improves (worsens) per-adult and per-capita consumption in the South but lowers (raises) per-adult and per-capita consumption in the North. Those effects on per-adult and per-capita consumptions stem from changes in the terms of trade of the regions. When a region experiences a real depreciation of its currency, it suffers a deterioration of its real terms of trade with the rest of the world. Other things equal, the deterioration of the terms of trade causes an adverse change in the welfare of the region's residents. In the example here, Southern residents in the benchmark simulation, because of the very large currency depreciation, experience a large deterioration in the relative prices at which South-produced goods can be traded for imported goods. With heightened substitutability parameters, the adverse changes from deterioration of the terms of trade are significantly mitigated. What is gained by the South when substitutability parameters are higher, however, is plainly an adverse development

for Northern residents. The Northern real terms of trade is less favourable than in the benchmark case and hence negatively impacts Northern per-adult and per-capita consumption.

Welfare inferences for particular nations or regions must focus on the possibility that outcomes beneficial for one part of the world economy may well be adverse for other parts. What is favourable cushioning for a region where a shock originates can turn out abroad to be unwelcome buffeting. Increases in cross-border substitutability augment the international transmission of shocks. But whether the consequences of heightened transmission are beneficial or adverse for a particular region depends on the type of shocks that occur and where the shocks originate. Heightened transmission can thus be a double-edged sword, cutting helpfully for some but unhelpfully for others.

Even the brief discussion here should suffice to establish the need for paying greater attention to the degree of cross-border goods substitutability when analysing macroeconomic interactions among different parts of the world economy. In particular, analysts and policy-makers require more reliable empirical estimates of the determinants of cross-border goods substitutability than the inadequate estimates currently available.

8. Concluding Observations

The overview in this paper in some places is, inescapably, preliminary. The overall conclusions are nonetheless robust. And such a survey provides a helpful place to start when initially familiarising oneself with existing knowledge.

To conclude, I recapitulate some main themes of the survey and highlight some points that most deserve emphasis from a policy perspective. I also suggest a few guidelines that should shape further analysis and research.

The importance of open-economy dimensions. The openness of economies decisively influences the macroeconomic consequences of asymmetric demographic transitions. The 'domestic' effects of demographic change are strongly influenced by cross-border transactions. Failure to take into account the powerful macroeconomic effects working through exchange rates and cross-border transactions can lead to a seriously inaccurate assessment of the net impacts of demographic change.

Alternative drivers of demographic change. Population ageing can result from different demographic causes. Macroeconomic consequences depend sensitively on the specific cause, or combination of causes. Most notably, the effects differ depending on whether the ageing occurs because of reductions in fertility (lower birth rates and hence fewer children) or, alternatively, increases in life expectancy (lower death rates and hence longer survival spans).

Aggregate versus per-capita outcomes. Analysis of the macroeconomic effects of demographic transitions should differentiate between aggregate effects for an economy as a whole versus effects on the economy's residents expressed in per-capita or per-adult terms. For several types of demographic shocks, the paths for aggregate levels of variables – for example the total output, consumption, and

savings of all the economy's residents – can move in the opposite direction from the paths of the same variables when measured in per-capita or per-adult terms. Differentiating between aggregate and per-capita variables would be important for the interpretation of outcomes even in a completely closed economy. For open economies experiencing different speeds and intensities of demographic change, the distinction is especially consequential and has great relevance for policy debates about population ageing.

Favourable or adverse welfare consequences? Depending on the specific nature of asymmetric demographic trends, nations and regions can be either favourably cushioned or adversely buffeted by the effects of resulting changes in exchange rates, trade flows and net flows of capital. Alternative assumptions about parameter values embodying the degree of cross-border substitutabilities can significantly change inferences about the consequences and the geographical distribution of effects. To form judgments about whether the welfare consequences will be favourable or adverse, analysis should carefully focus on the type of demographic shocks and the extent of cross-region asymmetry. It would also be desirable to conduct sensitivity tests of such judgments using alternative values of substitutability parameters.

Relative sizes of countries, demography and macroeconomics. Macroeconomic interactions in response to asymmetric demography can alter the relative sizes of economic activity in nations and regions. In effect, outputs, capital stocks and consumptions can be 'redistributed' across borders. Such redistributions can have major consequences for the relative welfares of nations, not only in economic but also in political and security terms.

When considering these redistributions, one has to bear in mind the cross-border mobility of labour. In the analysis underlying this paper, as is largely true in reality, workers cannot move across borders. In a world economy where cross-border movements of labour are prohibited, the effects of a country-specific demographic shock fall on the population, workers and effective labour forces *within* the nation where the demographic shock occurs. There can be no secondary or feedback effects, via emigration or immigration, on the sizes of the population, workers and effective labour forces outside that nation. Asymmetric demographic shocks do not have cross-border *demographic* effects.

In contrast, cross-border *macroeconomic* interactions can be powerful when goods, services and financial funds are relatively free to move internationally. Outputs, capital stocks and consumptions can be redistributed across borders with the passage of time. Within-border evolutions of effective labour forces play critical roles in determining economic activity, but the cross-border transactions can modify and redistribute the impacts of these changes. The relative sizes of economies measured by people and labour forces can thus evolve quite differently from the relative sizes measured by macroeconomic aggregates.

Will cross-border migration become more important in the future? In principle, flows of workers across borders could diminish cross-national differences in returns to capital and labour. For the destination nations where inward migration is now significant, migrants tend to be of working-age; thus they raise the ratio of workers

to non-workers, augment labour supply, and dampen changes in the capital-labour ratio that would otherwise result from demographic forces. Migration could raise saving relative to investment in destination countries and thereby improve those countries' current account balances (though remittances sent home are an offset to such effects).

As noted earlier, however, government policies severely limit or altogether restrict the flows of workers across borders. Inward and outward migration for most nations is still only of second-order importance and, in the shorter run, probably will not expand greatly. All things considered, large movements of people across borders in the next few decades are unlikely to significantly undermine the generalisations about the macroeconomic effects of demographic change summarised in this paper. Nor can one plausibly expect large-scale emigration to be a primary remedy for the economic problems of developing economies, regardless of demographic trends.

