Cross-Border Macroeconomic Implications of Demographic Change

Ralph C. Bryant

Introduction 1

This paper identifies key issues about the macroeconomic implications of demographic transitions and summarizes what is presently understood about them. I emphasize the cross-border aspects—interactions among national economies through exchange rates and external-sector transactions—because that part of the subject has so far received relatively less attention.

Given the nature of this symposium, issues and conclusions are presented in a nontechnical way without provision of the detailed underlying analysis. Amplifications, identification of technical points, and references to the literature are typically confined to footnotes. Readers who prefer to avoid such details can ignore the footnotes without loss of the main argument.[1]

It should be stated at the outset that this subject area requires substantially more research before it will be possible to summarize conclusions and policy recommendations with full confidence. My paper is an interim overview, not a comprehensive summary.

I begin by providing a background overview of how enhanced cross-border economic integration has influenced the macroeconomic evolution of national economies. Next, I identify major analytical points that should significantly influence how one interprets the macroeconomic consequences of demographic changes. With that background, I illustrate by postulating specific examples of a decline in fertility and summarizing the resulting outcomes. A further section contrasts the differing effects of population aging stemming from increases in life expectancy rather than declines in fertility. I summarize issues raised by the response of alternative public pension systems to demographic transitions. Finally, I address the question of whether the lagging demographic transitions of developing countries might be able to ease the adjustments to population aging in the advanced higher-income economies.

Macroeconomic implications of enhanced cross-border   2
economic integration

Many national economies became relatively closed to the rest of the world after the turbulent decades of the First World War, the Great Depression, and World War II. As the second half of the 20th century progressed, however, the economies of developed nations returned toward and probably even surpassed the greater openness that had been characteristic of the later 19th century and early 20th century.

The increasing cross-border integration of recent decades was driven by two underlying sets of causes. Many government policies that traditionally inhibited cross-border 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 behavior gradually more sensitive to developments abroad.

The greater sensitivity of economic behavior to foreign developments can be described in terms of secular trends in cross-border

"substitutability." Households and firms have manifested a gradual increase in their willingness to substitute home and foreign goods for one another 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"). In some circumstances, individuals themselves have been more willing to move across national borders, temporarily or permanently, in response to economic incentives (immigration and emigration of people).

Although technological innovations and social and cultural changes created enhanced incentives for cross-border interactions, they would not have produced such enhanced economic integration if they had been countermanded by barriers at borders and the policies of national governments. National governments traditionally erected "separation fences" at the borders of nations by taxing or restricting goods moving across national borders and limiting the cross-border mobility of financial funds. Barriers have long existed restricting the migration of people themselves. After World War II most governments began to lower their separation fences for goods and capital flows, or sometimes even to jettison parts of them altogether. The multilateral negotiations under the auspices of the General Agreement on Tariffs and Trade were the most prominent examples of fence lowering for trade in goods. The lowering of fences for financial transactions began later and was less dramatic. Nonetheless, by the 1990s government restrictions on cross-border capital flows, especially among the industrial nations, were much less important than at the end of World War II and in the 1950s.[2]

By shrinking the economic and psychic distances among nations, changes in technology and behavioral changes in cross-border substitutabilities would have progressively knitted national economies more closely together even in the absence of reductions in governments' separation fences. Reductions in separation fences would have enhanced cross-border mobility and interdependence even without

the technological innovations and behavior changes. Together, the two sets of evolutionary changes reinforced each other and powerfully transformed the world economy over the last 50 years.[3]

It is a central fact of life today that the progressive intertwining of national economies has caused macroeconomic variables to be more closely linked and interdependent across national borders. Somewhat larger proportions of macroeconomic adjustments required in response to shocks originating domestically now tend to be channeled through external-sector transactions. Similarly, shocks originating abroad now buffet the domestic economy more strongly. Speaking loosely, cross-border and cross-currency adjustments have risen in importance relative to purely domestic adjustments.

The preceding generalization applies to all sorts of macroeconomic variables, domestic and external-sector. In particular, and notably, it applies 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 substi-tutabilities across borders. Typically, the sizes and variations of an economy's current-account balance relative to gross output may be larger and exhibit larger swings than would have occurred in the middle decades of the 20th century.

In an economy completely closed to the rest of the world, it would, of course, necessarily be true that measured savings and investment would move together.[4] The saving and investment decisions of individual economic agents could and would be taken independently. When measured after the decisions were made and inconsistencies among them eliminated, however, the flows of aggregate saving and aggregate investment would necessarily be identically equal for the economy as a whole.

When an economy is open, an imbalance can exist—not only ex ante, but ex post—between national saving and domestic investment. If there were a single unified world financial system with no border barriers and with very high cross-border financial substitutability, savings made in any one economy might be equally likely to be invested anywhere in the world. A surge in investment in one economy, for example, would not need to be financed by domestic savings but could be financed out of the global reservoir of savings. Accordingly, one might think at first glance that there need not be a high correlation between national savings and domestic investment in an open economy.

In the extensive literature triggered by Feldstein and Horioka (1980), however, it has been shown many times that national saving rates and domestic investment rates exhibit a quite high correlation in cross-section studies of country data. This empirical evidence has been interpreted by many authors to mean that countries' financial systems are still primarily national, "that there are substantial imperfections in the international capital market and that a very large share of domestic savings tends to remain in the home country" (Feldstein 1983).

Interpretation of the strong correlation between national saving and domestic investment has been controversial. Some part of the correlation could be due to the dependence of changes in both saving and domestic investment on changes in incomes (for example, an investment boom leading to increased national income which simultaneously raises saving). A wide variety of policy and nonpolicy 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 the nation's borders. It has been shown in theoretical models, for example, that it is possible for an open economy to exhibit a high correlation between the national saving rate and the domestic investment rate, even though it has no separation fence at the border impeding

capital flows and even though assets denominated in its currency are very good substitutes for assets denominated in foreign currencies and issued in foreign nations.[5]

Two additional considerations affecting the interpretation of the Feldstein-Horioka correlation are important. First, cross-border goods substitutability, despite increases in recent decades, still tends to be relatively low; in any event it is markedly less than cross-border financial substitutability. Second, significant barriers remain that inhibit cross-border transactions in goods and services. These two factors both 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 much 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).

When a national economy runs a current-account deficit (domestic investment exceeding national saving, so that net capital inflows result in the addition of some foreign saving to domestic saving), the nation's net foreign asset position is diminished (or alternatively its net foreign liability position is increased). In essence, the decline in the nation's net foreign asset/liability position represents a net transfer of wealth to foreigners. Conversely, a current-account surplus and the resulting increase in the net foreign asset/liability position entail a net transfer of wealth from foreigners to home residents. Persisting wealth transfers among nations tend to be self-limiting. Eventually, a nation's current-account balance relative to the size of its economy tends toward an equilibrium in which the current-account/GDP ratio converges toward a level sustainable for the indefinite long run. Thus, the need for nations to satisfy an intertemporal long-run budget constraint is yet another reason why one should expect any individual nation to exhibit a fairly high correlation between domestic investment and national saving over a long run independently of the existence of border barriers and the degree of cross-border financial substitutability.[6]

Notwithstanding the complexities of interpreting the empirical correlation between national savings and domestic investment, there is abundant independent evidence that national capital markets are still far from being fully integrated. The phenomenon is often referred to as "home bias" in the patterns of asset holding and liability issuance. Domestic residents tend to invest a disproportionate percentage of their net worth in domestic assets, given the differential expected rates of return associated with domestic and foreign holdings.[7] Exchange rates still include so-called "country risk" premiums. Investing at home can seem a way of avoiding country and currency risks.

An illuminating perspective is to ask what one should expect *within* national economies about *regional* saving-investment imbalances. If it were true that the correlation between domestic investment and national saving were significantly unrelated to border barriers and cross-border financial substitutability, a strong correlation between investment and saving might also be found within regions inside a nation. Conversely, if an important part of the correlation observed internationally is attributable to border barriers and low cross-border substitutabilities for goods and financial holdings, one should expect to find a much smaller correlation within nations between regional investment and regional savings. Reliable regional data for investment and savings are not available for most nations. But studies for some countries have been made, notably by Helliwell and McKitrick (1999) for Canadian provinces where more complete data are available, but also by Dekle (1996) for Japanese prefectures, Sinn (1992) for U.S. states, and Bayoumi and Rose (1993) for the United Kingdom. The not-surprising conclusion from these intra-national studies has been that there is a much smaller correlation between regional investment and regional saving within a nation than exists between domestic investment and national saving across nations.

Even though the empirical correlation between national saving rates and domestic investment rates remains fairly high, more recent examinations have tended to show that it has fallen somewhat as

cross-border integration has continued to increase in the last several decades. Blanchard and Giavazzi (2002), for example, show that the correlation has fallen sharply within the European Union as economic integration has risen (lowering of border barriers, and increases in both goods substitutability and financial substitutability within the European Union). A recent speech by Alan Greenspan (2004) cites Federal Reserve staff calculations that the correlation has declined recently for OECD countries, especially if the United States is excluded.

Thus, even for developed nations as a whole, in the last two decades there has been a significant diminution in the correlation between domestic investment and national saving or, equivalently, a tendency for current-account imbalances to become larger and more variable. This tendency in turn reflects the fact that cross-border and cross-currency adjustments to policy and nonpolicy shocks have risen in importance relative to purely domestic adjustments.[8]

The preceding generalizations apply to macroeconomic adjustments occurring in response to all sorts of shocks. They are especially important when analyzing the macroeconomic consequences of demographic changes.

Effects of demographic transitions on macroeconomic evolutions   3

I begin the discussion of demographic changes by summarizing five key analytical points that are crucial for the interpretation of how ongoing demographic transitions in the world influence macroeconomic growth and cyclical fluctuations. Most of these points are not widely discussed and appreciated, and it is therefore helpful to state them in a general way at the outset. Subsequent sections provide illustrations and amplification.

First, *the basic macroeconomic consequences of population aging arise from effects on labor markets and the production sectors and production*

technologies of economies. These basic forces would, of course, operate in economies completely closed to the rest of the world and, although they are significantly influenced by the openness of economies, they are the fundamental determinants of the macroeconomic outcomes resulting from demographic transitions.

