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THE IMPACT OF AGING ON FINANCIAL MARKETS AND THE ECONOMY: A SURVEY

by

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ABSTRACT

All major industrial countries will experience significant population aging over the next several decades. In both academic circles and the business press it is widely believed that population aging will have important effects on financial markets because of its expected impact on saving rates and the demand for investment funds. This paper reviews the literature on the macroeconomic and asset market effects of population aging, focusing on four related issues: (a) The impact of population age structure on aggregate household saving; (b) The effect of population aging on investment demand; (c) Evidence on the influence of population age structure on financial market asset prices and returns; and (d) Effects of globalization on our interpretation of the impact of demographic change.

(a) Both microeconomic and macroeconomic studies find that the observed age profile of saving roughly conforms with the life-cycle model, which implies that saving rates rise over a worker's active career and then decline in retirement. The magnitude of implied effects across the two kinds of study are not consistent, however. Compared with macroeconomic analyses, microeconomic studies tend to show smaller variation in saving rates over the life cycle. One reason for the discrepancy may be that most microeconomic studies fail to include or accurately measure workers' pension fund saving. Another measurement issue arises because of the highly skewed distribution of wealth and saving across households. A small percentage of households accounts for an out-size fraction of private saving and wealth accumulation, and the behavior of high-saving households is poorly represented in most microeconomic surveys.

(b) According to standard neoclassical growth theory, slower labor force growth associated with population aging should reduce the demand for domestic investment, offsetting part or all of the expected decline in domestic saving. Empirical studies of the implications of demographic change for investment expenditures have largely been based on aggregate data. A critical question for future investment returns and cross-border capital flows is whether population aging in the high-income countries will reduce the rate of domestic investment by more than it reduces saving. At this stage in the research, conclusions about the relative magnitude of the changes in rates of saving and investment remain very sensitive to modest changes in the research design and the data employed.

(c) Population age structure can influence the demand for different classes of financial market assets both because of its effect on saving and because young, middle-aged, and elderly savers may seek to hold their assets in different forms. Empirical studies have uncovered evidence that population age structure affects stock market prices and the real returns of different classes of financial assets, but the consistency of this evidence is not overwhelming. It is unclear whether the effects of demographic influences on asset prices and returns are large relative to the effects of other and less predictable determinants of prices and returns. The estimated effects of demographic factors are sensitive to the start and end dates of the period covered by the analysis and to the countries included in the sample. Researchers sometimes find that the estimated

effects of population aging have the opposite sign in different countries, even countries which share similar demographic histories and financial institutions. Economists have offered plausible explanations for the divergent effects of demographic factors in different countries, but so far the evidence in support of these theories is weak.

(d) Population aging can induce unequal effects on the demand for investment and the availability of domestic savings even within an economy completely closed to the rest of the world. In national economies that are open, the effects of demographic change are still more complex. Significant parts of the required macroeconomic adjustments can be channeled through exchange rate movements and external-sector transactions. The timing and size of demographic transitions differ widely across countries. Countries with faster demographic transitions and greater population aging are likely to experience an appreciation of their currencies and strengthening of their current-account balances. Such changes cushion the rapidly aging economies from the full effects that demographic shocks would produce in a closed economy. The openness of an economy 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. For the high-income industrial countries, which are aging faster than developing countries, domestic demand for investment funds might initially tend to fall faster than national saving, thereby causing investment funds to flow to developing parts of the world where investment demand remains buoyant. It is uncertain, however, whether industrial countries as a whole can feasibly run large, sustained current-account surpluses with developing nations (exporting some of their higher savings to finance productive investments in developing nations). In order for such a major change in the saving-investment balance of developing regions of the world to occur, low-income countries will have to make major progress in macroeconomic management, prudential supervision of financial markets, and greater security for contracts.

THE IMPACT OF AGING ON FINANCIAL MARKETS AND THE ECONOMY: A SURVEY

ALL MAJOR INDUSTRIAL COUNTRIES will experience significant population aging over the next several decades. In Japan and much of continental Europe national populations are likely to decline. The European and Japanese aged-dependency rates (the ratio of persons aged 65 and over to the population aged 15-64) will exceed 40 percent by 2030 and 50 percent by 2050, substantially above today's rate of about 25 percent. The situation is less dramatic in the United States, where fertility and immigration rates remain higher than they are in other industrialized countries. Nonetheless, the U.S. aged-dependency rate is predicted to climb from 20 percent today to 35 percent in 2030 and 38 percent in 2050 according to forecasts of the Social Security Actuary.

What will be the primary effects of aging on the aggregate economy and on financial markets? Population aging implies a contraction of the future workforce in many industrial countries and a sharp slowdown of future workforce growth in the remainder. Slowing workforce growth or actual labor force contraction will reduce domestic investment opportunities, because employers will have less need to provide new equipment and facilities for additional workers. There is also potential for disruption of financial asset markets if large cohorts of retirees begin to sell off their assets to pay for retirement consumption.

Although population aging is a world-wide phenomenon, it is occurring at different rates within richer industrialized countries and with a different timing in the developing world. For the next few decades many developing countries, including China and India, will benefit as a result of the demographic transition. They will support declining numbers of children, and growing proportions of their populations will enter the prime ages for saving and labor force participation, expanding domestic opportunities for investment, saving, and faster growth.

At the same time, the liberalization of financial markets in recent decades has given rise to large increases in international capital flows. In a global economy that has declining barriers to cross-border trade and capital flows and increased sensitivity to foreign prices and rates of return, the link between demographic shifts and financial developments within a single country may be substantially weakened. For an economy that becomes more open over time, the correlation between domestic investment and national saving may be weakened further. The

important demographic changes from the perspective of financial market fluctuations may be those occurring at the global rather than the national level.

Our paper reviews the existing economic literature on the macroeconomic and asset market effects of population aging. We emphasize the open-economy and global nature of economic relationships. Most economists believe that population aging in either a closed or an open economy will have important effects on public and private saving and on the demand for capital. In the near term, as populations in the industrialized world grow older, the household saving rates in those countries are expected to rise as aging workers save in anticipation of their approaching retirement. A growing percentage of households will be headed by workers at the middle and near the end of their careers, when saving reaches a lifetime peak. As the process of population aging continues, this trend in private saving should eventually reverse as a growing fraction of households begin to draw down their retirement savings. Declining household saving rates will be accompanied by greater pressure on public budgets because of increased spending on public pensions and medical insurance for the aged. Additional public spending requirements may push government budgets toward deficit, reducing public saving in an era when private saving will also be shrinking. Many theorists therefore anticipate that aggregate saving will eventually decline as a percentage of national income. At the same time, however, a declining rate of labor force growth in the industrialized countries will lower the potential growth rate of the aggregate economy, reducing the demand for new investment.

A critical question for future cross-border capital flows is whether population aging in the high-income countries will reduce the rate of domestic investment by more than it reduces saving. For a single country, any imbalance between national saving and domestic investment (the current-account balance) may vary by larger amounts than in the past, suggesting that a larger proportion of the burden of adjustments to demographic changes will be channeled through exchange rates and external-sector transactions. If the domestic demand for investment funds falls faster than national saving in the industrial economies as a whole, investment funds may flow to parts of the world where investment demand remains buoyant, and in particular to developing countries. However, larger declines in national saving in the high income countries will imply that these countries will need to sell assets to the rest of the world in order to sustain consumption. Some observers fear that population aging will lead to a global shortage of capital. Analysis of the relationship between national saving-investment balances – and hence net cross-

border resource and financial flows – raises the possibility that an increasingly globalized economy can ameliorate some of the potential adverse implications of aging within individual high-income countries.