Accordingly, this paper treats the omission of migration as a defensible first approximation to a comprehensive analysis of asymmetric demography. Migration of people was an important feature of the world economy in the late 19th and early 20th centuries, however, and could become more important again in the future. Eventually, analysts of the partially integrated global economy must develop full-blown general equilibrium models that include cross-border movements of people as well as movements of goods, services and financial funds.

Guidelines for further analysis and research. The analysis summarised here is abstract and qualitative. One cannot confidently apply the generalisations to individual nations or regions. As further policy analysis and basic research are carried out prior to the successful inclusion of migration, the following points can serve as useful guidelines to shape that work.

First, analysis should focus on *relative* demographics and their likely consequences as insights are sought about interactions between a particular country or region and the rest of the world. Dependency ratios and active ratios, for example, can provide clues about saving, investment and saving-investment balances, and hence about the probable evolution of current account balances and net capital flows.

Second (a guideline related to the first), analysis should examine the relative sizes of effective labour forces and outputs for a country or region *vis-à-vis* the parts of the world with which it primarily has external transactions. The labour force and output relativities will diverge through time, but those divergences will themselves provide useful clues. The evolution of relative outputs is especially useful for generating insights about the likely direction of movements of real exchange rates and hence changes in the real terms of trade.

Third, future analysis should be conditioned by the facts that empirical estimates of relative price elasticities for trade flows, varieties effects on trade flows, and other parameters reflecting cross-border substitutability play critical roles in determining the projected global consequences of asymmetric demography, indeed of all types of shocks. And it merits emphasising again that it should be a high priority for future research to obtain more robust empirical estimates of those key parameters than the estimates currently available.

Finally, analysis should continue to study cross-border macroeconomic interactions in general equilibrium analytical frameworks. Only the least consequential economies in the world can be usefully studied with 'small, open-economy' models in which the remainder of the world is assumed exogenous, unaffected by developments in the nation or region of interest. Interactions between large individual nations – such as the United States, those of the European Union, Japan, China, India and Brazil – or between major regions of the world (for example, aggregations of developed and developing countries; North America, Europe and Japan) must be studied in frameworks that are capable of endogenously determining interest rates, exchange rates and external imbalances together with domestic macroeconomic variables in all nations or regions. Developing such frameworks is a formidable analytical task but merits the efforts that will be entailed.

Appendix A

Table A1: Fertility Rates

G7 countries, other G-20 countries and selected least-developed countries; births per woman

												UN medium projection								
	1950–1955	1955–1960	1960–1965	1965–1970	1970–1975	1975–1980	1980–1985	1985–1990	1990–1995	1995–2000	2000–2005	2005–2010	2010–2015	2015–2020	2020–2025	2025–2030	2030–2035	2035–2040	2040–2045	2045–2050
Canada	3.73	3.90	3.61	2.51	1.97	1.74	1.63	1.69	1.69	1.56	1.51	1.47	1.47	1.54	1.61	1.68	1.75	1.82	1.85	1.85
France	2.73	2.71	2.85	2.61	2.31	1.86	1.87	1.81	1.71	1.76	1.87	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85
Germany	2.16	2.30	2.49	2.32	1.64	1.52	1.46	1.43	1.31	1.34	1.32	1.34	1.41	1.48	1.55	1.62	1.69	1.76	1.83	1.85
Italy	2.32	2.35	2.50	2.49	2.33	1.89	1.53	1.35	1.28	1.21	1.28	1.38	1.41	1.45	1.52	1.59	1.66	1.73	1.80	1.85
Japan	2.75	2.08	2.02	2.00	2.07	1.81	1.76	1.66	1.49	1.36	1.33	1.37	1.44	1.51	1.58	1.65	1.72	1.79	1.84	1.85
UK	2.18	2.49	2.81	2.52	2.04	1.72	1.80	1.81	1.78	1.70	1.66	1.66	1.70	1.77	1.83	1.85	1.85	1.85	1.85	1.85
US	3.45	3.71	3.31	2.55	2.02	1.79	1.83	1.92	2.03	1.99	2.04	2.04	1.98	1.91	1.86	1.85	1.85	1.85	1.85	1.85
Argentina	3.15	3.13	3.09	3.05	3.15	3.44	3.15	3.05	2.90	2.63	2.35	2.25	2.16	2.08	2.00	1.92	1.85	1.85	1.85	1.85
Australia	3.18	3.41	3.27	2.87	2.54	2.09	1.93	1.87	1.87	1.77	1.75	1.75	1.79	1.84	1.85	1.85	1.85	1.85	1.85	1.85
Brazil	6.15	6.15	6.15	5.38	4.72	4.31	3.80	3.10	2.60	2.45	2.35	2.25	2.15	2.06	1.98	1.92	1.86	1.85	1.85	1.85
China	6.22	5.59	5.72	6.06	4.86	3.32	2.55	2.46	1.92	1.78	1.70	1.74	1.81	1.85	1.85	1.85	1.85	1.85	1.85	1.85
India	5.97	5.92	5.81	5.69	5.43	4.83	4.48	4.15	3.81	3.43	3.07	2.76	2.50	2.29	2.11	1.95	1.85	1.85	1.85	1.85
Indonesia	5.49	5.67	5.42	5.57	5.20	4.73	4.11	3.40	2.90	2.50	2.37	2.20	2.03	1.89	1.85	1.85	1.85	1.85	1.85	1.85
Mexico	6.87	6.96	6.82	6.82	6.60	5.40	4.30	3.70	3.20	2.70	2.40	2.15	2.03	1.95	1.89	1.85	1.85	1.85	1.85	1.85
Russia	2.85	2.82	2.55	2.02	2.03	1.94	2.03	2.13	1.55	1.24	1.33	1.40	1.44	1.51	1.58	1.65	1.72	1.79	1.85	1.85
Saudi Arabia	7.18	7.18	7.26	7.26	7.30	7.28	7.05	6.26	5.65	4.86	4.09	3.58	3.17	2.84	2.57	2.34	2.15	1.99	1.87	1.85
South Africa	6.50	6.50	6.50	5.80	5.47	5.00	4.56	3.85	3.34	2.95	2.80	2.64	2.48	2.34	2.23	2.13	2.05	1.97	1.90	1.85
South Korea	5.40	6.33	5.63	4.71	4.28	2.92	2.23	1.60	1.70	1.51	1.23	1.21	1.28	1.35	1.42	1.49	1.56	1.63	1.70	1.77
Turkey	6.90	6.60	6.19	5.70	5.30	4.72	4.15	3.27	2.90	2.69	2.46	2.31	2.21	2.11	2.03	1.96	1.89	1.85	1.85	1.85
Guatemala	7.00	6.60	6.50	6.30	6.20	6.20	6.10	5.70	5.45	5.00	4.60	4.15	3.71	3.29	2.92	2.61	2.35	2.14	1.97	1.85
Laos	6.15	6.15	6.15	6.15	6.15	6.69	6.69	6.30	5.80	5.30	4.83	4.28	3.74	3.30	2.94	2.65	2.41	2.21	2.04	1.89
Mali	7.11	7.11	7.11	7.35	7.56	7.56	7.56	7.47	7.38	7.22	6.92	6.58	6.21	5.80	5.34	4.85	4.33	3.85	3.43	3.10
Tanzania	6.74	6.80	6.80	6.79	6.75	6.73	6.55	6.36	5.90	5.48	5.04	4.45	3.89	3.42	3.04	2.73	2.48	2.27	2.09	1.93
Yemen	8.20	8.30	8.40	8.40	8.50	8.50	8.70	8.30	7.60	6.88	6.20	5.65	5.10	4.50	3.94	3.47	3.12	2.85	2.65	2.49