The rudiments of these basic forces include the following. Declines in birth rates (reductions in "fertility") and increases in adult life expectancy (declines in adult "mortality" rates) alter the composition of national populations such that the average age of individuals in the population rises, the ratio of elderly individuals to working adults (the "elderly ratio") increases, the ratio of youths to working adults ("youth ratio") declines, and the ratio of the effective labor force to the entire adult population falls.[9] Because the effective labor force falls relative to the output and capital stock of the economy, adjustments must occur in macroeconomic variables such as the capital-labor and the capital-output ratios. The marginal product of labor rises. With the effective labor force lower relative to the capital stock, the marginal product of capital falls and the capital-output ratio rises. Real interest rates decline over the medium run in association with declines in the marginal product of capital. As the effective labor force falls relative to the adult population and as the elderly ratio increases, less output is produced per adult than would otherwise have been generated. Forward-looking consumers experience increases in the medium run of per-adult human wealth and per-adult financial wealth.[10] The ratio of saving to output rises. As consumers adjust the intertemporal paths of their consumption, their marginal propensity to consume out of lifetime wealth falls. Population aging from fertility declines or increases in life expectancy entails that per-adult consumption declines over the longer run relative to what it otherwise could have been.

Second, *when national economies are open to the rest of the world and have extensive cross-border interactions with other economies, the "domestic" effects of demographic change can be strongly conditioned by that openness.* Virtually all domestic macroeconomic variables are

influenced, some quite significantly. Because of cross-border interactions, for example, real interest rates, the capital stock, output, saving, and consumption all follow different paths than would otherwise occur. Changes in exchange rates and external-sector transactions are integral components of the macroeconomic adjustments. Depending on the particular economy and the stage of its demographic transition relative to that of its trading partners, the effects can be favorable or adverse.

Demographic transitions vary considerably in size and timing, even among the higher-income industrial economies—not to mention the large differences between the industrial and developing economies. Countries with faster and larger demographic transitions in which population aging is proceeding most rapidly are likely to experience an appreciation of their currencies and strengthening of their current-account balances. Such changes may cushion the rapidly aging economies from the full effects that demographic shocks would otherwise produce. The openness of the economy fosters, in effect, a partial sharing of the large demographic shock with the rest of the world and works to mitigate the negative consequences of population aging on domestic output and consumption. Countries that age more slowly, on the other hand, may experience adverse effects as a result of openness because the larger demographic shocks abroad spill over into their economies, requiring them to absorb some of the burden of adjustment.

One should be cautious, however, in making generalizations about the macroeconomic effects of population aging either in relatively closed or highly open economies. The third analytical point to emphasize is that *population aging can result from several different demographic causes and the macroeconomic consequences depend sensitively on the specific cause or combination of causes. Most notably, the effects differ importantly depending on whether the aging 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).*

Actual demographic transitions in the higher-income advanced economies are, of course, a mixture of declines in fertility and increases in life expectancy. Declines in birth rates in recent decades seem to have been quantitatively more important than reductions in mortality rates as drivers for current and prospective population aging. As the 21st century progresses, on the other hand, increases in life expectancy due to further advances in medical science may become relatively more significant. I am not a demographer and do not have particular insights regarding the causes of the seismic ongoing changes in the populations of individual nations. Thus, I do not hold firm views about the allocation of responsibility for population aging in particular nations between the two causal categories of fertility declines and increases in life expectancy. What I do want to emphasize, and will discuss in a later section of the paper, is that the macroeconomic effects of the two categories of underlying causes can be very different, especially when cross-border interactions are taken into account.[11]

Fourth, *it is essential to carefully incorporate the implications of youth dependency and elderly dependency when analyzing the macroeconomic effects of demographic transitions.* Early contributions to the development economics literature considered the argument that youth dependency has a significant role in savings and investment decisions.[12] More recently, substantial macroeconomics research has studied the effects of population aging on saving, investment, and growth.[13] Research on policy issues has focused on the increasing burdens of elderly dependency on national budgets and pension systems.[14] Unfortunately, however, much of the initial macroeconomic analysis concentrated just on the size and growth rate of the total population, paying little explicit attention to shifts in the age structure of the population. If elderly-dependency and youth-dependency ratios were taken into account, analysts treated them simply as exogenous inputs rather than incorporating demographic developments as integral, endogenous parts of the analytical framework.

Numerous studies have focused on elderly dependency because of the effects of population aging on pension systems, particularly public pension systems that operate with pay-as-you-go procedures. But only recently has analytical work returned to emphasizing children and child support.[15] Allowing for youth dependency has major implications for key macroeconomic variables, especially when the underlying demographic change stems from fertility declines. Why? The key point is that the consumption-saving behavior of individual adults who provide in-vivo transfers to children is dramatically different, in theory and in practice, from the behavior of otherwise identical individuals without financial responsibilities for child support. If a demographic shock occurs lowering the numbers of children, other things being equal 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 steady state of the economy compared to what it would otherwise be in an analysis that disregards children and child support. Ignoring youth dependency suppresses this major source of macroeconomic effects.[16]

Fifth, *analysis of the macroeconomic effects of demographic transitions should differentiate carefully 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 (economy-wide) levels of variables—for example the total output, consumption, and savings of all the economy's residents—move in the *opposite* direction from the paths of the same variables when measured per capita or per adult.

Making this distinction would be important for the interpretation of outcomes even in a completely closed economy. For open national economies experiencing different speeds and intensities of demographic change, the distinction is especially consequential and has great relevance for policy debates about population aging, and more generally about the consequences of demographic transitions.

Economy-wide aggregates cannot be straightforwardly used to make normative or welfare judgments about the consequences of demographic shocks. Per capita or per adult measures are likely to be, at least for some purposes, a more useful focus for normative comparisons of pre-shock and post-shock outcomes. When an individual nation experiences faster declines in birth rates than occur abroad, for example, its macroeconomic aggregates decline relative to the rest of the world. Because its larger demographic shock is partly shared with the rest of the world, however, the welfare consequences for that economy's residents measured in per capita terms will be significantly less adverse—and may even constitute a net improvement—relative to the outcome that would occur in the absence of the economy's openness. The following section provides a specific example.

Of course, analysis of national welfare cannot rely exclusively on per capita or per adult measures of economic variables. For political or security purposes, it may be necessary to stress aggregate economy-wide data for a nation relative to nations in the rest of the world. If a country experiences a fertility decline sooner or faster than the rest of the world, its population, GDP, and consumption will shrink as a proportion of the world totals. With relatively fewer real resources available for investment or consumption, its government and the nation as a whole might well be supposed to have lessened influence in the world because of diminished relative power and security positions.

Thus, analysis cannot ignore the consequences of population aging for a nation's aggregate macroeconomic variables. But neither should one forget the effects on per-capita measures of economic welfare, which caution against simplified adverse judgments. From the perspectives of individuals in an open economy, conclusions about the welfare consequences of population aging may point in the opposite direction from those based solely on macroeconomic aggregates.

**Asymmetric fertility declines and population aging   4
among advanced economies**

The preceding points can be made more concrete by considering the effects of illustrative declines in fertility in the context of a macroeconomic model that endogenizes key aspects of demographic change and permits general-equilibrium analysis of the cross-border interactions among countries. The summary that follows draws on research that has developed such models.[17]

Imagine a world composed of two equal-sized economies having identical domestic structures and linked by cross-border flows of goods and capital. The exchange rate linking the two currencies and economies adjusts to ensure that the global (algebraic sum of both countries) current-account balance and the global net-foreign-asset position are always zero. Within each economy, optimizing firms produce a single composite good, determined by an aggregate production function with capital and (productivity-augmented) labor as its arguments. The composite 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. Preferences for domestic-produced versus foreign-produced goods are the same for households in each country. Most households are forward-looking and choose to smooth their consumption and savings intertemporally over the life cycle.[18]

Population growth and structure are endogenous in each economy. The population contains working adults, youth dependents (children for short), and elderly dependents who receive public pension benefits. For each economy, the fertility (child birth) rate, the child mortality rate, and the adult mortality rate (the inverse of adult life expectancy) are the key exogenous demographic variables in the model. Migration of people from one economy to the other is assumed absent.

This analytical framework, of course, greatly simplifies the complex reality of the world economy. But it contains the essential macroeconomic features needed for analysis and has the great merit of stripping away numerous details that might otherwise obscure fundamental behavioral relationships.

As a benchmark starting point, imagine a steady-state baseline solution for this model along which both economies follow identical balanced-growth paths and exhibit identical behavior. The child birth rate, the child mortality rate, and the adult mortality rate are set at constant values; the total population and its youth, adult, and elderly components thus all grow at a constant positive rate (for concreteness, say, at one-half of 1 percent per year). Assume that the productivity growth rate and the steady-state rate of inflation are likewise constant and identical for both economies. Along this baseline solution of the model, the exchange rate is constant at unity and the trade balances, current-account balances, and net-foreign-asset positions are all constant at zero.

To analyze the consequences of fertility shifts for macroeconomic variables, now imagine running shock simulations with the model, perturbing the exogenous paths of one or both countries' birth rates (with mortality rates kept unchanged) and comparing the resulting shock values of endogenous variables with their baseline values. Consider three alternative paths of fertility decline, labeled slow-gradual, faster-gradual, and large-cyclical. The *slow-gradual* fertility decline assumes a birth rate that monotonically declines over a period of 140 years to bring the economy to a new steady state in which the population and its components are stationary (the population growth rate falling gradually and smoothly from ½ to 0 percent per year). The *faster-gradual* decline likewise assumes a birth rate monotonically declining to a new steady-state position where the population is stationary but assumes that the decline is faster such that the stationary population is reached after only 90 years. The *large-cyclical* path entails a much greater demographic shock: The child birth rate declines sharply, remains at a low level for an extended period, and

then eventually recovers enough of its earlier decline to leave the economy with a population growth rate of zero; by construction, this shock causes for several interim decades a negative growth rate for the population as a whole.[19]

For analytical transparency, we can first postulate that any one of these three fertility declines occurs identically in both regions in the model world—in effect a *symmetric* or "global" shock. For a symmetric shock, the model will produce identical simulation paths for both economies. External-sector balances remain at zero and the exchange rate remains unchanged at its baseline value of unity. In effect, each economy behaves as though it were completely closed, which is, of course, true for the world as a whole. For shorthand I refer to these symmetric cases as "closed-economy" analysis. They facilitate interpretation of the most basic, domestic consequences of the shocks and serve as a benchmark for analytical interpretation of open-economy effects.[20]

Our primary interest is in analysis of *asymmetric* variants of demographic shocks in which one part of the world economy experiences different shocks and different outcomes from those occurring elsewhere and in which *open-economy interactions are critical determinants of the effects within each economy*. Think of one of the countries as the "home" economy and the other as the "rest of the world" (ROW). For fertility shocks with *milder asymmetry*, the home economy can be assumed to experience the faster-gradual decline in the birth rate while the ROW has the slow-gradual decline. An alternative combination of the shocks, labeled here as *bigger asymmetry*, assumes the home economy is buffeted by the large-cyclical shock to the birth rate while the ROW experiences the slow-gradual decline.[21]

For either asymmetric combination of the shocks, both economies eventually reach new paths with identical demographic growth rates; the populations decline, elderly ratios rise, youth ratios decline, and the ratios of the effective labor force to the adult population fall to markedly lower levels. The two economies get to that long run,

however, along quite different paths. Most important, because of the asymmetry in shocks, as explained further below, the interim and eventual *levels* of demographic and macroeconomic variables differ greatly between the two economies.