Our overview of the research evidence focuses on four related sets of questions:

- Does population age structure have the impact on aggregate household saving predicted by the life-cycle consumption hypothesis? This widely accepted economic theory is the basis for many economic forecasts predicting that aggregate private saving in the industrialized countries will first rise and later decline as a result of aging.
- Have trends in the population age structure actually had the effects on investment demand implied by standard economic growth theory? Has investment demand increased when the rate of labor force growth accelerated, and has it fallen when labor force growth slowed? What is the empirical evidence on the saving-investment balance in aging countries?
- Is there reliable evidence on the influence of population age structure on financial market asset prices? Does this evidence provide a reliable guide to thinking about the effects of future aging on future asset prices?
- Trends in global economic integration and cross-border capital flows have significantly altered the ability and willingness of savers in one country to buy and hold financial assets of another country. How should increasing global integration affect our interpretation of the effects of demographic changes on a nation's investment-saving balance? For individual aging countries, how strongly is the saving-investment balance influenced by imports of foreign saving or exports of domestic saving (net capital flows)? Will aging reduce the pool of available savings in developed aging societies faster or more slowly than the domestic demand for investment funds?

Our answers to some of these questions can be summarized briefly. We interpret the empirical literature on microeconomic household behavior to show consistent evidence of a lifecycle pattern in saving. The magnitude of dissaving during retirement years is quite modest, however, which taken by itself implies that population aging may have only a minor impact on aggregate saving. Yet it is not easy to translate the microeconomic results to the level of the aggregate economy. One complication is that the distribution of wealth and saving across households is highly unequal. Even though lifecycle saving may be important at the household level for the median family, it does not follow that the same pattern of lifecycle effects will be visible at the aggregate level. A small percentage of households accounts for an out-size fraction of private saving and wealth accumulation, and the behavior of these households is poorly represented in most microeconomic surveys. If their saving behavior differs significantly from

that of average households, the effect of the age distribution on aggregate saving may differ from the effect implied by the behavior of the median household.

Other empirical studies have focused directly on the impact of the age structure on aggregate saving and investment rates. These analyses use time-series or cross-national differences in the timing of changes in the demographic structure to infer the effects of population aging. Such studies often conclude that the effects of population aging on national saving are greater than implied by the microeconomic studies. On the other hand, they also find that rates of domestic investment, associated with slower growth in the labor force, move to partly mirror the induced declines in national saving. That is, slower labor force growth associated with population aging will reduce the demand for domestic investment, offsetting part or all of the forecast decline in domestic saving. At this stage in the research, conclusions about the relative magnitude of the changes in rates of saving and investment remain very sensitive to modest changes in the research design and the data employed. In addition, little has been done to explore the distinction between the saving of the public and private sectors. Researchers have also found striking cross-national differences in the time series pattern of decline in investment and saving rates.

Empirical researchers have found evidence that population age structure affects stock market prices and the real returns of different asset classes, but the consistency of this evidence is not overwhelming. It is not clear whether the evidence shows that demographic influences on asset prices and returns are large relative to other and less predictable determinants of prices and returns. The estimated effects of demographic factors are often sensitive to the start and end dates of the period analyzed and to the countries included in the sample. Researchers sometimes find that estimated demographic effects have the opposite sign in different countries, even countries such as Canada and the United States which share similar demographic histories and financial institutions. Economists can offer some plausible explanations for the divergent effects of demographic factors in different countries, but so far the evidence in support of these theories is weak.

Increasing global integration has linked macroeconomic variables across national borders more closely today than was the case in the past. External-sector transactions have become relatively more important. Cross-border and cross-currency adjustments to demographic shocks and policy changes have risen in importance relative to purely domestic adjustments. In

particular, the current-account balance relative to gross output for the United States and other industrial economies may be larger and exhibit larger swings than would have occurred in the past. Because demographic transitions in countries are unequal, varying widely in their pace and intensity, the macroeconomic evolutions of individual countries are strongly influenced by external-sector transactions and exchange-rate changes. Countries with faster demographic transitions and greater population aging are likely to experience an appreciation of their currencies and current-account surpluses (national saving exceeding domestic investment). Such changes partly cushion the rapidly aging economies from their larger demographic shocks; the openness of their economies works to mitigate the negative consequences for domestic output and consumption. On the other hand, industrial countries that are aging more slowly may experience opposite, adverse effects. It seems likely that population aging in the industrial economies will reduce the pool of available savings in those economies as a whole by less than it will reduce the domestic demand for investment funds. It is uncertain, however, whether industrial countries as a whole can feasibly run large, sustained current-account surpluses with developing nations (exporting some of their savings to finance productive investments in developing nations). In order for such a major change in the saving-investment balance of developing regions of the world to occur, low-income countries will have to make major progress in macroeconomic management, prudential supervision of financial markets, and greater security for contracts.

The remainder of this paper is organized in four major sections. In the next two sections we consider the impact of population aging on saving and investment, respectively. These sections focus on the implications of aging for domestic saving and investment; they largely ignore the possibility that saving and investment fluctuations can be reflected in cross-border flows of goods and capital. The following section examines the effects of demographic shifts on asset prices and returns. In the fourth section we consider the impact of aging within an international economic system where goods, services, and capital can move more or less freely across international borders. Our paper concludes with a brief survey of promising future research.

Demographics and Aggregate Saving within a Single Nation

Many business writers and economists believe population aging will lead to declining rates of saving as older households begin to draw down their retirement savings. The decline in household saving will be accompanied by increased pressures on the public sector to meet the income and health needs of the aged. Heavier spending requirements could push public budgets toward large deficits. Thus, conventional wisdom suggests that aggregate saving will eventually decline as a percent of national income. Some of the empirical research, however, suggests that saving behavior does not necessarily correspond with the standard life-cycle view of saving behavior. In this section we assess the current status of the empirical research on lifecycle saving. We begin with a brief overview of the major advances in analytical modeling before surveying the empirical literature.

Analytical framework. Much of the research on the influence of age on saving is motivated by the life-cycle hypothesis (LCH) proposed by Modigliani and Brumberg (1954). The theoretical literature is primarily concerned with the determinants of consumption, but it also translates into direct implications for saving behavior. In its simplest form the LCH argues that individuals will smooth consumption over their lifetime given expected lifetime resources. The theory leads to the prediction that individuals will exhibit a saving rate that rises with income during their work life, and declines and turns negative during retirement. Thus, the aggregate saving rate depends critically on the relative size of different age cohorts in the population. In particular, the aggregate saving rate will initially rise when declining rates of fertility reduce the number of young dependents, remain high for populations dominated by working adults, and then decline as an increasing portion of the population becomes old and retired.

Contributions to the consumption literature in recent years have expanded the life-cycle model to include other influences on consumption and saving. A recent survey is provided by Browning and Lusardi (1996).[1] The additions include evaluations of the role of uncertainty with respect to future income and lifespan (encouraging precautionary saving), liquidity constraints, and the desire to leave bequests (or dynastic savings).[2] Many of these extensions to the basic

[1] See also Browning and Crossley (2001)

[2] Recent references on liquidity-constrained consumption behavior include Zeldes (1989), Deaton (1991), Attanasio and Browning (1995) and Berloffa (1997). Researchers emphasizing the importance of

model reduce the influence of aging on saving or at least suggest that it could be overwhelmed by other factors.

Carroll (2001, 1997) highlights the close link between liquidity constraints and precautionary saving. Constrained consumers *cannot* borrow against expected future income, whereas consumers with a precautionary saving motive *choose* not to borrow. In either case, the implication for saving behavior is the same: current-period consumption is more closely tied to current-period income than implied by a simple life-cycle perspective. Uncertainty will also exert a major influence on the pace of wealth decumulation during retirement both because of the uncertainty of the timing of death and the limited options to respond to unforeseen contingencies. As they grow older, the retired elderly gradually lose the option of reentering the workforce and earning additional income.