Source: UN Population Division (2005)

Table A2: Life Expectancy at Time of Birth

G7 countries, other G-20 countries and selected least-developed countries; years

											UN medium projection									
	1950–1955	1955–1960	1960–1965	1965–1970	1970–1975	1975–1980	1980–1985	1985–1990	1990–1995	1995–2000	2000–2005	2005–2010	2010–2015	2015–2020	2020–2025	2025–2030	2030–2035	2035–2040	2040–2045	2045–2050
Canada	69.08	70.55	71.44	72.01	73.15	74.19	75.94	76.96	77.92	78.72	79.91	80.66	81.35	81.99	82.57	83.14	83.70	84.25	84.79	85.32
France	66.52	69.61	70.96	71.55	72.35	73.70	74.72	76.03	77.48	78.48	79.39	80.03	80.68	81.30	81.91	82.50	83.08	83.65	84.21	84.75
Germany	67.50	69.10	70.30	70.80	71.00	72.50	73.80	74.85	76.16	77.45	78.65	79.32	79.96	80.59	81.21	81.77	82.27	82.76	83.24	83.72
Italy	66.00	68.48	69.92	70.97	72.11	73.59	74.54	76.24	77.31	78.81	79.99	80.58	81.20	81.80	82.38	82.95	83.51	84.06	84.60	85.14
Japan	63.94	66.75	68.96	71.11	73.30	75.47	76.91	78.30	79.50	80.53	81.90	82.82	83.69	84.50	85.26	85.98	86.64	87.25	87.80	88.29
UK	69.18	70.42	70.76	71.36	72.01	72.76	74.04	75.01	76.42	77.22	78.30	78.97	79.60	80.22	80.81	81.38	81.93	82.47	83.00	83.51
US	68.87	69.67	70.03	70.38	71.52	73.32	74.12	74.65	75.25	76.53	77.31	77.92	78.48	79.07	79.65	80.22	80.79	81.35	81.90	82.45
Argentina	62.49	64.40	65.14	65.63	67.07	68.48	69.94	70.77	71.87	73.28	74.34	75.32	76.22	77.06	77.83	78.53	79.18	79.75	80.28	80.75
Australia	69.57	70.41	70.91	70.85	71.70	73.45	75.21	76.10	77.60	78.73	80.21	80.96	81.64	82.22	82.71	83.20	83.68	84.14	84.60	85.04
Brazil	50.92	53.29	55.67	57.63	59.50	61.49	63.15	64.94	66.63	68.85	70.30	71.91	72.94	74.16	75.24	76.18	77.03	77.82	78.54	79.20
China	40.76	44.61	49.53	59.58	63.18	65.33	66.56	67.06	68.07	69.70	71.49	72.59	73.30	73.84	74.45	75.27	76.21	77.12	77.96	78.73
India	38.69	42.60	45.45	48.01	50.27	52.87	54.82	57.20	59.46	61.50	63.12	64.87	66.75	68.47	70.00	71.39	72.66	73.83	74.90	75.91
Indonesia	37.47	39.92	42.52	45.96	49.20	52.70	56.16	60.14	62.64	64.88	66.53	68.70	70.00	71.04	71.99	73.08	74.18	75.19	76.09	76.90
Mexico	50.64	55.11	58.25	60.08	62.36	65.09	67.51	69.59	71.58	73.69	74.92	76.21	77.30	78.21	78.98	79.63	80.16	80.60	80.97	81.25
Russia	64.48	66.85	67.87	70.07	69.72	68.96	68.58	70.18	66.78	66.04	65.37	65.03	65.60	66.87	68.18	69.20	70.08	70.97	71.92	72.88
Saudi Arabia	39.87	42.86	45.91	49.90	53.88	58.69	63.01	66.29	68.76	70.54	71.62	72.87	73.90	74.82	75.65	76.43	77.15	77.86	78.53	79.18
South Africa	45.01	47.99	49.95	51.93	53.67	55.54	58.36	61.18	62.02	58.44	49.02	44.06	44.59	47.00	49.29	51.32	53.26	55.25	57.30	59.43
South Korea	47.46	52.57	55.20	57.64	62.61	64.79	67.17	69.81	72.22	74.65	76.85	78.20	79.38	80.45	81.42	82.19	82.77	83.34	83.90	84.44
Turkey	43.59	48.08	52.10	54.34	57.01	59.51	61.04	63.11	66.15	67.82	68.57	69.75	71.03	72.31	73.45	74.46	75.36	76.19	76.96	77.67
Guatemala	42.01	44.11	46.90	49.94	53.65	55.94	57.86	60.32	62.43	65.04	67.11	68.50	69.85	71.31	72.71	73.95	75.05	76.05	76.94	77.75
Laos	37.82	40.42	40.42	40.42	40.42	43.51	45.75	48.27	50.78	52.49	54.50	56.50	59.00	61.50	63.74	65.88	67.88	69.61	70.96	72.15
Mali	31.80	33.38	34.76	36.52	37.97	39.83	42.72	44.95	46.72	47.42	47.76	49.28	51.27	53.33	55.48	57.64	59.73	61.76	63.71	65.55
Tanzania	40.46	42.53	44.73	47.05	49.51	52.12	54.75	54.93	52.44	48.16	46.02	46.57	48.33	50.39	52.68	54.94	57.03	59.01	60.91	62.76
Yemen	32.55	33.97	35.18	36.98	39.85	44.17	49.11	52.92	55.66	57.71	60.33	62.67	64.87	66.91	68.74	70.14	71.21	72.17	73.04	73.84