For the milder asymmetric combination of shocks, the elderly ratio, the youth ratio, and the ratio of the effective labor force to the adult population in the home economy reach their new ultimate levels much sooner than in the ROW. As a result, home demographic variables relative to those in the ROW significantly shrink. For the combination of shocks with bigger asymmetry, the differences are much more dramatic. The home population and effective labor force become very much smaller than they would have been and are much smaller relative to ROW than before. Instead of declining smoothly as in the milder asymmetric case, the home ratio of the effective labor force to the adult population falls cyclically by a large amount before partially recovering in the long run. When the asymmetry is bigger, the rise in the home elderly ratio and the fall in the home youth ratio likewise have prominent cyclical features (large change followed by partial reversal).

Changes in the effective labor forces reflect not only the demographic shocks but also the complex effects of humped age-earning profiles over the life cycle on the determination of labor incomes and human wealths. As the demographic shocks pass through the age-earning profiles in the two economies, the dynamic effects of the demographic shifts, significant in themselves, get still further amplified.[22]

Reflecting the movement of the effective labor force relative to the adult population, the home economy-wide aggregate levels of human wealth, financial wealth, output, consumption, and the aggregate capital stock all decline to eventual levels that are significantly lower. Because the effective labor force is lower relative to the capital stock, the marginal product of capital falls and the home real interest rate declines, by more than the ROW real interest rate but by less than it would have to decline if the home economy were closed. The home

capital-output ratio rises substantially in the medium and longer runs, more than if the economy were closed, and remains at the higher level forever. The ROW experiences a smaller medium-run and permanent rise in its capital-output ratio than the increase in the home economy; the ROW increase is less than the rise that would occur if its economy were closed. These different interest-rate, capital-stock, and output evolutions in the two economies are associated with major differences in saving and external-sector behaviors, which in turn are associated with changes in the relative sizes of the economies.

Saving and financial wealth per adult in the home economy rise sharply relative to baseline in the shorter and early medium run even more strongly than if the economy were closed; part of the increase is gradually reversed in the late medium and long runs. In contrast, saving and financial wealth per adult in the ROW economy rise very little relative to baseline (actually fall in the bigger asymmetric case) and those ROW paths for saving and per-adult financial wealth are consistently below the paths that would prevail if the ROW economy were closed and experienced the slow-gradual fertility decline. The larger the generosity of adult support of children's consumption, the larger are the rises in saving and financial wealth relative to what would have occurred without the decline in the numbers of children. The increases in financial wealth are explained partly by the effects of the age-earning profiles on saving and partly by higher disposable incomes and savings reflecting the smaller support of child consumption. The large differences in saving behavior and hence in financial wealth between the home and ROW economies are attributable not merely to their different-sized demographic shocks but also to major effects working through the exchange rate and external-sector transactions.

As the asymmetric shocks progress, an interest differential in favor of the ROW economy opens up (the interest rate falling less in the ROW than in the home economy) that proximately puts pressure on the real and nominal exchange rates. The home currency begins a sustained appreciation, first in nominal then with a lag in real terms.[23]

In the new long-run steady state reached by both economies, the nominal and the real exchange rate settle at appreciated levels significantly higher than in the baseline.

To understand why the asymmetric shocks result in a real exchange rate permanently higher, remember that the asymmetric fertility declines are transitory in terms of differences between the two countries' demographic *rates of growth* but have permanent effects on the *relative levels* of demographic and macroeconomic variables. The relatively larger shock to the birth rate in the home economy, as already noted, causes the home population and effective labor force to fall further below baseline than the falls in the ROW economy and hence causes shrinkage in the home relative to the ROW population and labor force. Eventually the home and ROW population growth rates again become equal. But the ratio of the home to the ROW effective labor force remains permanently smaller. Correspondingly, home macroeconomic aggregates such as the capital stock and output become substantially smaller than the corresponding macroeconomic aggregates abroad. By the medium and long runs, therefore, the quantity of home-produced goods available for sale and consumption in the world is markedly smaller than the quantity of ROW-produced goods. Given unchanged preferences in each economy for the two types of goods, relative prices in the world economy must change. A permanent real appreciation of the home currency—an improvement in the home economy's real terms of trade—is an integral part of the required change in relative prices.[24]

Changes in exchange rates generate expenditure-switching incentives between the two economies. Thus, by the medium run, the home economy begins to import substantially more of the now relatively cheaper goods produced in the ROW. Home exports to the ROW relative to baseline are inhibited by the appreciation of the home currency. For the initial decades of the shock, the home real trade balance relative to real GDP changes little. Thereafter, however, the expenditure-switching effects cause the home economy to run a progressively larger *deficit* on 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 export real resources abroad and correspondingly curtail its consumption relative to what would otherwise be possible.

The medium-run trade deficit of the home economy is *not* associated with a deficit on current account. The home economy not only imports more from abroad, it also saves more relative to baseline and financial wealth *rises* relative to baseline.[25] A fraction of the higher home financial wealth is invested abroad at the higher interest rates available abroad. Hence, the home economy over the medium run starts to earn a higher flow of investment income from abroad. The net investment income payments received are more than enough to offset the increased deficit on trade account, with the result that the home economy in the medium run begins to experience a significant current-account *surplus*. The surplus reaches a peak during the medium run; thereafter it falls and even returns close to balance for several decades as the two economies move toward their new long-run steady states. Eventually, in the very long run the ratio of the home current balance to nominal GDP settles at a moderate surplus ratio.

The net foreign asset positions of the two economies are, of course, the integral over time of the current-account imbalances. The home economy—despite the relatively larger shock it experiences, causing the economy's output and aggregate consumption to fall well below the levels that would have been observed without the shock—accumulates a *positive* net foreign asset position, on which it earns a sizable return.

The directions of movement of key variables in the home and the ROW economies are qualitatively similar for both the milder-asymmetric and the bigger-asymmetric cases. With the milder asymmetry (the faster-gradual shock in the home and the slow-gradual

shock in the ROW economy), the changes in variables tend to be smaller and relatively smoother than for the bigger asymmetry. When the home economy experiences the large-cyclical shock to its birth rate and the asymmetry is correspondingly more dramatic, the movements of variables as expected tend to be quantitatively much larger and to have an important cyclical element. Notably, with the bigger asymmetry, the home currency appreciates very much more than with the milder asymmetry, and the home external financial situation improves by a great deal more.

The openness of the economies thus decisively influences the macroeconomic consequences of the demographic shocks. Domestic variables in both economies are strongly influenced by cross-border transactions. Because of the openness of the economy, home domestic variables are partly cushioned from the full impacts of the larger demographic shock hitting the home economy. As a counterpart, ROW variables are adversely buffeted by the larger shock emanating from the home economy. An important component of these cushioning and buffeting effects is associated with the changes in exchange rates. The appreciation in the real value of the home currency enables the home economy to enjoy a large improvement in its real terms of trade with the rest of the world. The opposite effect, a deterioration in real terms of trade, contributes to the adverse effects on the ROW economy.[26]

The preceding examples also illustrate the point emphasized in section 3 that analysis of the macroeconomic effects of demographic changes should carefully differentiate between aggregate levels of variables and their per-capita and per-adult values. As discussed, the larger fertility shocks occurring in the home economy inevitably cause larger negative effects on home aggregate output and consumption. The home path for aggregate real consumption falls much further below baseline than does the ROW path for aggregate real consumption. Yet, the home path for aggregate real consumption is significantly *above* the path that would be experienced in the hypothetical case where the home economy is completely closed

and therefore unable to cushion its larger shock through transactions with the rest of the world. For the reasons given, the openness of the economy works to mitigate the size of the negative effects on the aggregates.

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 demographic shock in the home economy is larger than in the ROW economy, home per-adult consumption is actually *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. For the case of bigger asymmetry in the fertility shocks, moreover, the cushioning effects are so substantial when measured in per-adult terms that individual adults in the home economy are significantly better off *not only relative to individual adults in the ROW economy but better off absolutely relative to the no-shock baseline.* With the bigger asymmetry in shocks, ROW consumption per adult is markedly *lower* than in the baseline despite the fact that the ROW population, aggregate ROW real GDP, and aggregate ROW consumption are all at higher levels than in the baseline.

Different macroeconomic effects from increases in life expectancy and declines in fertility   5

This section amplifies the general point emphasized earlier that the macroeconomic effects of increases in life expectancy (lower death rates and hence longer survival spans) can be very different from the effects of reductions in fertility even though both categories of demographic change lead to population aging.

The argument uses the same model and procedures underlying the preceding section. In particular, the benchmark starting point is the same steady-state baseline solution described before in which both economies follow smooth balanced-growth paths along which

productivity growth and inflation are constant and the populations and their components grow steadily at one-half of 1 percent per year. For comparison with the fertility-decline simulations already discussed, new simulations are prepared that perturb the exogenous path of one or both countries' adult mortality rates. Two cases are emphasized, a slow-gradual and a faster-gradual decline. For the *slow-gradual* decline in adult mortality, the adult death rate monotonically declines over a period of 140 years before leveling out at about three-fourths of its initial rate. The *faster-gradual* decline assumes the same ultimate size of fall in the mortality rate but the decline occurs more rapidly over a shorter period of 90 years. For comparability with the fertility shocks, the same 90-year and 140-year periods are chosen to represent the lengths of the "faster" and the "slow" declines.[27]

Analogously with the preceding section, either of the adult life-expectancy declines can be assumed to occur identically in the home economy and the ROW. Such a *symmetric*, global shock produces a "closed-economy" outcome for the world as a whole in which domestic variables are identical in both economies, the exchange rate remains exactly at unity, and all the external balances of both economies remain exactly at zero. Alternatively and asymmetrically, the home economy can be assumed to experience the faster-gradual decline while the ROW economy has the slow-gradual decline. For this asymmetric combination of shocks, each of the two economies is influenced by the other's evolution. The outcome for both economies and the world as a whole incorporates the essential features of openness and cross-border interactions. My comments here will focus on the asymmetric combination of mortality-decline shocks and emphasize how those consequences differ from the effects resulting from the milder asymmetry in fertility-decline shocks described in the preceding section.