The claim that large portions of wealth are inherited has generated substantial interest in the role of bequests. Kotlikoff and Summers (1981) argued that as much as 80 percent of household wealth is inherited, but their interpretation of the importance of inherited wealth was strongly challenged by Modigliani (1988) and others. Munnell and Sundén (2003) also examine gift and bequest behavior and conclude that gifts and bequests are important; they may account for about half of total wealth in America. Of course, with uncertainty concerning the date of their own death, most people will die leaving some bequests, but the size of bequests reported by Kotlikoff and Summers hardly seems consistent with the view that most bequests are accidental. In principle, individuals can respond to their uncertainty over mortality by converting their wealth into annuities, but the market for annuities outside of social security and employer-provided pensions is highly imperfect. Adverse selection drives up the cost of buying an annuity outside of a group pension plan and may make this investment option an uneconomical choice for many workers (Finkelstein and Poterba, 2002). As a result, private annuities are only rarely a part of household investment portfolios.

The analytical treatment of bequests within the lifecycle framework is outlined in Hurd (1989) and Bernheim (1991). Their principal conclusions are that a bequest motive should tend

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precautionary saving and doubting the empirical importance of the life-cycle theory include Deaton (1991, 1992), Carroll and Summers (1991), Carroll (1992, 1997, 2001), Hubbard, Skinner and Zeldes (1994), and Carroll and Samwick (1997). The papers in the international comparison volume edited by Poterba (1994) tend to have a similar emphasis.

to flatten what would otherwise be a declining time pattern for wealth and consumption during retirement. However, both wealth holdings and consumption should still be expected to decline during retirement if the subjective rate of time discount exceeds the rate of interest. Hurd also suggests that the importance of the bequest motive can be evaluated by comparing the behavior of individuals with and without children.

In sum, most theoretical treatments of saving continue to suggest that saving rates should follow a hump-shaped pattern over the life cycle. This implies that the aggregate saving rate should first rise and then decline when fertility reductions and rising longevity increase and then gradually reduce the importance of age groups expected to have high saving rates. This theoretical prediction remains valid even after considering a variety of amendments to the basic life cycle model aimed at making it more realistic.

Measuring saving. Before we consider the empirical literature on saving, it is useful to consider how saving is measured and how different measures of saving may be affected by the population age structure. Although some of this discussion may seem arcane, the details are crucial for understanding why different analysts reach conflicting conclusions about the impact of population aging on aggregate saving. At the outset it is important to distinguish between two alternative measures of saving, both of which offer a valid way for viewing saving. The first defines saving as income minus consumption expenditures. This concept underlies measures of saving in the national income and product accounts (NIPA). The unconsumed portion of output is available for investment in productive assets. These investments in turn will make possible an increase in future production and consumption. This definition of saving excludes the revaluation of existing assets. The second defines saving as the change in net worth. Net wealth accumulation includes capital gains and losses, adjusted for general inflation, and is more relevant for purposes of measuring changes in individuals' economic well-being. By enabling workers to make larger future consumption claims, an increase in wealth improves individuals' well-being, regardless of whether the increase in wealth comes from "saving" (under the NIPA definition) or a revaluation of existing assets. If all investors were forward looking and perfectly knowledgeable about the future, the changes in valuation would necessarily reflect changes in the productivity of capital. In practice, however, revaluations of the capital stock as reflected in the stock market seem much more random.

In the parts of this paper that focus on the balance of national saving and investment, we will use the NIPA concept of saving as a measure of resource use. As argued by Poterba (1994), the NIPA measure of saving more accurately reflects individual decisions about consumption versus saving, but capital gains and losses are obviously critical to understanding the implications for financial markets.

The NIPA measure of aggregate saving is not always consistent in its treatment of different kinds of consumption. The NIPA measure of income and consumption treats housing as an asset, charging to consumption a measure of the rental equivalence of owner-occupied homes and imputing to home owners an income return from home ownership. In contrast, consumption of other kinds of durable goods is measured on an expenditure basis. Actual spending on consumer durables is treated in the same way as spending on nondurable goods, such as food. The issue is important for considering the impact of aging because many individuals will accumulate wealth in the form of housing and consumer durables during their work life and consume a flow of services from their homes and durables during retirement. It is also an important distinction when considering the conflicting results from aggregate-level and household-level research. While some researchers argue that the national accounts should extend the treatment of housing to other forms of durables, many of the microeconomic studies continue to measure the consumption of housing as out-of-pocket costs.

Another measurement issue is also important for thinking about the role of aging on consumption and saving. In particular, the treatment of pensions plays a critical role in the evaluation of the life-cycle model. Since a pension system involves the accumulation of contributions and investment earnings during a worker's active career and the payment of a benefit (often an annuity) during retirement, the estimate of annual saving depends critically on whether income is defined to include contributions to the pension system when workers are active or benefits received from the system when workers are retired. By construction, the accumulation and decumulation of saving in a pension program will exhibit strong life-cycle effects when payouts from the system take the form of life annuities. This life-cycle pattern can be missed in some microeconomic studies depending on the definitions of income and saving used in the study. For example, many of the microeconomic studies of household saving fail to find evidence of dissaving among the elderly. In some of those studies, contributions to a

pension plan during the working years are ignored and retirement income is defined to include annuity income.

Jappelli and Modigliani (1998) and other economists have argued that this treatment is incorrect. They maintain that contributions to a pension system should be recorded as saving and the annuity benefit, which is a subtraction from retirement wealth accumulation, should be excluded from retirement income. Thus, they make a case for distinguishing between two concepts of income, *disposable income* and *earned income*. "Disposable income" would be defined to exclude public pension contributions (since they are taxes or subtractions from gross income) and to include pension benefits (which represent transfers that add to spendable income). In contrast, "earned income" is defined prior to the payment of contributions and receipt of pension benefits. This distinction reflects a long-standing debate among public finance economists over whether the public pension system should be treated as a tax and transfer program or a retirement program.[3]

Jappelli and Modigliani (1998) argue that the two income concepts give rise to two corresponding measures of saving. *Total saving* is the difference between earned income and consumption, and *private saving* is the difference between disposable income and consumption. *Mandatory saving* is then the difference between total saving and private saving. The authors go on to define total wealth as the sum of private wealth and pension wealth. It is noteworthy that the treatment proposed by Jappelli and Modigliani does not incorporate the capital income of the pension fund as part of saving. Mandatory saving is defined from the perspective of the individual. Thus, their proposed definition yields the same estimate of saving for both funded and pay-as-you-go retirement systems.

While the concepts proposed by Jappelli and Modigliani were discussed within the framework of the public pension system, they can be applied equally well to private pension programs.[4] Most household surveys will not capture the employer pension contributions as part of wage income and will fail to credit the worker with the interest income on his pension account.

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[3] The issue usually arises in the context of whether social security should be included as an integral part of the public budget or as a separate account that can accrue savings over time.

[4] In 2000, employer-sponsored pension benefit payments in the United States amounted to $460 billion compared to $400 billion in benefit payouts for the social security program.

Furthermore, those surveys often include pension annuities as part of retirement income whereas a large percentage of the annuity payment represents the decumulation of assets.

Most of the microeconomic studies do not incorporate the Jappelli and Modigliani perspective with respect to publicly-provided pensions, preferring the tax-transfer interpretation. In some studies, however, analysts attempt to incorporate private pensions as part of saving. This is most often the case for defined-contribution plans where the individual is likely to have information on the value of accumulated assets under the plan. Researchers find it much more difficult to obtain accurate estimates of accrued benefits within employer-provided defined-benefit plans.