Source: UN Population Division (2005)

Table A3: Average Annual Growth Rate of Total Population

G7 countries, other G-20 countries and selected least-developed countries; per cent

												UN medium projection								
	1950–1955	1955–1960	1960–1965	1965–1970	1970–1975	1975–1980	1980–1985	1985–1990	1990–1995	1995–2000	2000–2005	2005–2010	2010–2015	2015–2020	2020–2025	2025–2030	2030–2035	2035–2040	2040–2045	2045–2050
Canada	2.7	2.6	1.9	2.0	1.3	1.2	1.1	1.4	1.1	0.9	1.0	0.9	0.8	0.8	0.7	0.7	0.6	0.5	0.4	0.4
France	0.8	1.0	1.3	0.8	0.7	0.4	0.5	0.5	0.5	0.4	0.4	0.3	0.3	0.2	0.1	0.1	0.0	0.0	–0.1	–0.1
Germany	0.6	0.7	0.8	0.6	0.1	–0.1	–0.2	0.4	0.6	0.2	0.1	0.0	0.0	–0.1	–0.1	–0.1	–0.2	–0.2	–0.2	–0.2
Italy	0.6	0.6	0.7	0.6	0.6	0.4	0.1	0.0	0.2	0.1	0.1	0.0	–0.1	–0.2	–0.3	–0.3	–0.3	–0.4	–0.4	–0.5
Japan	1.4	0.9	1.0	1.1	1.3	0.9	0.7	0.4	0.3	0.2	0.2	0.1	–0.1	–0.2	–0.3	–0.4	–0.4	–0.4	–0.5	–0.5
UK	0.2	0.5	0.8	0.5	0.2	0.0	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.3	0.2	0.2	0.2	0.2
US	1.6	1.7	1.4	1.0	0.9	1.0	1.0	1.0	1.1	1.1	1.0	0.9	0.8	0.8	0.7	0.6	0.5	0.5	0.4	0.4
Argentina	2.0	1.7	1.6	1.5	1.7	1.5	1.5	1.4	1.3	1.2	1.0	0.2	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.1
Australia	2.3	2.2	2.3	2.0	1.4	1.4	1.4	1.5	1.2	1.2	1.1	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.5	0.4
Brazil	3.1	2.9	3.0	2.6	2.4	2.4	2.2	1.9	1.5	1.5	1.4	1.3	1.1	0.9	0.8	0.7	0.5	0.4	0.3	0.2
China	1.9	1.5	2.1	2.6	2.2	1.5	1.4	1.5	1.1	0.9	0.6	0.6	0.6	0.4	0.2	0.1	0.0	–0.1	–0.2	–0.4
India	2.0	2.3	2.3	2.3	2.2	2.1	2.1	2.1	1.9	1.7	1.6	1.4	1.3	1.1	0.9	0.8	0.6	0.5	0.4	0.3
Indonesia	1.7	2.1	2.1	2.4	2.3	2.2	2.0	1.8	1.5	1.3	1.3	1.1	0.9	0.7	0.6	0.5	0.4	0.3	0.2	0.1
Mexico	2.7	3.0	3.1	3.2	3.2	2.8	2.2	2.0	1.9	1.6	1.3	1.1	1.0	0.9	0.7	0.6	0.4	0.3	0.1	0.0
Russia	1.6	1.5	1.1	0.6	0.6	0.6	0.7	0.7	0.0	–0.2	–0.5	–0.4	–0.5	–0.5	–0.6	–0.6	–0.6	-0.6	-0.6	–0.6
Saudi Arabia	2.3	2.5	3.2	3.6	4.7	5.6	5.9	4.8	2.6	2.8	2.7	2.4	2.2	2.0	1.8	1.5	1.3	1.1	0.9	0.8
South Africa	2.3	2.5	2.7	2.6	2.6	2.5	2.5	2.1	2.6	1.7	0.8	0.2	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.1
South Korea	2.5	3.1	2.6	2.0	2.0	1.6	1.4	1.0	1.0	0.8	0.4	0.3	0.2	0.1	0.0	–0.1	–0.3	–0.4	-0.6	–0.7
Turkey	2.7	2.7	2.5	2.6	2.6	2.3	2.4	1.9	1.8	1.7	1.4	1.3	1.1	1.0	0.9	0.7	0.6	0.4	0.3	0.2
Guatemala	2.8	2.7	2.7	2.7	2.7	2.5	2.5	2.3	2.3	2.3	2.4	2.4	2.2	2.0	1.8	1.6	1.3	1 .2	1.0	0.8
Laos	2.0	2.3	2.2	2.2	2.2	1.2	2.4	2.6	2.5	2.4	2.3	2.2	2.0	1.9	1.7	1.5	1.3	1.1	1.0	0.8
Mali	2.2	2.3	2.1	2.4	2.7	2.3	2.4	2.4	2.6	2.8	3.0	2.9	2.9	2.9	2.8	2.6	2.4	2.2	2.0	1.8
Tanzania	2.6	2.8	3.0	3.1	3.3	3.2	3.3	3.3	3.3	2.3	2.0	1.8	1.7	1.5	1.4	1.2	1.1	0.9	0.8	0.7
Yemen	1.8	2.0	2.1	1.7	1.9	3.2	3.9	3.9	4.6	3.3	3.1	3.1	3.0	2.8	2.5	2.2	2.0	1.9	1.7	1.5