As with fertility declines, increases in adult life expectancy lead to rises in elderly ratios, declines in youth ratios, and falls in the ratios of the effective labor force to adult population. Increases in life expectancy and fertility declines are qualitatively similar in those

dimensions. But such similarities in direction of movement are much less noteworthy than qualitative differences for other variables. When the adult mortality rate declines from an initial to a lower level and remains thereafter at the lower level, the aggregate sizes of the total and adult working populations *rise* and the ultimate steady-state rate of growth of population and its components moves *higher.* The exact opposite is true for declines in fertility: A decrease from an initial to a lower birth rate with the birth rate remaining thereafter at the lower level causes the aggregate sizes of the total and adult working populations to *fall* and the ultimate steady-state rate of growth of population and its components to move *lower.*[28]

The different direction of movements for demographic aggregates stemming from the two underlying categories of demographic change is obvious once attention is focused on it. The difference does not seem to have been discussed in macroeconomic analysis of demographic change, however, and yet the ramifications of the difference are far-reaching. Not only demographic aggregates such as the population and effective labor force but also most major macroeconomic aggregates—specifically including the capital stock, output, and consumption of an economy's residents—move in opposite directions depending on whether population aging results from increases in life expectancy or from fertility declines.

The opposite direction of movement of demographic and macroeconomic aggregates would, of course, be observed even in an economy completely closed to the rest of the world. The difference has still more important implications in open economies where demographic transitions occur asymmetrically. For asymmetrically larger increases in life expectancy experienced by an open home economy, the interim and eventual levels of home macroeconomic variables not only change in an opposite direction from the changes associated with asymmetrically larger declines in fertility; they change in an opposite direction from changes associated with asymmetrically larger declines in fertility *relative to the corresponding macroeconomic aggregates in the rest of the world.* For example, an asymmetrically

larger home increase in life expectancy causes home output and consumption to *expand* relative to output and consumption abroad instead of *shrinking* relative to the rest of the world with asymmetrically larger home reductions in fertility.

Given the difference just emphasized and if you closely followed the argument in the preceding section about reductions in fertility, you should now jump to the conclusion—correctly—that the currency of the home economy should *depreciate* rather than appreciate relative to foreign currencies when increases in life expectancy are asymmetrically larger in the home economy. With an asymmetrically larger home decline in mortality, real and nominal interest rates in the home economy decline *less* than the falls in interest rates abroad. The interest differential in favor of the home economy, which other things equal, must proximately be offset by an expected incipient depreciation of the home currency, puts pressure on the exchange rate to manifest an actual depreciation. This depreciation of the home currency is the medium- and long-run macroeconomic outcome consistent with the facts that the home effective labor force is *increasing* relative to the ROW effective labor force and that the world supply of home-produced relative to ROW-produced goods is *rising*, not falling as it does for the case of fertility declines. Given unchanged preferences in each part of the world economy for home-produced and ROW-produced goods, relative prices for the two types of good must change. A permanent real depreciation of the home currency—a deterioration in the home economy's real terms of trade—is an integral part of the change in relative prices required by the asymmetrically larger home mortality decline.[29]

The consequences of the asymmetrically larger mortality decline for the home economy's net external balances on trade, investment income, and the current account are complex. The consequences differ in important ways from, but also have significant similarities with, the effects on home external-sector variables resulting from an asymmetrically larger home fertility decline. The salient points are the following. A non-negligible real depreciation of the home currency

occurs almost immediately after the onset of the asymmetrically larger increase in life expectancy (whereas significant appreciation of the home currency is delayed until the early medium run for the asymmetric fertility decline). Because of expenditure-switching associated with the currency depreciation, the ratio of home imports to home real GDP falls somewhat and the ratio of home exports to home real GDP rises somewhat (whereas these home ratios change little in the shorter run for the asymmetric fertility decline and then in the medium run the import ratio rises and the export ratio falls). Consequently the real trade balance (also the nominal trade balance) of the home economy improves modestly in the shorter run (whereas the changes are very small in the shorter run for the asymmetric fertility decline). Over the medium run, however, the home trade balance progressively falls and turns into a deficit; by the long run, the home trade balance must again start to improve and move into surplus.

  Because of the shorter-run improvement in the home trade balance, the home current-account balance also improves in the shorter run; that improvement leads to a modest and gradually increasing positive change over the short and medium runs in the net foreign asset position of the home economy. The positive net foreign asset position in turn gives rise to a modest net inward flow of investment income. In what at first seems a paradoxical result, therefore, the current-account and net-foreign-asset positions of the home economy improve for the asymmetric increases in life expectancy as well as for the asymmetric declines 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. Although the home trade balance is moving progressively into a deficit in the early and then middle and late medium runs, by that time the buildup in inward net investment income flows is more than sufficient to offset the growing trade deficit (a relationship that also prevails qualitatively for the case of asymmetrically larger home fertility declines). The similarities in

external positions (though *not* exchange-rate changes) resulting from the two types of asymmetric shocks, however, begin to turn into major differences over the late medium and longer runs. The net foreign asset position of the home economy gradually begins to decline algebraically for the asymmetrically larger increases in life expectancy (with the ROW external-sector position evolving correspondingly in a positive direction); in the long 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 (in sharp contrast with the sustained positive net foreign asset position of the home economy resulting from the asymmetrically larger fertility decline). In sum, the evolutions of external-sector outcomes over time become progressively different when asymmetric increases in life expectancy are compared with asymmetric declines in fertility.

Two of the general conclusions from the preceding section remain true for asymmetric increases in life expectancy. Just as before, the openness of both regions of the world economy decisively influences the macroeconomic outcomes. And just as before, analysis should carefully differentiate between the aggregate levels of variables and their per-capita or per-adult counterparts. The preceding summary has already emphasized that major macroeconomic aggregates move in opposite directions for increases in life expectancy and fertility declines. One of the reasons for focusing on per-capita or per-adult values is the further insights obtained about the implications of openness for the two types of demographic change.

When an asymmetrically larger life-expectancy shock hits the home economy, home domestic variables are partly cushioned from the full impacts of the larger shock by the economy's openness. Per-adult consumption in the home economy declines by somewhat less through the medium run than it would have to decline in the hypothetical case in which the home economy were closed and the effects of the larger increase in life expectancy could not be partially shared with the rest of the world. Unlike for asymmetric fertility declines,

however, the cushioning effects of openness on the home economy for asymmetric increases in life expectancy are weaker. Furthermore, they eventually fade away. After the medium run—after the deteriorations in the real exchange rate and the real terms of trade continue—it is *not* true that home per-adult consumption remains higher relative to baseline than it would be in the closed-economy case. In the longest run, per-adult consumption falls *further* for the asymmetric open-economy case than it would be required to fall for the closed-economy case where the effects of the larger increase in life expectancy could not be partially shared with the rest of the world.

Welfare comparisons between the two parts of the world economy also depend sensitively on whether population aging occurs because of increases in life expectancy or declines in fertility. Although the home economy in the short and early medium runs can be described as better off than it would be if its economy were closed as it experienced its larger life-expectancy shock, home per-adult consumption does *not* fall less relative to baseline than ROW per-adult consumption (the result when the home economy experiences an asymmetrically larger fertility decline). If anything, for the shorter run and medium run, home per-adult consumption falls relative to baseline a bit *more* than does ROW per-adult consumption. In the longer run, moreover, there is a further gradual *fall* below baseline for home per-adult consumption whereas ROW per-adult consumption *recovers* part of its earlier decline relative to baseline.

To judge from the research so far carried out, the "cushioning" and "sharing" effects of openness are stronger and more beneficial for a home economy that experiences a faster or larger demographic transition if the dominant underlying causes of the demographic transition are fertility declines rather than increases in life expectancy.[30]

Population aging and public pension systems   6

This section turns to alternative public pension systems. The emphasis is on how the openness of economies shapes the outcomes and policy choices under alternative pension systems when demographic shocks are asymmetric across countries.

The most important conceptual distinction among public pension systems is between *continuously balanced* versus *unbalanced* systems. In *continuously balanced* systems that strictly enforce "pay-as-you-go" (PAYG) rules, pension benefits and taxes collected to fund the benefits are strictly equal in every period. By always maintaining a zero balance in the pension fund, balanced systems may be characterized as independent of the rest of the government's budget ("off-budget"). A first extreme variant of balanced systems, a *tax-balanced system*, sets the benefit rate exogenously (say, on political grounds) and therefore must adjust the tax rate for the collection of pension-tax revenues period by period to keep the zero balance in the pension fund. The opposite extreme variant, a *benefit-balanced system*, reverses the roles of the benefit rate and the pension tax rate; the pension tax rate is set exogenously (again, say, on the basis of political considerations), which forces the benefit rate to be adjusted continuously to prevent any imbalance emerging in the pension fund. A third, intermediate variant is a combination of the other two. Rather than the extremes of setting the benefit rate exogenously while varying the pension tax rate or setting the pension tax rate exogenously while varying the benefit rate, an *intermediate-balanced system* keeps the pension fund continuously balanced by adjusting *both* the pension tax rate and the benefit rate. Specifically, the pension tax rate is adjusted upward by enough to offset one-half of any incipient pension-fund deficit in the current period and the benefit rate is adjusted downward by enough to offset the other half of the incipient deficit (and vice versa if the pension fund in the current period runs an incipient surplus).[31]

In variants of *unbalanced* PAYG pension systems, the systems are "on-budget." The pension tax rate and the components of pension

benefits are both set exogenously on political or other grounds while the cash balance in the pension fund adjusts endogenously through time, taking on non-zero values. A pension-fund actual deficit or surplus thus proximately leads to an overall deficit or surplus in the government's budget as a whole and therefore proximately causes an increase or decrease in the stock of the government's debt. The behavior of the fiscal authority in setting non-pension tax rates, discretionary government expenditures, and constraints on changes in the stock of government debt then plays a crucial role in determining how unbalanced pension systems affect macroeconomic variables. In one variant of an unbalanced pension system, for example, the government is assumed not to permit sustained deficits or surpluses in its overall budget because it varies income-tax rates as required to offset imbalances in the pension fund; that behavior prevents the government debt stock from permanently rising or falling because of imbalances in the pension fund. In a quite different unbalanced variant, the government is assumed to permit pension-fund imbalances to cause sustained deficits or surpluses in its overall budget, in turn allowing sustained changes in the stock of total government debt that reflect the imbalances in the public pension system.

Original planning blueprints usually specify that PAYG public pension systems should remain balanced, if not continuously then at least over time. Yet real-life governments exhibit inertia in implementing such designs, especially if the public pension system is "on budget" instead of "off budget" with the pension fund permitted to become unbalanced for lengthy periods. Politicians prefer to let problems build up. They defer necessary policy responses until the evidence is unambiguous that policy reform needs to be taken. For example, as population aging occurs and a PAYG pension system starts to have benefit payments that exceed revenues collected, a government may be slow to adjust its pension policies. Political consensus cannot readily be generated for pension tax increases, pension benefit cuts, or some combination of the two. The course of least resistance is to postpone difficult decisions. In the meantime,

actual deficits in the pension system accumulate and still larger prospective deficits loom across the horizon.[32]

The presence or absence of a public pension system in an economy, and the nature of its operations, can significantly affect *private* saving behavior. The pressures of population aging on public pension systems and hence on overall government budget imbalances can critically influence government saving or dissaving. National saving (the net sum of private saving and government saving) and the operation of a public pension system are thus two subjects inevitably entangled together.