In aggregate cross-national comparisons of saving, the NIPA definition of disposable income typically treats the contribution to the mandatory public pension system as a tax and the benefit as a transfer. However, *funded* employer-provided plans (including those for public employees) are treated as part of household saving. Employer and employee contributions are not deducted from earnings in arriving at disposable income, and the investment income of the pension fund is included as part of the capital income received by households.[5] Thus household saving, as measured in the national accounts, should exhibit strong life-cycle properties in countries where funded occupational pensions are an important component of employee compensation.[6]

Empirical analysis. Empirical analysis on the link between saving and population aging has focused on three types of data: cross-sectional surveys of saving and wealth at a point in time, panel surveys that follow a set of individuals over time, and macroeconomic time series data. It is generally agreed that simple cross sectional data are of limited value because they do not permit analysts to distinguish between age and cohort effects. That is, we have no reason to believe that today's 45-year-olds will behave in ten years like today's 55-year-olds when they may have had much different lifetime experiences. However, repeated cross sections for different periods can be used to create synthetic cohorts as long as the samples are representative of the underlying populations (Browning, Deaton, and Irish, 1985). The saving and wealth of 25-year-olds at time *t* can be legitimately compared to the saving and wealth of 26-year-olds in

[5] The methodology is embedded in the current international system of national accounts (SNA93), but there are proposals to expand the treatment to include unfunded pension arrangements.

[6] Meredith (1995) discusses these issues in the context of Japan.

period t+1, for example. Panel surveys represent the ideal form of micro data because they make it possible for analysts to observe the same individuals over time rather than just an average value for the cohort. Unfortunately, good panel data sets are expensive to create and fairly uncommon.

The microeconomic time series studies can be distinguished by whether saving is measured as income minus expenditures or as the change in wealth. While income minus expenditures seems like the most direct measure of saving, when analysts try to reconcile estimates of aggregate saving implied in microeconomic surveys with estimates of household saving reported in the national accounts they find large discrepancies. These are probably due to survey respondents' inability to recall accurately their income and consumption outlays. Note that even small errors in reported income and consumption can lead to large errors in the measured saving rate when true saving is a small percentage of household income. A 2003 report of the Bureau of Labor Statistics documented the large gaps between consumption reported in the U.S Consumer Expenditure Survey (CEX) and aggregate consumption estimated in the NIPA accounts (Garner et al., 2003). Overall, the CEX captures only 60 percent of NIPA consumption. Of greater concern, the ratio of household-reported to aggregate expenditures on comparable items has declined over time (from 89 percent in 1992 to 80 percent in 2000). The variability of the coverage ratios is also very high across expenditure classes. For example, both the CEX and NIPA data sets yield very similar estimates of housing expenses, but because of discrepancies in other components of consumption, the CEX implies that housing represents a fraction of total consumption that is nearly double the share indicated in the national accounts. For the United States and several other countries that conduct regular surveys of consumer expenditures, the estimates of saving from the surveys do not correspond over time to changes in saving as reported in the national accounts.

An alternative approach is to measure saving as a change in wealth. Several U.S. surveys have collected wealth information on an annual basis. The main problems with such surveys are the short period of time over which the wealth change is measured and the difficulty of obtaining reliable information on the value of employer-provided pensions. The 1989 Survey of Consumer Finances (SCF) included a panel component of respondents from the 1983 SCF. While the six-year time interval between interviews improves the measurement of saving by reducing the relative importance of random noise, sponsors of the survey encountered serious problems as a

result of high sample attrition and conceptual difficulties in adjusting for changes in asset values (Kennickell and Starr-McCluer, 1997). Most researchers have found a disappointingly low signal-to-noise ratio when attempting to measure saving from changes in wealth data.[7]

Some other U.S. micro economic data sets are also available. The Panel Study of Income Dynamics (PSID) has followed individual households since 1968. The PSID survey obtains regular information on household income and less regular information on wealth and food expenditures. The Health and Retirement Study (HRS) provides a panel data set with wealth (including pensions) and income information for the population aged 51-61 in 1992. The Survey of Income and Program Participation (SIPP) also collects information on both income and household wealth. Both the HRS and SIPP have been linked to respondents' social security earnings records, so the expanded data sets can provide consistent information that allows researchers to compare household wealth to an estimate of breadwinners' lifetime earnings.

Bosworth, Burtless and Sabelhaus (1991) examined a range of different household surveys for three countries, including the CEX and the SCF surveys for the United States and similar surveys for Canada and Japan. Their estimates of U.S. saving rates, by age, in the early 1980s are displayed in Figure 1. The top panel shows estimates of saving rates obtained using household income and consumption data reported in the CEX. The bottom panel shows saving rates estimated using data from the SCF, where saving is calculated as the change in household net worth between the 1983 and 1986 surveys. To make the two sets of estimates comparable, the authors estimated capital gains between 1983 and 1986 and subtracted these gains from households' reported changes in real asset holdings. The saving rate is calculated as a percentage of households' after-tax incomes. Both sets of survey estimates imply that saving rates differ significantly across age groups, but the age pattern of saving differs in the two surveys. Estimates based on net income less consumption imply that the saving rate peaks between ages 55 and 64, but the saving rate among households headed by someone past age 64 is slightly higher than the population average. The drop in saving is larger at older ages if saving is estimated as the change in net worth. Bosworth et al. (1991) interpreted their results to show that shifting demographics played a relatively minor role in accounting for time-series changes in

[7] An exception is Canadian household expenditure data. Interviewers and researchers take considerable pains to ensure a degree of consistency between estimates of the survey household's saving defined as income minus consumption and the change in the household's wealth.

aggregate saving rates in the three countries. Since their study was completed there have been important advances in both the available survey data and the techniques used to examine them.

Poterba (1994) reports on a set of studies that used successive consumer expenditure surveys from six OECD countries to construct age profiles of saving that control for cohort effects. The studies uncovered weak evidence in support of the life cycle model. In combination, these studies suggest that differences and time-series changes in demographic composition can do little to explain cross-national differences in saving rates. Several country studies find that household saving rates remained unexpectedly positive after workers retire in several of the countries. Deaton and Paxson (1997) used similar data for four countries (United States, Britain, Taiwan and Thailand) to construct cohort-based measures of the age profile of saving. They find an age pattern of saving that generally coincides with the life cycle model for the United States and Taiwan, but the data for Britain and Thailand do not conform well with the model's predictions. The authors conclude that the life cycle effects are too small for either changes in population or income growth to have large effects on aggregate saving.

A recent paper by Demery and Duck (2001) reports estimates of the age profile of saving adjusted for cohort effects, including the effects of private pensions. These authors' estimates reflect an adjustment suggested by Deaton and Paxson (2000) that converts household saving into saving rates of individual household members. The conversion to individual saving rates is designed to avoid the bias introduced by the "disappearance" of the low-income elderly into institutions or households headed by younger people. Their results are quite consistent with predictions from the life cycle model, aside from their finding of an increase in the saving rate among the very old. Even though Demery and Duck find evidence of a pronounced hump-shaped pattern in individual saving rates over the life cycle, differences in saving rates at different ages are not large enough to generate major changes in the aggregate U.K. saving rate over the next 20-40 years. In fact, they conclude that future U.K. saving rates are likely to rise over the next few decades because of the increasing importance of late middle-aged people in the U.K. population (Demery and Duck, 2003).

The studies that focus on wealth changes have been somewhat more favorable to a finding of strong life cycle effects on the saving rate. Hurd (1992) reports declines in wealth after age 70 using data from the SCF, the SIPP, and the HRS. However, the estimated rates of decline are quite low (2 -5 percent annually). Furthermore, *inter vivo* transfers rather than actual

consumption may be responsible for a significant part of the wealth decline among older households. However, Hurd (1987) argues that bequests were largely accidental based on a finding that there is no significant difference in the size of bequests when he compares people who have surviving children with people who do not.[8]

A more recent study by Hildebrand (2001) undertook a detailed examination of the wealth measures from the SIPP, controlling for cohort effects. He concluded that the cohort measures show little or not wealth decumulation at older ages. Instead, he highlights the striking absence of pre-retirement saving by large proportions of households. Even more than the absence of post-retirement dissaving, it is the overall lack of pre-retirement saving which seems to contradict standard life-cycle models.