Source: UN Population Division (2005)

Table A4: Youth Dependency Ratio

G7 countries, other G-20 countries and selected least-developed countries;
ratio of population between the ages of 0 and 19 to the total population

												UN medium projection								
	1950–1955	1955–1960	1960–1965	1965–1970	1970–1975	1975–1980	1980–1985	1985–1990	1990–1995	1995–2000	2000–2005	2005–2010	2010–2015	2015–2020	2020–2025	2025–2030	2030–2035	2035–2040	2040–2045	2045–2050
Canada	0.375	0.393	0.413	0.424	0.399	0.363	0.326	0.291	0.277	0.271	0.258	0.243	0.226	0.211	0.206	0.205	0.207	0.209	0.210	0.210
France	0.302	0.310	0.325	0.341	0.331	0.319	0.303	0.289	0.277	0.259	0.252	0.245	0.239	0.235	0.230	0.223	0.218	0.215	0.213	0.212
Germany	0.304	0.300	0.286	0.289	0.300	0.289	0.270	0.239	0.217	0.215	0.213	0.202	0.188	0.180	0.178	0.181	0.186	0.190	0.192	0.195
Italy	0.348	0.335	0.323	0.323	0.317	0.316	0.304	0.279	0.234	0.212	0.196	0.189	0.186	0.179	0.173	0.166	0.162	0.163	0.168	0.173
Japan	0.458	0.433	0.402	0.368	0.328	0.315	0.306	0.289	0.265	0.228	0.205	0.191	0.191	0.196	0.201	0.206	0.206	0.207	0.212	0.222
UK	0.289	0.293	0.301	0.311	0.312	0.307	0.291	0.273	0.256	0.253	0.252	0.247	0.234	0.224	0.221	0.224	0.227	0.229	0.227	0.223
US	0.341	0.362	0.382	0.391	0.376	0.349	0.316	0.294	0.287	0.288	0.286	0.280	0.278	0.279	0.284	0.289	0.287	0.284	0.283	0.285
Argentina	0.397	0.393	0.392	0.390	0.384	0.380	0.388	0.391	0.393	0.388	0.368	0.351	0.335	0.320	0.306	0.294	0.280	0.266	0.254	0.244
Australia	0.333	0.356	0.376	0.386	0.377	0.366	0.341	0.322	0.301	0.291	0.282	0.266	0.250	0.238	0.233	0.232	0.230	0.227	0.221	0.217
Brazil	0.516	0.522	0.527	0.537	0.530	0.513	0.494	0.474	0.453	0.429	0.401	0.372	0.351	0.336	0.319	0.300	0.283	0.268	0.256	0.246
China	0.433	0.457	0.472	0.495	0.507	0.489	0.463	0.424	0.383	0.346	0.327	0.303	0.277	0.270	0.271	0.277	0.273	0.265	0.261	0.265
India	0.492	0.490	0.493	0.499	0.503	0.500	0.489	0.479	0.468	0.454	0.441	0.420	0.402	0.387	0.376	0.365	0.349	0.332	0.318	0.311
Indonesia	0.500	0.497	0.499	0.506	0.519	0.520	0.509	0.494	0.466	0.437	0.405	0.378	0.355	0.335	0.314	0.292	0.274	0.262	0.254	0.247
Mexico	0.518	0.533	0.548	0.559	0.569	0.573	0.564	0.543	0.514	0.476	0.439	0.409	0.376	0.343	0.316	0.293	0.275	0.259	0.245	0.234
Russia	0.386	0.379	0.361	0.377	0.360	0.329	0.299	0.292	0.298	0.286	0.267	0.237	0.212	0.212	0.220	0.218	0.210	0.205	0.207	0.214
Saudi Arabia	0.519	0.525	0.532	0.539	0.544	0.543	0.538	0.519	0.510	0.506	0.488	0.473	0.449	0.421	0.396	0.374	0.352	0.330	0.307	0.285
South Africa	0.484	0.494	0.506	0.517	0.528	0.527	0.523	0.511	0.494	0.462	0.441	0.429	0.421	0.407	0.393	0.381	0.371	0.361	0.349	0.335
South Korea	0.517	0.505	0.515	0.523	0.519	0.503	0.462	0.406	0.363	0.321	0.289	0.253	0.229	0.201	0.181	0.175	0.171	0.166	0.163	0.160
Turkey	0.513	0.504	0.509	0.523	0.520	0.521	0.511	0.490	0.466	0.437	0.408	0.383	0.364	0.345	0.324	0.306	0.289	0.275	0.262	0.252
Guatemala	0.554	0.554	0.556	0.559	0.555	0.552	0.559	0.563	0.563	0.560	0.553	0.541	0.527	0.507	0.483	0.455	0.424	0.394	0.363	0.335
Laos	0.522	0.523	0.524	0.525	0.526	0.526	0.524	0.534	0.541	0.540	0.532	0.520	0.499	0.477	0.454	0.429	0.403	0.377	0.353	0.329
Mali	0.561	0.552	0.546	0.547	0.553	0.561	0.573	0.585	0.590	0.593	0.597	0.592	0.590	0.581	0.569	0.554	0.536	0.514	0.489	0.462
Tanzania	0.564	0.561	0.560	0.561	0.561	0.564	0.566	0.565	0.562	0.558	0.552	0.542	0.523	0.502	0.479	0.454	0.429	0.403	0.377	0.352
Yemen	0.523	0.544	0.563	0.579	0.598	0.614	0.613	0.617	0.622	0.602	0.598	0.581	0.562	0.545	0.526	0.504	0.477	0.448	0.420	0.397