Unbalanced public pension systems influence private and national savings strongly, especially if they lead to sustained imbalances in overall government budgets and sustained changes in the stock of government debt. But even balanced pension systems may have significant savings effects. For example, a public pension scheme can somewhat discourage individuals from saving for their old age outside the pension system. Intuitively, if the present discounted value of an individual's current and future pension taxes ("social-security contributions") will be roughly equal to the present discounted value of expected future pension benefits, the operation of a public pension system will not much change the individual's lifetime human wealth. But the private saving that forward-looking individuals would otherwise do on their own without a pension system tends to be partially displaced by their pension taxes under a pension scheme. If an individual entering the labor force at the beginning of work life were to expect future pension benefits to exceed current and future pension taxes (both being appropriately discounted to present value), then the individual's saving outside the pension system (for short, his private saving) would be likely to fall by a still larger amount. Conversely, if discounted pension taxes were expected to exceed discounted future pension benefits, his private saving would rise above what it would be with the present values of pension taxes and pension benefits expected to be equal. A further consideration affecting saving outside the pension system is that the operation of a public pension system

providing assured annuities in old age may weaken the precautionary motive for private saving when longevity is uncertain. The preceding generalizations are consistent with a public pension system providing a net *positive* correction for a tendency for some, possibly many, individuals to save too little for retirement and ill health in old age (notwithstanding the public pension system's partial discouragement of private saving outside the pension system).

In an economy open to the rest of the world, the saving behaviors described in the preceding paragraph and their implications for the financial wealths of households are significantly conditioned by exchange rate movements and external-sector transactions. To give an example: For the case of bigger asymmetric shocks to birth rates discussed in section 4, the large-cyclical fertility shock hitting the home economy causes home private saving and per-adult financial wealth to be much higher than they would be in a closed economy. The medium- and long-run behavior of private saving and financial wealth also differ substantially among alternative public pension systems. Open-economy home saving in the medium and long runs, for example, is substantially higher under the benefit-balanced than under the intermediate-balanced system, higher under the intermediate-balanced than under the tax-balanced system, higher under the tax-balanced than under an unbalanced system that permits no sustained increase in the government debt stock, and lowest of all under an unbalanced system where the government's overall budget is in deficit for a protracted period and the outstanding debt stock is permitted permanently to rise by a large amount.[33]

Alternative pension systems can, of course, produce dramatic differences in benefits. Because the pension tax rate must rise sharply in a tax-balanced system, the burden of adjustment falls on workers paying the pension tax. In the medium run under a tax-balanced system, recipients of pensions may even receive payments representing a modestly *higher* fraction of average per-worker labor income. Conversely, benefits have to fall sharply under a benefit-balanced system if population aging would otherwise lead to pension-fund

deficits. The benefit-balanced system places the adjustment burden entirely on pension recipients, the oldest of adults. An intermediate-balanced system falls roughly in the middle between the two balanced extremes. In unbalanced systems, pension benefits relative to revenues collected from pension taxes and other taxes of course depend on all aspects of the fiscal authority's behavior. Choosing among alternative pension systems obviously entails difficult issues of intergenerational equity.

A home government's choice of how to operate the public pension system influences the behavior of the nominal and real exchange rates as the economy interacts with the rest of the world in adjusting to demographic shocks. Introduction of public pension systems into an analytical model relative to a model variant without pensions unambiguously *reduces* the degree to which the home currency appreciates in response to asymmetric fertility shocks.[34] When the pension system is unbalanced and the home fiscal authority permits a substantial rise relative to baseline in the stock of home government debt, the diminution in the size of the appreciation of the home currency that would otherwise occur is especially noticeable.

Consider again the illustrative case of bigger asymmetry in fertility shocks discussed in section 4 (the home economy having a large-cyclical fall in its birth rate while the rest of the world has a slow-gradual decline). As would be expected from the differential effects on the real and nominal exchange rates, the pension system associated with the smallest real appreciation of the home currency—the unbalanced system in which the government debt stock is permitted to rise sharply—is also associated with the least large increase in the home import ratio, the smallest fall in the import ratio abroad, and the least large deficit in the home external-trade account. If one were to judge pension systems by their influence on the size of the net import of real resources by the home economy and hence their ability to cushion home consumption in the face of the symmetrically larger shock to home fertility, the benefit-balanced system performs best and the unbalanced-with-large-debt-increase system is

the least satisfactory. A similar ranking applies to the sizes of net investment income flows from abroad. Home savings are least robust and hence result in the smallest net inflow of investment income under the unbalanced regime that permits large debt increases. Thus, under that unbalanced regime the current-account balance as a percent of nominal GDP correspondingly shows the smallest medium-run increase of all alternative pension systems; the balanced systems all produce larger medium-run increases than the unbalanced systems; the benefit-balanced system with its higher savings is associated with the biggest surplus ratio. The home net-foreign-asset position, the stock counterpart of the period-by-period current-account flows, is a complex net outcome from all the external-sector transactions. The balanced pension systems produce stronger net-foreign-asset positions than the unbalanced. In the very long run the home net-foreign-asset position progressively deteriorates under the unbalanced-with-large-debt-increase system and eventually turns negative so that the home economy has a sizable net-foreign-*liability* position.

Policy choices about public pension systems should be shaped by analysis that looks well into the future as well as at short-run pressures. Longer-run economic welfare, appropriately discounted back to present value today, depends importantly on choosing pension policies that encourage—or at least do not unduly penalize—national saving. For a single open economy that is moving faster into or is further along in its demographic transition, policymakers should also give substantial weight to encouraging the economy's ability to cushion the effects of its demographic transition by sharing them with the rest of the world.[35]

These criteria of encouraging national saving and taking into account the cushioning available through cross-border transactions have important implications for choices about the operation of PAYG public pension systems. Other things equal, because of the effects in fostering national savings and thereby promoting higher long-run growth of the economy, policymakers should prefer a pension system

that stays balanced over pension policies that permit imbalances to cumulate between pension revenues and pension tax revenues. Given the two criteria, moreover, policymakers should be especially wary of allowing population aging to produce large overall budget deficits and mounting increments to government debt.

Among balanced pension systems, a benefit-balanced system would encourage the largest possible saving and growth effects. Unbalanced pensions systems can influence national savings and long-run growth especially adversely if, to repeat, they are associated with sustained budget deficits and ballooning government debt stocks. The adverse effects can loom larger in open economies when exchange rate changes and external-sector transactions shape the outcome.

The preceding comparisons do not address the difficult issues of intergenerational equity. Criteria for choosing the operation of a public pension system that maximizes national saving or strongly supports the ability of the economy to exploit the cushioning available from cross-border transactions do not take into account the distributional effects that favor or disfavor the individuals alive today relative to future generations. A benefit-balanced system, for example, notwithstanding its more favorable effects on saving and long-run growth, is politically skewed against current recipients of pension benefits and emphasizes the welfare of future generations at the expense of today's elderly. Running budget deficits and increasing government debt now so that cuts in pension benefits or increases in pension taxes can be deferred into the future undermines consumption possibilities for the long run but is preferable from the perspective of current pension recipients.

Individuals alive today are voters. Generations as yet unborn do not vote in today's elections. This one fact alone means that the analytical and political issues of intergenerational equity are central to policy choices about public pension systems. Confronting the intergenerational aspects squarely is politically difficult, but obfuscation about them is probably worse.

Could lagging demographic transitions in developing economies ease the adjustments to population aging in advanced economies?

7

The generalizations in preceding sections pertain primarily, I believe, to the higher-income advanced economies. Japan is the most prominent example of an industrial nation whose fertility rates and mortality rates have fallen dramatically and whose population is aging more rapidly than other OECD nations, in particular the United States.[36] Significant asymmetries in the pace of aging also exist among other countries, for example within Europe. The analysis summarized in this paper was originally motivated by these asymmetries within the OECD economies, especially by Japan's demographic transition relative to those of other industrial nations. The underlying model analysis rests on stylized macroeconomic relationships that are characteristic of the higher-income advanced economies.

Could a similar analysis nonetheless shed light on demographic asymmetries between the industrial nations as a whole ("the North" for short) and emerging market and other developing countries also considered as a group ("the South")? Much of the biggest demographic differences in the world exist between individual countries in the North and in the South. True, great demographic heterogeneity exists within the South (think only of the differences between China and Africa), just as asymmetries are significant within the North. Even so, when viewed from a world perspective, the demographic transitions among the higher-income Northern countries themselves appear relatively small if contrasted with the larger differences between the demographic transitions of Southern countries as a whole and Northern countries as a whole.

Suppose one tries to apply the analytical apparatus underlying sections 4 and 5 of this paper to macroeconomic interactions and capital flows between the North and South. One possible (although, as discussed below, problematic) line of thinking might go as follows. Interpret the "home" economy as the OECD nations as a group. Let

the ROW economy be Southern countries aggregated together. Given demographic developments in the two regions, might there be scope for the North to run current-account surpluses vis-à-vis the South in the shorter and medium runs, exporting Northern savings to the South so that investment within the South can be higher than it otherwise could be?

A few analysts have addressed this issue of whether differences in demography between developed and developing economies could work in the direction suggested by the preceding line of thinking, stimulating net capital flows from the North to the South where the capital-output ratio tends to be lower and the rate of return to capital tends to be higher. If investment demand could reach high levels in Southern economies, for example, asset owners in the North could continue to earn comfortable returns on their savings, avoiding the prospect of diminishing returns that would otherwise be associated with lower ratios of the effective labor force to the population and a lower marginal product of capital. This relatively optimistic view of North-South capital flows associated with demographic transitions in the North and South is suggested by, for example, Attanasio and Violante (2000) and Brooks (2003).[37]

Because of the inherent policy importance of the issue and because the conclusions summarized in this paper about demographic asymmetries within the Northern economies invite one to consider the possibility, I have been sympathetic to the suggestion that net capital flows from the North to the South might contribute to easing the adjustments to demographic transitions in Northern economies as well as facilitating development in the South. This line of thinking needs to be questioned on two different grounds, however, both of which cast doubt on its plausibility. Moreover, further clarifying research is needed about the interpretation of empirical correlations between demographic ratios and current-account balances and about the consistency of these correlations with inferences made from analytical models like the one underlying sections 4 and 5 above. These points are discussed in turn below.