Weil (1994) focused on a different aspect of bequests, namely, their impact on the saving of the children who expect to receive them. He argued that even if the old do not dissave themselves, their wealth accumulation reduces required saving among the young who expect to receive bequests. He went on to point out that the effects estimated in macro studies appear to be much stronger than typically found when age effects are estimated using microeconomic data. Weil suggested that the impact of bequests offer an explanation for the strong estimated effects of age when estimates are obtained using macroeconomic data.

Some economists are skeptical of the use of macroeconomic data to estimate the age profile of saving, arguing that meaningful estimates of the underlying parameters of consumption behavior can only be reliably detected at the individual or household level. In predicting the effects of a changing population age structure on saving, however, we are ultimately interested in the impact of the shift on aggregate saving. All micro studies agree that saving behavior is extraordinarily heterogeneous at the household level. Even if we could agree on the importance of age effects at the microeconomic level, we would still face an enormous challenge in aggregating the individual-level estimates back up to the aggregate level, in part because the determinants of saving at the individual level are so varied. Thus, there is a powerful argument for supplementing the findings from microeconomic studies with estimates based on macroeconomic evidence of saving at the aggregate level. Large cross-national information sets

[8] Kara E. Levine (2003) found that the preference for bequest increases with the presence of children in the family but decreases as family size increases. Bernheim (1991) also found evidence more supportive of a bequest motive.

containing national-level panel data on aggregate saving, the components of saving, population age structure, and other determinants of saving offer an attractive source of information for investigating these issues.

Weil (1994) uses a panel data set covering private saving in 14 industrial countries over the period of 1960-85 to examine the influence of changes in the age distribution among the young (ages 0-19), working age (20-64), and old (65 and over). He found that changes in the age composition of the population have strong and statistically significant effects on the saving rate. Moreover, the effects are in the direction predicted by the life-cycle model.

An econometric concern with these estimates is that the cross-national differences in the age structure could be correlated with differences in other national determinants of saving. Thus, the cross-country differences in demographics may not be a meaningful measure of the influence of changes over time. Most economists agree that cross-national differences in institutional structure and culture exert strong influences on saving. For example, the importance of pay-as-you-go pensions, which can undermine workers' incentive to engage in lifecycle saving, differs widely across industrialized countries. This casts some doubt on the value of cross-national comparisons for estimating the influence of demographic variables on saving. One fact to bear in mind, however, is that the national-level economic data show a large range of time-series variation, both with respect to the saving rate and the age-related demographic variables. Using 25 years of data, Weil (1994) was able to estimate a fixed-effects model of the national determinants of saving. In effect, Weil's fixed-effect model estimates the influence of demographic variables based on within-country variation over time rather than between-country differences that persist over the full period covered by his analysis. The fixed-effects estimates of the influence of age on saving are much less precisely measured than earlier estimates based on cross-national differences in saving rates, but the economic magnitude of the estimates are nonetheless quite large.

Another concern with macroeconomic or aggregate-level cross-national models is that both saving and domestic investment are strongly influenced by demographic change. The effects of demography on investment and the linkages between saving and investment are discussed in following sections. At this point, however, recall merely that saving and investment are linked at the national level by a simple accounting identity that defines the surplus of national saving over domestic investment as equal to the balance of non-financial transactions with the

rest of the world (the current account). Feldstein and Horioka (1980) and many subsequent researchers emphasized that, even in open economies, national rates of saving and investment tend to move together. That correlation means we cannot be confident that the demographic effects estimated in aggregate domestic-economy models reflect the influence of demography on saving or on domestic investment. This is a major concern if we are interested in projecting saving rates over an extended future period in which the technological and institutional features governing international trade may change substantially, changing the statistical relationship between national saving and domestic investment within and across countries.[9]

In recent years, several studies have explored the role of demographics and other factors, such as economic growth and substitution between public and private sector saving, in large cross-country data sets. Masson, Bayoumi, and Samiei (1995, 1998) used time series data on private saving for 21 industrial countries over the period of 1971-93 and for 40 developing countries from 1982-93 to evaluate the effects of growth, demographic change, private-public substitution, interest rates, and wealth. They were interested in the overall dependency ratio, and so their demographic variable reflected the sum of the youth dependency ratio (the population under age 20 divided by the 20-64 year-old population) and the old-age dependency ratio (the population over age 64 divided by the working age population). In regressions that included fixed country effects, the authors found highly significant effects of this demographic variable on saving in both the industrial and developing countries.[10]

Bosworth (1993) examined private saving in 13 OECD countries and found a small significant effect of demographics in a pooled regression that allowed for fixed country effects. The demographic measures were usually insignificant for individual countries, however. This illustrates a common problem that the demographic changes in any one country are too small and gradual to produce statistically precise estimates of the effects of population age structure on saving. To obtain relatively precise estimates of the influence of demographic variables it is therefore necessary to assume the influence of the demographic and other included variables is

[9] The strong correlation between domestic investment and national saving and the possible reasons for it are discussed further in a later section of the paper.

[10] Meredith (1995) identifies a number of other studies that have found statistically significant effects of dependency ratios in macroeconomic-data regressions for saving rates.

uniform across countries. By increasing the range of observed variation in the independent variables, this strategy can improve the apparent precision of the estimated effects.

Higgins (1998) developed an empirical framework that allowed for more detailed exploration of the impact of population aging by including the distribution of the population in five-year age brackets, from ages 0-4 up to ages 70 and over. Ordinarily, this approach would yield quite imprecise estimates because of the substantial multicollinearity of the many demographic variables. Higgins dealt with this problem by constraining the age profile to a third-degree polynomial in age. He estimated the model to infer the effects of demographic variables on both national saving and investment over the period from 1950 to 1992 using information from 100 countries. He found strong demographic effects on both saving and investment in an estimation that included separate country fixed effects. The magnitude of the coefficients would suggest a decline in the saving rates of the high-income economies of the OECD of 5-7 percent of GDP by 2025.

Bosworth and Keys (2004) applied the model of Higgins to a panel data set consisting of 88 countries with annual information on the age structure, GDP, national saving, and investment. These authors also found very large demographic effects on saving rates. The peak impact on saving occurs among people aged 40-55, and the demographic effect on aggregate saving is highly negative by age 70. Unfortunately, the findings were sensitive to the countries included in the analysis. The main results depend heavily on the inclusion of the countries in East Asia and Latin America. The demographic variables were not statistically significant when the sample was limited to the high-income OECD countries.

Summary. Economists have found evidence that saving rates are affected by age and by the age profile of the population. The effects found in empirical studies often conform broadly with the general predictions of the life-cycle model. We are struck, however, by the major differences between the implications of the studies based on microeconomic evidence, on the one hand, and on macroeconomic or cross-national panel evidence, on the other. The great majority of empirical studies has been based on evidence at the household or individual level. This kind of evidence seems best suited to testing implications of models that are clearly based on microeconomic theoretical foundations. Although many of the microeconomic studies find evidence that saving rates differ across age groups in the expected direction, virtually all of the empirical estimates imply that the overall effect of demographic shifts has been small in the past

and will remain relatively small over the foreseeable future. Bosworth, Burtless, and Sabelhaus (1991) summarize their results in a way that echoes the findings of many other microeconomic researchers:

> … we find that shifts in the *composition* of the population between groups that are traditionally high savers, such as married couples and the middle-aged, and groups that are low savers, like the young and the retired, have been inconsequential as an explanation for the decline [in saving]. We thus reject the prediction that the private saving rate will necessarily rise in the near future as the large baby-boom cohort enters middle age. In fact, comparing the variability of each group's saving rate over time to the difference in saving rates between the groups leads us to question the view that the overall saving rate will necessarily decline in the longer term as the population ages.