Source: UN Population Division (2005)

Table A5: Elderly Ratio

G7 countries, other G-20 countries and selected least-developed countries;
ratio of population at age 65 and older to the total population

												UN medium projection								
	1950–1955	1955–1960	1960–1965	1965–1970	1970–1975	1975–1980	1980–1985	1985–1990	1990–1995	1995–2000	2000–2005	2005–2010	2010–2015	2015–2020	2020–2025	2025–2030	2030–2035	2035–2040	2040–2045	2045–2050
Canada	0.077	0.077	0.075	0.077	0.079	0.085	0.094	0.103	0.113	0.120	0.126	0.131	0.142	0.162	0.184	0.209	0.233	0.243	0.249	0.253
France	0.114	0.116	0.116	0.121	0.129	0.135	0.140	0.130	0.140	0.156	0.163	0.166	0.169	0.190	0.208	0.226	0.242	0.255	0.264	0.267
Germany	0.097	0.107	0.115	0.125	0.137	0.148	0.156	0.146	0.150	0.155	0.164	0.188	0.204	0.207	0.221	0.239	0.266	0.288	0.290	0.285
Italy	0.083	0.087	0.093	0.100	0.109	0.120	0.131	0.127	0.153	0.166	0.182	0.200	0.211	0.230	0.245	0.264	0.291	0.321	0.346	0.356
Japan	0.049	0.053	0.057	0.062	0.071	0.079	0.090	0.103	0.120	0.146	0.172	0.197	0.223	0.255	0.272	0.278	0.285	0.294	0.310	0.315
UK	0.107	0.113	0.117	0.120	0.129	0.140	0.151	0.151	0.159	0.159	0.159	0.160	0.165	0.181	0.188	0.198	0.214	0.228	0.231	0.230
US	0.083	0.088	0.092	0.095	0.098	0.105	0.112	0.117	0.122	0.124	0.123	0.123	0.127	0.138	0.153	0.168	0.180	0.183	0.182	0.178
Argentina	0.042	0.048	0.055	0.062	0.070	0.076	0.081	0.085	0.089	0.094	0.099	0.102	0.105	0.111	0.119	0.127	0.135	0.144	0.156	0.175
Australia	0.081	0.084	0.085	0.085	0.083	0.087	0.096	0.101	0.112	0.115	0.121	0.127	0.137	0.155	0.172	0.190	0.206	0.218	0.226	0.231
Brazil	0.030	0.031	0.033	0.035	0.036	0.039	0.041	0.041	0.044	0.049	0.054	0.061	0.068	0.078	0.091	0.107	0.125	0.141	0.156	0.173
China	0.045	0.046	0.048	0.044	0.043	0.044	0.047	0.052	0.056	0.061	0.068	0.076	0.082	0.094	0.114	0.130	0.153	0.181	0.199	0.200
India	0.033	0.034	0.034	0.035	0.037	0.038	0.040	0.042	0.043	0.045	0.049	0.053	0.056	0.061	0.067	0.076	0.086	0.097	0.107	0.115
Indonesia	0.040	0.037	0.034	0.031	0.031	0.033	0.035	0.036	0.038	0.043	0.049	0.055	0.060	0.064	0.073	0.086	0.100	0.118	0.137	0.156
Mexico	0.044	0.045	0.046	0.045	0.043	0.040	0.038	0.037	0.039	0.043	0.048	0.053	0.061	0.071	0.083	0.099	0.117	0.139	0.167	0.192
Russia	0.062	0.063	0.063	0.066	0.077	0.089	0.102	0.097	0.100	0.120	0.123	0.138	0.126	0.133	0.152	0.176	0.193	0.196	0.202	0.212
Saudi Arabia	0.033	0.033	0.033	0.033	0.032	0.030	0.028	0.024	0.023	0.023	0.026	0.029	0.032	0.035	0.041	0.049	0.062	0.076	0.089	0.103
South Africa	0.036	0.038	0.039	0.039	0.034	0.032	0.031	0.031	0.032	0.033	0.036	0.042	0.051	0.061	0.072	0.081	0.088	0.091	0.091	0.089
South Korea	0.030	0.037	0.033	0.033	0.033	0.036	0.038	0.043	0.050	0.058	0.074	0.094	0.113	0.132	0.156	0.196	0.234	0.269	0.303	0.326
Turkey	0.032	0.033	0.034	0.039	0.043.	0.044	0.046	0.042	0.040	0.045	0.051	0.054	0.057	0.062	0.072	0.085	0.101	0.118	0.136	0.154
Guatemala	0.025	0.026	0.026	0.028	0.029	0.028	0.029	0.030	0.033	0.036	0.040	0.043	0.045	0.047	0.050	0.053	0.056	0.061	0.069	0.080
Laos	0.028	0.027	0.024	0.024	0.026	0.027	0.028	0.045	0.038	0.039	0.035	0.037	0.035	0.037	0.039	0.045	0.051	0.058	0.066	0.075
Mali	0.019	0.019	0.020	0.021	0.022	0.023	0.024	0.025	0.027	0.028	0.028	0.027	0.026	0.024	0.023	0.023	0.023	0.026	0.029	0.034
Tanzania	0.022	0.023	0.023	0.024	0.025	0.025	0.026	0.027	0.027	0.028	0.030	0.032	0.034	0.037	0.038	0.040	0.043	0.045	0.050	0.058
Yemen	0.039	0.034	0.030	0.027	0.025	0.024	0.022	0.021	0.020	0.026	0.024	0.023	0.023	0.024	0.026	0.030	0.033	0.036	0.039	0.045