The first set of doubts emphasizes that the analytical apparatus used in the earlier analysis may not be sufficiently applicable to developing economies. The economies and policies of many developing nations have problematic features that may inhibit their net absorption of foreign saving. Macroeconomic management of the economies, especially monetary policies for constraining inflation and fiscal policies for establishing responsible government budgets, is frequently even less sound than the counterpart macroeconomic management of Northern economies. The prudential supervision and regulation of financial institutions and financial markets may be inadequate. Business contracts may sometimes be less secure than in the OECD economies and so on. To state the same point more broadly, the quality of institutions and collective governance may be weaker in particular developing countries than they are on average in the higher-income countries of the OECD.

Thus, while Southern economies might in principle provide substantial investment opportunities at the margin, the South as a whole might not be able to absorb enough Northern savings to alter significantly the saving-investment balance for the North as a whole. Most analysts can probably agree that investments in the South by Northern owners of financial capital—*if feasible*—could bring potential advantages to both the North and South through enhanced risk diversification and higher rates of return. But feasibility is the rub. For Southern economies to capture those potential gains, the frictions and impediments—economic, political, and legal—that inhibit Northern investment in the South must not be too severe. External-debt dynamics must not be perceived as too problematic. Country-risk premiums must not be too high. Some analysts—for example, (Holzmann, 2000) and John Helliwell's paper for this symposium (2004)—are relatively pessimistic that improvements in institutional quality and collective governance are feasible within a sufficiently short time.[38] My own views on this score are agnostic but also relatively pessimistic.

To make satisfactory progress in evaluating the degree to which Southern frictions and impediments to investment may inhibit the

net absorption of foreign saving and hence constrain the scope for the South to run current-account deficits vis-à-vis the North, it is necessary to have an analytical apparatus with at least rudimentary representations of the problematic features of Southern economies and polities. At the same time, the analytical apparatus must be capable of capturing the co-evolution of Southern and Northern economies in a way that allows for the general-equilibrium macroeconomic interactions that will crucially determine the outcome of the demographic pressures differing across world regions. The analytical task is daunting, and one cannot be sure in advance that efforts to tackle it can succeed. At the least, it must be acknowledged that the necessary analytical apparatus does not satisfactorily exist as of the time of this writing.[39]

The suggestion that net capital flows from the North to the South might result from asymmetric demographic transitions in the two parts of the world economy needs careful scrutiny for a second set of reasons. Those who have made this suggestion, including myself, have been too readily inclined to presume that the North is aging faster than the South. The facts about recent historical decades, to be sure, are consistent with that presumption. Youth ratios in most OECD nations, particularly in Japan and Europe, have undoubtedly fallen more rapidly and to much lower levels than youth ratios in most developing economies. Similarly, in the recent past, OECD elderly ratios have risen faster and to much higher levels than elderly ratios on average in the South. But will these trends continue? Will the demographic transitions in the North for the next several decades persist as faster and larger than those in the South?

The great heterogeneity within developing economies and also within the OECD makes it hazardous to generalize about the North and South as a whole. But it seems plausible, if not even likely, that the demographic transition for the South as a whole, and certainly the transitions of important individual developing economies, will in coming decades move just as fast or faster than the continuing demographic transitions within the OECD. The higher-income advanced countries may have already experienced the larger part of their demo-

graphic transitions and may now be "slowing down" while transitions within the South are just now "picking up speed." Large countries such as China and India dominate the demographic statistics for developing economies and may be illustrations of "picking up speed."

I have not looked closely enough at the demographic statistics for individual Southern economies or the South as a whole to be able to make confident generalizations about the relative speeds and intensities of aging over the next few decades between the North and the South. But the longer I worry over this question, the more I am inclined to the view that, in contrast to the past, the North should now be perceived as aging *less rapidly*—not more rapidly— than the South.[40]

If the North will age more slowly than the South in the future, note that the facile presumption made above about the identification of the two regions in the analytical model of sections 4 and 5 should probably be reversed! Perhaps the "home" economy with its larger demographic shocks should be associated not with the OECD nations as a group but rather with the Southern countries aggregated together. For a two-region world, moreover, recall the conclusion that asymmetrically larger fertility declines and asymmetrically larger adult-mortality declines in one of the regions lead that region to run a current-account *surplus* with the rest of the world over the shorter and medium runs. The direction of movement of the exchange rate for asymmetric fertility declines differs from the direction of movement for asymmetric declines in the adult mortality rate. But for both cases the region with the larger shocks runs a current-account surplus and builds up a positive net-foreign-asset position with the rest of the world in the shorter and medium runs. If the home region with larger shocks is identified with the South, therefore, the model would then predict that the demography would cause the North to run current-account *deficits* rather than surpluses vis-à-vis the South in the shorter and medium runs. The North would become, in other words, a net importer of financial capital, not a net exporter.[41]

An uncomfortable aspect of such a prediction is that evolving demographic asymmetries by themselves would cause savings to flow away from the lower-income South. Rather than "excess" Northern saving flowing to the South to facilitate growth and development in the South, the "excess" savings would arise in the South, with net outward capital flows from the South diminishing Southern domestic investment relative to what it might otherwise be. Helliwell's paper for this symposium (2004), drawing on Higgins (1998), Lührmann (2003), and his own charts and regressions, summarizes the implications of the empirical evidence in that latter way. He reasons that, other things equal, demography-induced capital movements would tend to flow toward the OECD nations, not away from them.

In practice, would savings really flow net from the South to the North even if demographic forces by themselves were to move current-account balances in that direction? Helliwell gives some reasons in his paper for doubting such an outcome. I share his skepticism.

I am even skeptical about the analytical prediction that, abstracting from other forces, demography-induced capital movements would flow away from rather than toward the South. In the remainder of the comments here, I identify some doubts about whether our analysis of the demographic influences on current-account balances is well enough advanced to permit reliable conclusions. Further clarification of the interpretation of the empirical correlations between demographic ratios and current-account balances seems needed. More clarification and refinement is certainly needed for the results stemming from general-equilibrium analytical models.

Empirical regressions focused on reduced-form relationships between demographic ratios and current-account balances, such as in Higgins (1998), Lührmann (2003), and Helliwell (2004), predict that countries with youth ratios or elderly ratios rising faster than the counterpart ratios in other countries tend to become larger net importers (or smaller net exporters) of financial capital; the current-account balances of such countries, in other words, weaken (move

toward larger deficits or smaller surpluses). Conversely, countries with relatively large increases in the ratios of working-age adults to the total population (called the "active ratio" since working-age adults are often referred to as the economically active population), tend to become larger net exporters (or smaller net importers) of capital.[42]

My so far limited examination of these regression results raises some doubts for me about their interpretation. To be sure, Higgins and Lührmann investigated several alternative specifications and carried out extensive sensitivity analysis of their results. Helliwell's summary is cautious. Nonetheless, the statistical significance of some of the coefficients on dependency ratios is low, especially for some estimates of the effects of elderly dependency. The values of the coefficients bounce around quite a bit, depending sensitively on the sample of countries and the time period. The variability of current-account data, as pointed out by Helliwell, tends to be markedly higher for developing countries than for the OECD (so that the correlation between national savings and domestic investment is lower for the developing economies). But that result, as Helliwell says, is almost surely not attributable to greater capital mobility among the non-OECD countries than within the OECD. I suspect that the quality of current-account, saving, and investment data for developing economies is poorer than for the OECD, which makes one worry that the estimated effects of demography on the current balance for developing economies might be less robust.[43]

More broadly, I worry that the reduced-form empirical correlations may be a less-than-robust foundation for drawing conclusions about the dynamic effects of demographic changes on saving-investment balances. The dynamic effects of demographic shocks on youth ratios and elderly ratios (hence active ratios too), and of course more broadly the dynamic effects on key macroeconomic variables, depend on whether the underlying shocks are declines in birth rates or declines in mortality. If the underlying cause is a decline in mortality rates, the dynamic effects are definitely sensitive to whether the decline is for youths or adults. Almost surely, furthermore, the effects

of a mortality decline differ depending on the age of the adults proximately affected (the implications of a decline in death rates for 20-year-olds, for example, having much greater effects on the labor force than a decline in death rates for elderly adults over age 60).[44] The reduced-form empirical regressions cannot capture such differences. The regressions estimate the effects on savings and on current-account balances of a decline in youth ratios or an increase in active ratios, for example, as *invariant to why the ratios change.* My conjecture is that this concern might apply especially to interpretation of the effects of changes in the active ratios.[45]

Investigating the effects of countries' asymmetric demographic transitions on their saving-investment balances and net capital flows with an analytical model has the clear advantage that differing dynamic effects due to differing underlying causes of the demographic change can be analytically separated and studied explicitly. But a model such as that underlying the analysis in sections 4 and 5 has the serious disadvantage of not being sufficiently well based on empirical data for actual countries.

To what degree are my model results and the reduced-form empirical correlations consistent with each other? The comparison depends sensitively on whether it is made for declines in fertility or increases in life expectancy. It also depends on whether the focus is on youth ratios, elderly ratios, or active ratios.

For asymmetric declines in birth rates, the model results and the empirical correlations conform reasonably well. The "home" country with the faster fertility decline experiences a markedly faster decline in the youth ratio and then eventually, after the demographic shock has largely passed through, a faster rise in the elderly ratio. The home active ratio at first rises more than the foreign ratio; the difference between the home and foreign active ratios reaches a peak after several decades, after which the home ratio starts to decline faster; after being above the foreign ratio during the shorter and early medium runs, the home ratio falls progressively below the foreign ratio; the home active

ratio remains below the foreign ratio throughout the later medium and long runs.[46] The empirical correlations and the model both predict that the faster decline in the home youth ratio should move the home region toward being a net capital exporter (current-account surplus). The early-decades rise of the home relative to the foreign active ratio is also consonant with the home region moving into current-account surplus (in both the empirical correlations and the model). Once the decline in the home youth ratio is largely complete and as the elderly ratio is in the middle of its sustained rise, the home active ratio falls well below the foreign active ratio. The empirical correlations suggest (because of the faster rise in the home elderly ratio and the fall of the home relative to the foreign active ratio) that the home current-account balance by the later medium run should be reversing, moving the home economy toward being a smaller net capital exporter (or even becoming a net capital importer). The model results here too conform fairly well to this pattern; as noted in section 4, the home current-account surplus reaches a peak during the medium run and thereafter falls and even returns close to balance for several decades as the demographic transitions eventually converge for the two economies.