In contrast, the macroeconomic studies often uncover a much larger impact of demographic shifts on aggregate saving. The macroeconomic findings suggest that the microeconomic studies may fail to detect important intergenerational interactions in the determination of overall saving. Alternatively, the microeconomic estimates may produce results that are difficult to aggregate because of severe problems of heterogeneous behavior at the household level. Even if we base our forecasts of future saving behavior on findings from macroeconomic empirical studies, the uncertainty of our forecast remains large. As we have seen, the results of these studies are highly sensitive to model specification and to the sample of countries included in the analysis.

Domestic Investment and the Saving-Investment Balance

Much of the analysis of the demographic effects of population aging in the industrial economies has been concerned with the effects of aging on public and private saving. Researchers have devoted less attention to the influence of demographic factors on investment and the supply side of the economy. Yet the response of national rates of investment to changes in the population age structure might be equally important.

Our expectations about the effect of demographic shifts on investment follow from the standard neoclassical model of economic growth. In that model the growth of output is determined by the rate of growth in the labor force, labor-augmenting technical change, and increases in capital per worker. In the long term, the capital stock needs to expand in line with output to avoid a progressive decline in the rate of return. Thus, the sustainable rate of growth in output and the capital stock is given by the combination of labor force growth and labor-

augmenting technical change. If one also makes the assumption of a fixed capital-output ratio, the share of investment in output can also be assumed proportionate to output growth.

As their national populations grow older, the high-income countries can anticipate large declines in rates of labor force growth. U.S. labor force growth has been as high as 1½ percent per year during the past quarter century, but the growth rate will approach zero within a decade or two. Labor force growth is expected to fall to -1 percent a year in Japan and some parts of Europe. With marginal capital-output ratios in the range of 2-3, these countries can anticipate declines in their rates of net investment on the order of some 4 percent or more of GDP. If declines of this size occur in the domestic investment rate, most rich industrialized countries will have little trouble accommodating the predicted decline in aggregate private saving that is expected to occur as a result of population aging.

Little research has been done, however, to examine the link, if any, between labor force growth and technical change.[11] If slower growth in the labor force were to be accompanied by a faster rate of change in labor-augmenting technical change, the slowdown in the growth of "effective" labor might be substantially smaller than the slowdown in the working-age population.

The importance of demographic influences on the optimal investment rate was emphasized in the study by Cutler et al. (1990). By assuming a closed economy in their main theoretical model, however, they explicitly assumed that future rates of saving and investment must move in tandem. If instead we assume that national saving and domestic investment are determined within open economies in which savers are free to invest in other countries, there is no reason whatsoever to believe that national saving and domestic investment will be equal in every future year. As discussed later in the paper, fluctuations in the domestic saving and investment balance would be absorbed by changes in the current account balance.

Most aggregative macro models have no explicit demographic variables in their investment equations. If the models were to embody significant disaggregation across types of goods, and hence were to include several different capital stocks for producing the different products, the varying effects of demographic influences on the demands for the products and the types of capital used in producing them might be captured indirectly through relative-price

[11] Bloom, Canning and Malaney (1999) explored the links between demographic shifts and technical change in East Asia.

movements (for the products and the types of capital). In aggregative macro models specifying explicitly only one composite good and one composite type of capital, on the other hand, such relative-price effects are absent by construction. A possible disadvantage of a disaggregated approach is that the effects of changes in the population age structure might be difficult to identify statistically because of cross-border migration or substitutions among industries and products.

Fair and Dominguez (1991) incorporated demographic variables in equations for aggregate investment, and such equations have been used in versions of the Fair model for the United States. For example, those authors explored the effects of the age distribution on housing investment and consumer durable goods purchases using quarterly data for the United States over the period from 1954 to 1988. They found strong age effects, but the effects do not necessarily conform with the predictions that emerge from the standard neoclassical growth model. The estimated coefficients are positive for the young and the old, and negative for ages 20-55. In other words, increases in the relative size of individuals less than age 20 or older than age 55 generate increases in investment demand for housing and consumer durables; increases in the relative size of the working-age population reduce such demand. The implied age profiles are not easily interpreted since they were derived from regressions that also include aggregate measures of wealth and income, and it seems likely that both those variables are also affected by the population age structure.

Empirical research on the links between demographic change and investment stumble on the correlation noted earlier between aggregate national saving and aggregate domestic investment. Saving and domestic investment rates are not independently determined and move together to some extent, even in significantly open economies. Because of this correlation, many empirical researchers have accepted a simplified link between labor force growth and investment requirements, and built the projections of labor force growth directly into their macroeconomic model simulations. That was the approach taken, for example, by Masson and Tryon (1990), in their simulation study of the effects of aging.

The most recent effort to study the effect of the age structure on investment is that of Higgins (1998), discussed earlier in our survey of empirical research on saving.[12] His results for

[12] See also Bloom and Williamson (1997) and Higgins and Williamson (1997).

investment yielded a humped-shaped pattern of the effects of the age structure on the share of investment in GDP. Higgins found that the impact of age on investment peaked at a significantly younger age than the age of peak impact on saving. The peak effect occurred at age 15-24 for investment versus ages 30-45 for saving. Higgins also performed a sensitivity analysis in which he divided countries into two groups depending on their openness to international trade.[13] Relatively closed economies had a much flatter age profile for saving, and the significance of the age coefficients was lower for both saving and investment, compared with the results obtained for open economies. The difference in statistical results for closed and open economies suggests that it may be hard to distinguish between the separate impacts of the age structure on saving and investment in the case of closed economies.

Higgins (1998) also combined his analysis of national rates of saving to project the effect of future changes in the demographic structure on the current-account balances of a number of countries. In the short run, 1995-2010, he predicted that demographic shifts will push relatively young OECD countries like the United States and Canada into surplus because of modest declines in national saving (1-2 percent) paired with large declines in investment (5-6 percent of GDP). The U.S. and Canadian current account balance will eventually decline but remain in surplus out to 2025. The declines in saving and investment demand will occur at a much faster pace for other OECD countries with older populations. Over the medium term, Higgins argues that the average decline in investment demand will exceed the drop in saving (by 2025), leaving the high-income countries with substantial current-account surpluses. Rates of saving and investment are projected to rise most in developing economies, but because of greater effects on saving, the global balance is pushed toward current account surpluses. Note, however, that his projections imposed no requirement that investment and saving be balanced at the global level.

In updating Higgins' model, Bosworth and Keys (2004) obtained very similar results but also looked at the longer run. In addition, they attempted to distinguish between the effects of changes in the age distribution that are due to increased life expectancy and those that are due to lower birth rates. Their estimates suggested there are statistically significant differences in the two kinds of effect only in the models that exclude country fixed effects. Moreover, the addition of income per capita to distinguish between rich and poor countries reduced the significance of

[13] The openness variable is taken from Sachs and Warner (1995).

age in the explanation of differences in investment. In their projections, however, the current-account balances of the high-income countries would be highly negative by 2050, when the cumulative decline in rates of national saving would exceed the drop in domestic investment rates. The implied current-account deficits would be offset, however, by rising surpluses in the current accounts of middle- and low-income countries, which are predicted to have high saving rates and sharply declining labor force growth by the middle of this century.