Source: UN Population Division (2005)

Table A6: Active Ratio

G7 countries, other G-20 countries and selected least-developed countries;
ratio of population between the ages of 20 and 64 to the total population

												UN medium projection								
	1950–1955	1955–1960	1960–1965	1965–1970	1970–1975	1975–1980	1980–1985	1985–1990	1990–1995	1995–2000	2000–2005	2005–2010	2010–2015	2015–2020	2020–2025	2025–2030	2030–2035	2035–2040	2040–2045	2045–2050
Canada	0.548	0.529	0.512	0.500	0.522	0.552	0.580	0.606	0.610	0.609	0.616	0.626	0.632	0.627	0.610	0.585	0.560	0.547	0.541	0.537
France	0.584	0.575	0.559	0.538	0.540	0.546	0.558	0.581	0.583	0.586	0.585	0.589	0.592	0.575	0.562	0.551	0.540	0.530	0.523	0.520
Germany	0.599	0.593	0.599	0.586	0.563	0.562	0.574	0.615	0.633	0.630	0.623	0.610	0.608	0.612	0.602	0.580	0.548	0.522	0.518	0.520
Italy	0.569	0.578	0.584	0.577	0.574	0.564	0.565	0.594	0.612	0.621	0.622	0.611	0.603	0.591	0.582	0.570	0.547	0.516	0.486	0.471
Japan	0.493	0.514	0.541	0.569	0.601	0.606	0.603	0.608	0.615	0.627	0.622	0.611	0.587	0.549	0.527	0.516	0.509	0.499	0.477	0.463
UK	0.604	0.594	0.582	0.569	0.558	0.553	0.559	0.576	0.585	0.588	0.589	0.594	0.601	0.595	0.591	0.578	0.558	0.543	0.542	0.547
US	0.576	0.550	0.526	0.514	0.525	0.547	0.572	0.589	0.590	0.588	0.590	0.597	0.595	0.583	0.563	0.543	0.533	0.532	0.536	0.537
Argentina	0.561	0.558	0.552	0.548	0.547	0.544	0.531	0.524	0.517	0.518	0.533	0.547	0.559	0.569	0.575	0.579	0.584	0.590	0.590	0.581
Australia	0.586	0.560	0.539	0.529	0.540	0.547	0.564	0.577	0.587	0.593	0.596	0.607	0.613	0.608	0.595	0.578	0.564	0.555	0.552	0.552
Brazil	0.455	0.447	0.440	0.428	0.433	0.448	0.465	0.485	0.503	0.523	0.545	0.567	0.581	0.586	0.590	0.593	0.592	0.591	0.588	0.580
China	0.522	0.497	0.480	0.461	0.450	0.467	0.489	0.524	0.561	0.594	0.605	0.621	0.641	0.636	0.614	0.593	0.575	0.554	0.540	0.535
India	0.474	0.477	0.473	0.466	0.461	0.461	0.471	0.479	0.489	0.500	0.510	0.527	0.542	0.552	0.557	0.559	0.565	0.571	0.575	0.575
Indonesia	0.461	0.467	0.467	0.463	0.450	0.448	0.457	0.471	0.496	0.521	0.546	0.567	0.584	0.601	0.613	0.622	0.626	0.620	0.609	0.597
Mexico	0.438	0.422	0.406	0.395	0.388	0.387	0.399	0.420	0.446	0.482	0.513	0.537	0.562	0.586	0.600	0.608	0.608	0.601	0.588	0.575
Russia	0.553	0.557	0.576	0.557	0.563	0.582	0.598	0.611	0.601	0.595	0.610	0.626	0.663	0.655	0.629	0.606	0.597	0.599	0.591	0.574
Saudi Arabia	0.447	0.441	0.434	0.428	0.424	0.427	0.434	0.456	0.468	0.470	0.486	0.498	0.518	0.544	0.563	0.577	0.586	0.594	0.604	0.612
South Africa	0.480	0.468	0.456	0.444	0.438	0.441	0.447	0.458	0.474	0.505	0.522	0.528	0.528	0.532	0.536	0.538	0.540	0.547	0.560	0.576
South Korea	0.452	0.459	0.452	0.444	0.448	0.461	0.500	0.551	0.587	0.621	0.637	0.652	0.658	0.667	0.663	0.630	0.595	0.565	0.534	0.514
Turkey	0.455	0.463	0.457	0.438	0.437	0.435	0.443	0.469	0.494	0.518	0.541	0.563	0.579	0.593	0.604	0.609	0.609	0.607	0.602	0.594
Guatemala	0.421	0.420	0.418	0.413	0.416	0.419	0.412	0..407	0.404	0.403	0.406	0.416	0.428	0.446	0.467	0.493	0.519	0.545	0.567	0.585
Laos	0.450	0.450	0.452	0.451	0.448	0.447	0.448	0.421	0.422	0.422	0.433	0.443	0.466	0.487	0.507	0.536	0.546	0.565	0.582	0.596
Mali	0.420	0.429	0.434	0.432	0.425	0.416	0.404	0.390	0.383	0.379	0.375	0.381	0.384	0.394	0.408	0.423	0.440	0.460	0.481	0.504
Tanzania	0.414	0.416	0.416	0.415	0.414	0.410	0.408	0.409	0.411	0.414	0.418	0.425	0.442	0.461	0.482	0.505	0.528	0.551	0.573	0.590
Yemen	0.438	0.422	0.408	0.395	0.377	0.362	0.365	0.362	0.359	0.372	0.378	0.396	0.415	0.431	0.447	0.466	0.490	0.517	0.541	0.558

Source: UN Population Division (2005)

References

Batini N, T Callen and WJ McKibbin (2006), 'The Global Impact of Demographic Change', IMF Working Paper No WP/06/9.

Blanchard OJ (1985), 'Debt, Deficits, and Finite Horizons', *Journal of Political Economy*, 93(2), pp 223–247.