   For asymmetric increases in life expectancy, on the other hand, a comparison of the results from the model and predictions based on the reduced-form empirical correlations does not suggest consistency. The faster rise of the home elderly ratio suggests that, other things equal, the home country should move toward current-account deficit (import capital net from the rest of the world). The home and foreign active ratios both decline moderately, but the decline in the home ratio is greater; the home ratio remains below the foreign ratio throughout the simulation (until both economies eventually converge to the same ratio, lower than the initial ratio at the outset). The relative movements of the two active ratios also suggest that the home economy should move toward current-account deficit (smaller surplus or larger deficit than initially). The model, on the other hand, unambiguously predicts a move toward current-account *surplus* for

the short and early medium runs (after which the surplus is definitely reversed, even becoming a deficit in the longest run).[47]

A candid appraisal must therefore acknowledge that the results from my analytical model and the correlations highlighted in the reduced-form empirical regressions are not fully consistent. Whether the analytical model is flawed or alternatively whether the empirical correlations require a more nuanced interpretation is for the moment unclear. More sensitivity testing of the model results is called for, which should lead to a better understanding of the current-balance and net-foreign-asset-position outcomes produced by the model and how those results can be reconciled with the observed empirical correlations.[48]

Analyses of North-South net flows of financial capital will probably have important implications for political dialogues and debates about macroeconomic policies in both the OECD and developing economies. Unfortunately, for the reasons summarized, we cannot yet confidently generalize about these flows. The analytical aspects merit more investigation. Only after further refinements are made in our understanding of the empirical correlations and of the analytical models will it be possible to develop reliable judgments about the prospective direction and quantitative magnitude of these flows.

My discussion has not commented at all on the difficult issues of migration and whether flows of people between the South and North can ease adjustments to economic and demographic shocks, including not only demographic transitions but a variety of other economic problems. I remain sympathetic to the possibility that—under favorable conditions—net flows of financial capital from North to South might be able marginally to help ease Southern and Northern adjustment problems. But Helliwell's paper for this symposium is probably right in stating that one cannot optimistically look to large-scale movements of either people or financial capital as primary remedies for economic problems in the South or the North.

Several conclusions summarized in this paper, especially those about the influence of demographic transitions on North-South capital flows, are interim and unsatisfying. I am reluctant to end on a downbeat. So, as a final observation, let me emphasize what I hope is evident from the paper as a whole. In the last few years, the economics profession has made substantial progress in analyzing the cross-border macroeconomic implications of demographic transitions. The issues are attracting increasing attention. More good research is in the pipeline. Looking ahead several years, it is plausible to predict that analysts, policymakers, and journalists will have made significant further progress in understanding this fascinating and important subject.

Endnotes

[1]Readers wishing to dig more deeply into the analysis are likely to be frustrated by suppression of many of the details. The underlying technical papers, which include numerous charts and full expositions of the arguments, are identified in subsequent footnotes and are available through the Brookings Institution Web site (*www.brookings.edu*).

[2]John Helliwell's paper for this symposium (2004) discusses changes in border barriers inhibiting migration of people. The dramatic increases in cross-border capital mobility in the second half of the 20th century and the early years of the 21st century are probably due at least as much to reductions in financial separation fences as to changes in communications and information technologies and to enhanced financial asset substitutability; for discussion, see Obstfeld and Taylor (2002).

[3]In the 1970s, Daniel Bell (1999, first published in 1973) wrote about the "eclipse of distance." He had in mind not merely geographical distances and the shrinking of time required to travel across them, but also the foreshortening of economic, social, and psychic distances. Many commentators about "globalization" have exaggerated this point. It is emphatically *not* true that one can accurately speak of the eclipse of distance and territoriality in the initial years of the 21st century. Nor is it sensible to identify "supra-territoriality" as the distinguishing feature of today's world economy. Empirical analysis—see, for example, the summaries in Helliwell (1998, 2000, 2003)—has strongly refuted the generalization that cross-border economic linkages have intensified to the point that they are as tight as those within national economies (after taking due account of such factors as transportation and communication costs). National borders are significantly less important than they were in the middle of the 20th century. But it is a wild exaggeration to assert that national borders are dissolving and that geographical distance and territoriality will soon be superceded. When analyzing the growing integration in the world economy, it is essential not to exaggerate the declining economic significance of national borders.

[4]The concept of national saving referred to here is the national-accounts concept (the difference between flows of income and expenditure excluding capital gains and losses), not the net wealth accumulation concept that includes capital gains and losses.

[5]Obstfeld and Rogoff (1996, 2001), for example, review alternative interpretations of the Feldstein-Horioka empirical findings.

[6]See, for example, Alan Taylor (2002).

[7]See, for example, Tesar and Werner (1992, 1994, 1998); French and Poterba (1991); Baxter and Jermann (1997); Lewis (1999); Ahearne, Griever, and Warnock (2000).

[8]Interpretation of the empirical correlation for developing countries raises further complexities, in part because of the greater prevalence for them of balance-of-payments crises (which can force rapid and large adjustments in current account balances and hence in the saving-investment balance). See for example Dooley-Frankel-Mathieson (1987) and Helliwell's paper for this symposium (2004). Ho (2003) presents evidence that the empirical correlation between national saving and domestic investment depends on the relative sizes of national economies.

[9]Throughout the paper, I define the *elderly ratio* as the ratio of elderly individuals to the adult working population, not as the proportion of elderly individuals in the total population (youths plus workers plus the elderly). Similarly, the *youth ratio* refers to youths as a proportion of adult workers not as a proportion of the entire population. These definitions are the more common ones in the literature. The effective labor force is the labor force adjusted for labor-augmenting technical change (so-called efficiency units of labor).

[10]The movements in per-adult human wealth and financial wealth over the longer run depend on the specifics of the demographic transition (see below).

[11]The two categories of underlying demographic causes are, no doubt, interrelated in complex ways. For example, the decline in birth rates is probably, in part, an endogenous response to actual and expected declines in mortality rates at all ages (perhaps especially reductions in mortality for infants and young children). A helpful recent overview of the demography is provided by Lee (2003).

[12]For example, see Coale and Hoover (1958).

[13]Contributions include Cutler, Poterba, Sheiner, and Summers (1990); Bosworth, Burtless and Sabelhaus (1991); Auerbach, Cai, and Kotlikoff (1991); and Deaton and Paxson (1997). Bosworth, Bryant, and Burtless (2004) provide a survey of this literature.

[14]Among the many contributions, see for example Aaron, Bosworth, and Burtless (1989), Bosworth and Burtless (1998), Aaron and Reischauer (2001); Wise (1994), Gruber and Wise (1999), Disney (1996); World Bank (1994), OECD (1998); Lee and Skinner (1999), Lee and Edwards (2002), Elmendorf and Sheiner (2000), Kotlikoff, Smetters, and Walliser (2001), Brooks (2002), and Velculescu (2004).

[15]Bryant, Faruqee, Velculescu, and Arbatli (2004) study changes in youth dependency and illustrate their major importance for domestic and cross-border macroeconomic variables.

[16]Evidence exists in the literature suggesting that youth dependency matters for the determination of national saving, investment, and foreign capital accumulation. Mason (1987, 1988) finds that changes in the growth rate of the population and in the youth dependency ratio can have opposite effects on aggregate saving. Bloom and Williamson (1997), Higgins and Williamson (1997), and Williamson (1998) investigate the implications of youth dependency for growth in East Asia; see also Higgins (1998). The conclusion that high growth rates in East Asia before 1990 can be explained primarily by dependency-ratio effects has been questioned; but the view that changes in youth dependency can have significant macroeconomic effects is well supported. Numerous empirical studies, some going back to the 1980s, have identified a negative macroeconomic link between dependency ratios and saving rates. Table 2 in Bryant and McKibbin (1998), reproducing an updated version of a table by Meredith (1995), identifies many of the empirical studies of the effects of dependency ratios on saving rates and summarizes their main findings. Recent empirical evidence suggesting that both youth and elderly dependency ratios have a significant negative effect on savings is summarized by Loayza, Schmidt-Hebbel, and Serven (2000). Bloom, Canning, and Sevilla (2001) and Bosworth, Bryant, and Burtless (2004) survey some of the issues.

[17]My own work at Brookings with a stylized two-region world model, done in collaboration with Hamid Faruqee and Delia Velculescu, and the skillful research assistance of Elif Arbatli and Marc de Fleurieu, is summarized in Bryant, Faruqee, Velculescu and Arbatli (2004) and Bryant (2004a, 2004b). Warwick McKibbin and I have been collaborating on this general line of research; see Bryant and McKibbin (1998, 2004). McKibbin's research implements our analytical ideas in conceptually similar frameworks based on McKibbin's MSG3 model in which several alternative country and regional disaggregations are used; see for example McKibbin and Nguyen (2004). The models underlying this research are works in progress and continued refinements are needed (see, for example, the next footnote).

[18]A smaller fraction of households is assumed to be constrained by an inability to borrow and must therefore consume out of current income. The treatments of household consumption, saving, and wealth accumulation build on the overlapping generations framework of Blanchard (1985), Weil (1989), and Yaari (1965) as extended by, among others, Faruqee, Laxton, and Symansky (1997) and Faruqee (2002) to incorporate age-earnings profiles and a "bottom-up" determination of labor income. As explained in our technical papers, the Blanchard-Yaari approach uses a key simplification that assumes age-invariant probabilities of death for adults. This simplification has powerful advantages because it facilitates an aggregation across all the households in an economy without having to keep explicit track of the consumptions, savings, and wealths of every age cohort separately and thus permits an easier construction of multi-country general-equilibrium models. However, this simplification is also unrealistic and problematic (as discussed further in footnote 30). Research is going forward to develop multi-country general-equilibrium models that relax this assumption. When available, such models will permit a refinement and may even lead to significant modifications of the analysis.

[19]This large-cyclical shock to fertility is studied extensively in our papers already cited. The shock is interesting in part because it is roughly analogous to the recent and prospective demographic experience of Japan. The major decline in fertility in Japan took place in the second half of the 20th century. This shock thus roughly combines Japan's past fertility experience and projections of its demographic future.

[20]Readers seeking detailed discussion of the closed-economy cases for the slow-gradual shock and the large-cyclical shock may consult Bryant (2004a) or Bryant, Faruqee, Velculescu, and Arbatli (2004).

[21]For analytical clarity, it is helpful to assume that for asymmetric shocks both parts of the world end up in the very long run in a sustainable world steady state in which demographic growth rates are everywhere the same.

[22]When individuals first enter the labor force, they have relatively low productivity and are relatively low savers. Then as younger workers age, gain experience, and have higher productivity, they in effect ascend the left side of the hump of the economy's age-earning profile. Individuals reach their years of peak earnings and high savings when they are in their forties and fifties. Eventually, they start to descend the right side of the humped age-earning profile, and consequently their labor incomes and saving decline. At that point, their consumption must be increasingly financed out of their privately accumulated financial wealth as supplemented by pension transfers from the government (if a public pension system exists). We first stressed the importance of these age-earning-profile effects in a 2001 paper, published as Bryant and McKibbin (2004); see in particular the comparisons in that paper between simulations with and without the age-earning profiles present.