Asset Prices and Relative Returns

Demographic shifts can influence real returns and asset prices as well as aggregate saving and investment demand. In a standard neoclassical growth model, a demographically induced change in the aggregate saving rate will reduce (increase) the real rate of return on capital if it increases (lowers) the capital-output ratio. This follows from the fact that the return on capital is determined by its marginal product, which in turn is determined by its relative scarcity in comparison with the other factors of production, including labor. When thinking about the effects of demographic shifts in a closed economy, most economists assume desired saving will be equal to actual investment in the long run. The short-run and ultimate effects of demographic change on returns then depend on whether the saving-investment equilibrium produces a faster increase in the capital stock than is warranted by the growth in labor supply. If this equilibrium produces excessive growth in the capital stock relative to labor supply, the real rate of return on capital will fall.

The impact of demographic shifts on the investment-saving balance may change over a demographic cycle, of course. One plausible model suggests that a surge in fertility followed by a sharp decline in the birth rate will produce a cycle in the real return on capital, with returns rising as the entry of the baby boom generation into the workforce temporarily boosts the rate of labor supply growth and increases the relative scarcity of capital. Capital returns will subsequently decline when the baby bust generation enters the workforce, depressing labor force growth. This scenario depends on the assumption that aggregate saving when the baby boom generation first enters the workforce will be too low to maintain the capital-output ratio on its previous path. As discussed in earlier sections, the share of aggregate output that is saved is presumed to fall because of the increased importance of population age groups with low saving rates. When the baby bust enters the workforce a couple of decades later, groups with high

expected saving rates will be relatively more important, boosting the saving rate and the share of investment in aggregate output. The capital stock will grow faster than is warranted by growth in the labor force, and the real return on capital will fall. Lower real returns may be reflected in lower yields on short- and long-term bonds and lower dividend flows or slower price appreciation on equities.

While this scenario may seem theoretically plausible, it does not account for the post-World-War-II trend in U.S. private saving. The private saving rate was relatively constant from the late 1940s through the middle 1980s, a period that saw first the entry of a small population cohort and then the entry of a large cohort into the labor force. As the large baby boom cohort reached middle age and entered its high saving years in the late 1980s, the private U.S. saving rate began to decline. Economists interested in aggregate saving are now trying to explain why U.S. private saving is unexpectedly low rather than account for the asset market effects of saving rates that are above their long-term historical average.

Age-related demand for assets. Analysts have also identified a second mechanism that can produce changes in asset returns. Not only do saving rates vary as people grow older, workers also hold different kinds of assets as they age, and retirees hold different kinds of assets than active workers. If workers systematically vary their investment portfolios as they grow older and if these age-related investment preferences remain constant over time, shifts in the age composition of the population can have important effects on demand for different kinds of assets. By implication, the shifts in relative demand may affect asset prices and relative returns of different asset classes.

One of the first and best known studies to document a relationship between the age composition of the population and asset prices was an examination of housing demand and home prices by Mankiw and Weil (1989). Owner-occupied homes are a broadly held asset in the United States, and equity in homes is a principal component of the net wealth of most households (Aizcorbe et al., 2003). Using Census survey information about the age composition of U.S. households and the value of their homes, Mankiw and Weil found that housing demand for people under 20 contributes negligibly to overall demand, while housing demand rises steeply for young adults between ages 20 and 35. After age 35 demand tends to fall. One implication of this finding is that aggregate demand for housing will be strongly influenced by

the age composition of the population, with increases in demand occurring when the share of the population between 20 and 35 is rising.

Increased demand could be reflected in faster rates of homebuilding or higher prices of existing homes. Mankiw and Weil (1989) concluded that most of the measurable impact of demographic swings was reflected in home prices. They argued that the two-decade rise in home prices starting in the late 1960s was mainly driven by the entry of the large baby boom generation into age groups in which housing demand was rising rapidly. They forecast a substantial long-term decline in home prices after 1980 when the population past age 40 would become increasingly important and the population between 20 and 40 would account for a shrinking percentage of the population. This prediction has proven incorrect so far. If the price of homes is measured using the method suggested by Mankiw and Weil, the relative real price of homes has increased 16 percent since 1990 reaching its highest level of the post-war period (see Figure 2). The bottom panel in Figure 2 shows the lagged change in housing prices measured against the demographic "housing demand" calculated by Mankiw and Weil. Note that the two series are strongly correlated through the year Mankiw and Weil completed their study, but the two series have moved in opposite directions since then. Of course, changes in other determinants of home prices may have produced this effect, offsetting the impact of age shifts. Nonetheless, it is suggestive that U.S. home prices rose strongly in a period when changes in the age composition of the population may have depressed the demand for this asset.[14]

Schieber and Shoven (1997) pointed to a second channel of influence of the population age structure on asset prices: The time series pattern of asset accumulation and decumulation in funded defined-benefit pension plans. They assumed U.S. employers would contribute to their pension plans under the funding formulas that were then common and pay out benefits according to pension formulas that were prevalent in the early to mid-1990s. The aim of their calculations was to predict the time-series pattern of real pension fund saving measured as a percentage of annual U.S. wages. Schieber and Shoven's tabulations showed that fund saving would decline from almost 4 percent of wages in the early 1990s to zero by 2024. In years after 2024 the funded pension system would subtract from U.S. private saving, as real asset sales to pay for current retirement benefits would exceed real asset purchases to fund future pension obligations.

[14] Other analysts are skeptical of Mankiw and Weil's finding that demand for housing declines with age after people reach age 35 or 40. See Green and Hendershott (1996).

By 2040 their forecast showed the private pension system would generate real dissaving equal to 1½ percent of U.S. annual wages. Schieber and Shoven posed a question about the implications of this finding: Could dissaving on this scale be accomplished without inducing a large decline in asset prices and ex-post rates of return? Pension funds would be required to sell an increasing share of their asset holdings each year, but buyers for those assets might be scarce.[15] Schieber and Shoven did not, however, make specific forecasts of the fall in returns or asset prices implied by their findings.

Other analysts have made such predictions. Researchers base their forecasts on two approaches to the data. One approach is to examine microeconomic evidence on the composition of asset demand across different age groups in the population and then use a simulation model to predict the influence of shifting population weights on asset prices or on the relative and absolute returns of each class of assets. Another approach is to estimate directly the influence of demographic shifts on asset returns (or prices) using time series information on such returns as a dependent variable in regressions that include demographic variables on the right-hand side. Excellent summaries of this literature can be found in Poterba (2001) and Davis and Li (2003).

The starting point for both kinds of analysis is the idea that adults of different ages have different portfolio preferences. Although this proposition may seem intuitively plausible, it does not follow from the most popular theoretical models of portfolio allocation. As noted by Canner et al. (1997), the mutual-fund separation theorem, which is a critical element of the capital asset pricing model, implies that all investors should hold the same portfolio of risky assets, varying only the fraction of their net worth that is held in a risk-free asset in order to obtain their desired balance of risk and return. Merton (1969) and Samuelson (1969) considered investors who could invest in a risk-free asset (such as an insured money market fund) and a risky asset offering a risk premium above the risk-free interest rate. Their analysis implied that investors' optimal portfolio would be independent of the time to the end of their expected life. In other words, under the Merton-Samuelson assumptions the optimal portfolio is independent of an investors' age. The

[15] Schieber and Shoven's forecast is based on a maintained assumption regarding the average rate of real return obtained by pension funds on their invested assets. Ex post rates of return can diverge widely from the expected return, forcing fund managers to increase contributions to under-funded plans and allowing them to suspend or reduce contributions to over-funded plans. See Munnell and Soto (2003) for analysis of these issues and a survey of actual fund contributions over the 1981-2000 period.

Merton-Samuelson conclusion conflicts with popular investment advice, which recommends that investors gradually reduce the share of their portfolio held in risky assets as they grow older (Canner et al., 1997). It is of course possible that this advice is based on sound reasoning. Even if financial advisors' reasoning is wrong, however, their recommendations to the public may reflect the actual preferences of investors as they age.