Bosworth BP and SM Collins (2003), 'The Empirics of Growth: An Update', *Brookings Papers on Economic Activity*, 2, pp 113–206.

Bryant RC (2003), *Turbulent Waters: Cross-Border Finance and International Governance*, Brookings Institution Press, Washington DC.

Bryant RC (2004a), *Crisis Prevention and Prosperity Management for the World Economy: Pragmatic Choices for International Financial Governance, Part I*, Brookings Institution Press, Washington DC.

Bryant RC (2004b), 'Cross-Border Macroeconomic Implications of Demographic Change', in GH Sellon Jnr (ed), *Global Demographic Change: Economic Impacts and Policy Challenges*, Proceedings of a Symposium Sponsored by the Federal Reserve Bank of Kansas City, Jackson Hole, pp 83–144.

Bryant RC (2004c), 'Demographic Pressures on Public Pension Systems and Government Budgets in Open Economies', Brookings Discussion Paper in International Economics No 164.

Bryant RC (2005), 'Demographic Interactions between North and South and the Implications for North-South Capital Flows', The Brookings Institution, October, draft paper.

Bryant RC (2006), 'Asymmetric Demographic Transitions and North-South Capital Flows', Brookings Discussion Paper in International Economics No 170.

Bryant RC and M de Fleurieu (2005), 'Exchange-Rate and External-Balance Consequences of Asymmetric Demographic Transitions: Key Determinants of Cross-Border Substitutability', paper presented at the International Collaboration Projects Meeting, Economic and Social Research Institute of the Japan Cabinet Office, Tokyo, 15–16 February.

Bryant RC, H Faruqee, D Velculescu and E Arbatli (2004), 'Fertility Declines and Youth Dependency: Implications for the Global Economy', Brookings Discussion Paper in International Economics No 163.

Bryant RC and WJ McKibbin (1998), 'Issues in Modeling the Global Dimensions of Demographic Change', Brookings Discussion Paper in International Economics No 141.

Bryant RC and WJ McKibbin (2004), 'Incorporating Demographic Change in Multi-country Macroeconomic Models: Some Preliminary Results', in P Onofri (ed), *The Economics of an Ageing Population: Macroeconomic Issues*, ESRI Studies Series on Ageing, Edward Elgar Publishing, Northampton, pp 349–408.

Faruqee H (2002), 'Population Aging and its Macroeconomic Implications: A Framework for Analysis', IMF Working Paper No WP/02/16.

Faruqee H, D Laxton and S Symansky (1997), 'Government Debt, Life-Cycle Income and Liquidity Constraints: Beyond Approximate Ricardian Equivalence', *IMF Staff Papers*, 44 (3), pp 374–382.

Feldstein MS and C Horioka (1980), 'Domestic Saving and International Capital Flows', *Economic Journal*, 90, pp 314–329.

Frankel JA (1986), 'International Capital Mobility and Crowding Out in the U.S. Economy: Imperfect Integration of Financial Markets or of Goods Markets?', in RW Hafer (ed), *How Open is the U.S. Economy?*, Lexington Books, Lexington, pp 33–67.

Frankel JA (1991), 'Quantifying International Capital Mobility in the 1980s', in BD Bernheim and JB Shoven (eds), *National Saving and Economic Performance*, University of Chicago Press, Chicago, pp 227–260.

Freeman RB (2006), 'People Flows in Globalization', *Journal of Economic Perspectives*, 20(2), pp 145–170.

Gertler M and K Rogoff (1990), 'North-South Lending and Endogenous Domestic Capital Market Inefficiencies', *Journal of Monetary Economics*, 26(2), pp 245–266.

Hall RE and CI Jones (1999), 'Why Do Some Countries Produce So Much More Output per Worker than Others?', *Quarterly Journal of Economics*, 114(1), pp 83–116.

Holzmann R (2000), 'Can Investments in Emerging Markets Help to Solve the Aging Problem?', World Bank Social Protection Working Paper No SP 0010.

Lee RD (2003), 'The Demographic Transition: Three Centuries of Fundamental Change', *Journal of Economic Perspectives*, 17(4), pp 167–190.

McKibbin WJ (2005a), 'Global Demographic Change and Japanese Macroeconomic Performance', paper presented at the Economic and Social Research Institute (ESRI) International Collaboration Projects Meeting, Tokyo, 15–16 February.

McKibbin WJ (2005b), 'The Global Macroeconomic Consequences of a Demographic Transition', Lowy Institute for International Policy Working Papers in International Economics No 7.05.

McKibbin WJ and J Nguyen (2004), 'Modelling Global Demographic Change: Results for Japan', paper presented at the International Collaboration Projects Meeting, Economic and Social Research Institute of the Japan Cabinet Office, Tokyo, 16–18 February.

OECD (2006), *International Migration Outlook*, Annual Report, OECD, Paris.

Temple J (1999), 'The New Growth Evidence', *Journal of Economic Literature*, 37(1), pp 112–156.

UN Population Division (2001), *World Population Prospects: The 2000 Revision*, United Nations, New York.

UN Population Division (2003), *World Population Prospects: The 2002 Revision*, United Nations, New York.

UN Population Division (2005), *World Population Prospects: The 2004 Revision*, United Nations, New York. Available at <www.un.org/popin/data.html>.

Weil P (1989), 'Overlapping Families of Infinitely-Lived Agents', *Journal of Public Economics*, 38, pp 183–198.

Wetterstrand WH (1981), 'Parametric Models for Life Insurance Mortality Data: Gompertz's Law over Time', *Transactions of Society of Actuaries*, 33, pp 159–179.

World Bank (2002), *World Development Report 2002: Building Institutions for Markets*, Oxford University Press, New York.

World Bank (2004), *World Development Report 2005: A Better Investment Climate for Everyone*, Oxford University Press, New York.

Yaari ME (1965), 'Uncertain Lifetime, Life Insurance, and the Theory of the Consumer', *Review of Economic Studies*, 32(2), pp 137–150.