[23]The underlying model enforces a variant of the uncovered interest parity condition as part of the behavior determining the exchange rate. An interest differential in favor of the ROW economy must be offset, other things being equal, by an expected depreciation of the ROW currency (an appreciation of the home currency).

[24]One can legitimately question the model's working assumption that preferences for domestically-produced and foreign-produced goods remain unchanged over time (alternatively stated, that the substitutability in demand of domestic and foreign goods is independent of large changes in the relative sizes of economies). Yet, most of the existing analysis of international trade operates with this assumption. Products are assumed to have, in effect, *spatially-determined* characteristics that make them imperfect substitutes (an electronic device produced in Japan not being a perfect substitute for a functionally similar electronic device produced in the United States, a wine from France not being a perfect substitute for an Australian wine made with the same grape, etc.). If one questions the conventional treatment of goods preferences as inappropriate, such doubts could also lead to

doubts about the strength of the exchange rate and terms-of-trade effects identified here. Note, however, that even if one were to believe that shrinkages in the relative quantities of similar goods produced at home versus abroad were to induce somewhat higher elasticities of substitution between home and foreign goods *merely because home goods were more scarce in the world*, it would require very great changes in preferences to completely offset the exchange-rate and terms-of-trade shifts that would otherwise be caused by the relative shrinkages in home-produced goods. This issue clearly merits further research. Gagnon (2003) is a recent paper arguing that the standard assumption about preferences for home-produced versus foreign-produced goods is not appropriate. In future research I intend to carry out sensitivity tests with alternative assumptions about goods preferences.

[25]Numerous channels cause private saving to rise in the home economy. Among them is the fact that the population aging caused by the relatively larger fertility decline requires the government authority operating an "intermediate-balanced" pension system (assumed in the simulations discussed in the text) to raise pension taxes and reduce pension benefits (relative to baseline), which in turn is an incentive for increases in private saving. A later section comments on alternative pension systems.

[26]Effects on the real exchange rate, trade balances, current-account balances, and net-foreign-asset positions of the two economies are larger when analysis takes into account the economic effects of children and child support than when it does not. For example, the positive effects on home saving and financial wealth resulting from the fertility decline are larger because resources are freed up as support payments to children become smaller. A fraction of the incrementally freed resources from lower child consumption are saved rather than consumed. The home currency appreciates by a larger amount. The associated net capital flows permit the home current-account surplus to be larger by the medium run than it would otherwise be without youth dependency taken into account. The resources freed up by declining numbers of children, partly invested abroad, increase the cushioning effects on the home economy from its openness to the rest of the world.

[27]The adult mortality rate in the baseline solution of the model is .015 (1.5 percent per year). In the shock simulations it declines smoothly until reaching .011 (1.1 percent per year), a fall of some 26½ percent in the rate. For analytical transparency, it is again presumed that both regions of the world eventually reach new steady-state paths along which demographic growth rates are identical. As emphasized in a previous footnote, the underlying model uses the Blanchard-Yaari simplifying assumption that adults have an age-invariant probability of death. The model has a separate mortality rate for youths, also age-invariant for the youth cohorts. The assumptions of age-invariant mortality rates for adults and youths are advantageous because they permit the analysis to avoid keeping track of multiple age cohorts with their cohort-specific wealths, saving-consumption totals, and life

expectancies. But life expectancies in real life are of course cohort-specific and the assumption of age-invariance is problematic.

[28]Even for demographic variables such as elderly ratios and labor-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 labor forces to adult populations.

[29]The careful reader will again wish to take note of the important issue identified in endnote 24.

[30]I stress again that the generalizations summarized in this paper may need to be refined or modified by further research. Conclusions about the effects of changes in life expectancy may be especially subject to modification. The text focuses only on, in effect, average changes in adult life expectancy because the underlying model distinguishes mortality rates only for adults as a whole and youths as a whole, with the adult mortality rate age-invariant across all adults and the youth mortality rate age-invariant across all children. The assumption that mortality rates are age-invariant rather than age-specific, of course, departs seriously from reality. Blanchard (1985) 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 in real life do rise with age (sometimes modeled by "Gompertz's Law," suggesting that mortality rates after puberty rise in geometric progression as in Wetterstrand (1981)), reaching rates (in the United States) in the neighborhood of 16 percent by age 80 and 67 percent by age 100. Faruqee (2003) modifies the simplifying assumption that all adults are subject to the same age-invariant probability of death; with that modification, however, it is no longer straightforward to achieve the macroeconomic aggregation across individuals and age cohorts that is the marked advantage of the Blanchard-Weil-Yaari framework. In real life, macroeconomic effects presumably depend sensitively on the specific age cohorts for which life expectancy increases. Declines in mortality rates for adults, especially elderly adults, for example, presumably have very different macroeconomic effects than declines in mortality rates 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 immediately evident. For example, reductions in mortality rates for children in fact lead to lower rather than higher ratios of *elderly* individuals to the working population and *higher* rather than lower ratios of children to the adult population. The consequences for major macroeconomic aggregates are also significantly different.

[31]In real-life PAYG systems, maintaining pension taxes unchanged or maintaining pension benefits unchanged would, of course, have quite different political and economic implications. Probably neither extreme is politically realistic. In actual PAYG systems, moreover, it is implausible to suppose that the pension authorities vary tax rates, benefit rates, or both continuously, period by period, so as to keep the pension trust fund exactly balanced. The balanced systems identified in the text are, of course, intended as analytical benchmarks, not as realistic depictions of PAYG systems.

[32]The distinction between balanced and unbalanced public pension systems is not synonymous with the distinction between "defined contribution" and "defined benefit" plans, but the two distinctions are related. The risk that sustained deficits in the overall government budget will result in sustained increases in government debt is significantly higher with defined benefit than with defined contribution plans.

[33]Effects of alternative pension systems on private saving depend in part on the degree to which individuals and households are forward-looking in their consumption, saving, and wealth accumulation. A consensus interpretation of the empirical evidence on this matter does not exist. Hence, judgments about it remain controversial. The analytical models used in my research err on the side of specifying sophisticated forward-looking behavior. One may doubt that most individuals and households are as forward-looking and perspicacious as assumed by model-consistent expectations and nonetheless see merit in examining saving and pension behavior utilizing that benchmark assumption.

[34]Bryant (2004b).

[35]Conversely, policymakers for open economies experiencing slower-than-average aging, for whom the "sharing" effects of openness may be adverse rather than beneficial, should give weight to the possible adverse effects when choosing their pension policies.

[36]Between the end of World War II and the end of the 20th century, Japanese fertility declined from over four to some 1.4 lifetime births per woman. The ratio of youths to the total population fell from over 45 percent to less than 21 percent between 1950 and 2000. Projections for the ratio of elderly to the total population show a near doubling over the next five decades from 17.2 percent to 36.9 percent.

[37]See also Borsch-Supan's cautious comments about the issue (1996).

[38]The analysis of Brooks (2003) and Attanasio and Violante (2000) take into account to some extent the limited abilities of Southern economies to absorb Northern savings by calibrating Southern economies to be of smaller effective size than Northern economies (by adjusting total-factor-productivity parameters in production functions).

[39]One of many complications about modeling the economies of Southern nations is how to model their exchange regimes (including whether they peg their currencies to currencies of Northern economies or whether they permit flexibility, and how differing exchange rate behavior in the short and long runs affects macroeconomic outcomes). My colleague Warwick McKibbin is developing multi-region variants of his MSG3 model that embody endogenous demographics. Both of us intend to focus in our future research on the issues of net capital flows between Southern and Northern economies.

[40]The evidence summarized in Helliwell's (2004) charts and tables and conversations with him during the course of preparation for our two papers for this symposium have pushed me further in this direction.

[41]This possibility is discussed in Taylor (1995).

[42]Regression effects on saving, investment, and current balances from the active ratio combine together the effects of the youth dependency ratio and of the elderly dependency ratio separately into effects from a single non-dependency ratio (with the regression estimates of course having the opposite sign). In the text I state the generalizations based on the empirical correlations in terms of *changes* in the effects on current-account balances attributable to *changes* in the demographic ratios. The generalizations are sometimes made in terms of *levels* of rather than *changes* in the variables, for example observing that countries with unusually large active ratios tend to be net capital exporters. Whether the generalizations are appropriately applicable to levels as well as changes seems to me to merit further study.

[43]Helliwell's (2004) Tables 5a and 5b indicate that the demographic effects on current-account balances for OECD countries *declined* over the last quarter of the 20th century (and became statistically insignificant) whereas the demographic effects for the non-OECD countries rose and became statistically significant by the end of that period. These differing trends coming out of the regressions seem puzzling to me and contribute to my worrying about their robustness.

[44]Recall again the issues identified in endnote 30.

[45]The importance of these doubts about the empirical correlations is, I am the first to acknowledge, uncertain. I raise the doubts here as a prelude to investigating this issue in more detail.

[46]For this case of asymmetric fertility declines, the home region with the larger shock has levels of the active population and effective labor force that are always below, and become markedly lower than, the counterpart *levels* abroad. The behavior of the home active population *ratio* relative to the *ratio* abroad, however, has the more complex cyclical behavior described in the text. Given the nature of the analytical model, as described earlier in the paper, the home and foreign active

ratios start out and end up at the same values, and differ only while the asymmetric shocks are in process.

[47]The model shows a mild fall in the home youth ratio slightly greater than the even milder fall in the foreign youth ratio, so the relative changes in the youth ratios by themselves suggest a move of the home economy toward current-account surplus. The changes in the elderly ratios and active ratios that point in the opposite direction (from the perspective of the reduced-form empirical correlations), however, are an order of magnitude larger than the changes in youth ratios.

[48]Another aspect of the analytical model that requires refinement is a further development of model-consistent baseline solutions (against which the results of shock simulations are compared). As noted in a previous endnote, the economies in the model are assumed to have identical demographic and macroeconomic structures in the analytical baseline. Hence, for example, the economies in the baseline have identical birth rates and identical adult mortality rates. In real life, countries have quite different structures. If one wishes to analyze prospective demographic developments using the current position of national economies as a starting point, a model-consistent baseline solution must be developed that is both analytically satisfactory and that incorporates initial differences in the *levels* of demographic and macroeconomic variables (not least for birth rates and mortality rates themselves). For the moment, I am agnostic about whether the failure of my analytical framework to start economies off from different initial conditions seriously undermines the relevance of the analysis. By the way, this issue (again!) of levels versus changes also arises in the literature investigating reduced-form empirical correlations. Higgins (1998), for example, includes country dummy variables in his "fixed-effect" regressions; that estimation method has the effect of transforming the data into deviations from country-specific means and therefore emphasizing only time-series variation in the data (thereby not fully incorporating differences in the *levels* of the variables across the country sample).

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