Empirical results. Empirical evidence suggests that portfolio allocations do vary by investors' age, but the observed variation does not conform either with popular investment advice or with the optimal portfolio path implied by the Merton-Samuelson theory.[16] Figure 3 displays tabulations of common stock holdings of U.S. investors by age, measured both as a percentage of household net financial assets and as a percentage of household net worth. We also display the average net worth of each age group in the bottom panel. The estimates were obtained by Poterba (2001), and they are based on wealth reported in the 1983-1995 waves of the Survey of Consumer Finances. The estimates reflect reported assets held directly, held in mutual funds, and held in households' defined-contribution pension plans. They do not reflect assets held in employer-sponsored defined-benefit pension plans, nor do they include social security wealth. Poterba was careful to measure the impact of age on portfolio holdings taking account of shifts in portfolio preferences across different birth-year cohorts. The estimates shown in Figure 3 were obtained by pooling responses from five point-in-time surveys conducted between 1983 and 1995 and jointly estimating the separate impacts of age and birth-year cohort on wealth holdings. The results show that common stocks represent an increasing share of investors' average net financial holdings through age 40-44. At older ages, stocks constitute a gradually shrinking percentage of financial holdings. Measured as a percentage of investors' net worth, equity investments represent an increasing share of portfolios through age 55-59 and a declining percentage thereafter. Note, however, that the percentage of net worth that is invested in common stocks shows very little decline after age 60. In particular, the share of net worth held as common stocks never falls below the percentage observed for 45-49 year-olds.

The microeconomic data thus imply that investors boost the share of their wealth invested in the risky financial asset through age 60 but do not significantly reduce their exposure to this risk thereafter. The lifetime pattern of investment in risky equities clearly fails to conform with

[16] McCarthy (2004) offers a useful and succinct summary of cross-national evidence on portfolio allocation and its correspondence with theoretical investment models.

popular investment advice, which implies that the percentage of household assets held as equities should fall continuously with increases in age. The discrepancy could arise because young adults are accumulating low-risk assets for precautionary saving or for the purchase of their first home. Nor does the lifetime pattern conform with the Merton-Samuelson implication that the portfolio share held in risky assets should be independent of investors' age. Nonetheless, the differences documented in Figure 3 could imply that demand for different asset classes will vary depending on the age structure of the population.

In summarizing the empirical evidence on this question, both Poterba (2001) and Davis and Li (2003) point to a number of studies that find a statistically significant impact of the age structure of the population on some measure of asset prices or asset returns. Notable among these are studies by Yoo (1994) of the relationship between stock, bond, and Treasury bill returns and the age structure of the U.S. population, by Brooks (1998) of equity prices in 14 OECD countries, and by Bergantino (1998) of house and equity prices in the United States. Using information on returns between 1926-1988, Yoo (1994) concluded that larger shares of population in the high-saving years are associated with lower returns on Treasury bills, though his findings are less definitive on the impact of age structure on returns from riskier assets. In contrast, Brooks (1998) found the share of the population between ages 40 and 65 was positively associated with the real stock market price in 11 of the 14 countries included in his study. Bergantino (1998) also found a significant positive association between his derived estimate of population demand for equities, which was based on the age structure of the population, and real U.S. equity prices. [17]

When Poterba (2001) examined the relationship between five measures of the demographic structure and real returns from investment in Treasury bills, long-term government bonds, and common stocks, his estimates offered weak evidence of a demographic influence on returns. If there does exit a correlation between population age structure and U.S. asset returns, the best evidence for it pertains to Treasury bill returns (in other words, on the real return of the risk-free asset). Neither the long bond return nor the return on equities seems strongly correlated with simple measures of the U.S. age structure. Treasury bill returns decline with increases in the fraction of the population between ages 40-64, presumably the fraction of the population that

[17] See also Brooks (2000, 2002) and Abel (2001, 2003).

is saving heavily for retirement. Interestingly, the evidence for a demographic effect on returns is stronger for the period before World War II than it is in the post-war era. Poterba (2001) extended his analysis to cover post-war investment returns in Canada and the United Kingdom. He interprets these results as weakening the claim that demographic influences play a large and consistent role in determining returns. In Canada he finds a statistically significant impact of the demographic variables on Treasury bill returns and the return on long government bonds, but the effect is the opposite sign of that found for the United States. Canadian bill and bond returns rise with increasing shares of the population in the 40-64 age group. In the United States, a rising share of the 40-64 age group produces a reduction in the Treasury bill return.

Before discussing the remainder of Poterba's findings, it is useful to contrast the findings just described with comparable results from a more recent study by Davis and Li (2003). Davis and Li use panel data on returns from seven large OECD countries to estimate the influence of post-war demographic changes on annual changes in real equity prices and on real long bond yields.[18] The authors' estimated a fixed-effect specification to measure the impact of two demographic variables – the share of the population aged 20-39 and the share aged 40-64. Unlike Poterba (2001), the authors also include other determinants of share prices and bond yields in their model, including the trend in national consumption and (in their model of share prices) the real long-term interest rate. Their basic panel estimates show that real equity prices rise significantly with increases in the shares of the population between 20 and 39 and between 40 and 64. When the United States is included in the panel, the estimated impact of the population share between 20 and 39 is roughly half the size of the population share between 40 and 64, a finding that seems consistent with cross-sectional U.S. evidence indicating that people between 40 and 64 are the ones most likely to demand corporate equities in their portfolios. However, when the United States is excluded from the sample the estimated coefficients on the two population variables are essentially indistinguishable. This implies that equity prices rise with the working-age share of the population and decline when the working-age share declines. When Davis and Li re-estimate their equity-price model to obtain separate estimates of the effect

[18] The included countries are the United States, Japan, Germany, France, the United Kingdom, Italy, and Spain, and the data cover the period from 1950 to 1999. In some of their robustness tests, the authors estimate their model with data through 1990 and compare their model predictions with actual returns observed in the 1990s. On the whole, these predictions appear to support the conclusion that demographic effects are well supported by the data.

of the demographic variables for each included country, they find estimated coefficients that have the expected sign for both variables and that are statistically significant in 8 out of 14 possible cases. In the United States, the effect of the population share between 40 and 64 is six times that of the population share between 20 and 39, indicating that equity prices are particularly sensitive to the fraction of the adult population that is in the second half of its working career. A variety of diagnostic tests tend to support the authors' finding of significant demographic effects on equity prices.

Davis and Li (2003) also find significant impacts of their demographic variables on real long bond yields. Their panel estimates show that increases in the fraction of the population between 20 and 39 tend to increase real bond yields, possibly reflecting the demand of this age group for mortgage borrowing. Increases in the fraction of the population between 40 and 64 significantly reduce long bond yields, presumably because these high-saving households wish to hold long bonds in their investment portfolio. The individual country regressions are broadly consistent with this pattern of findings, although in Italy and Spain the estimated coefficients have the opposite sign of that found in the panel model estimates. Thus, unlike Poterba (2001) Davis and Li (2003) argue that they have found statistically significant and consistent effects of the main demographic variables on stock and bond returns. They further argue that their findings broadly conform with theoretical expectations. However, their estimates are sensitive to their specification of demographic effects. When they divide the population into three adult age groups – the young, the middle-aged, and those past retirement age – their out-of-sample forecasts of future equity prices and bond yields diverge sharply from their forecasts when only two demographic variables are included in the statistical specification. Using their baseline model results, which estimate separate impacts for the young and late career age groups, real equity prices are predicted to rise over the next 25 years and bond yields are predicted to remain relatively constant. Using model results that show separate estimates of the impact of young, middle-age, and older age groups in the population, the authors predict that equity prices will begin to fall sharply starting in 2020 while real bond yields will begin to rise sharply in about the same year. Thus, even though the authors find demographic variables to be important in the determination of stock and bond returns, it is not clear what implication this has for the future course of stock market prices and bond yields.

Poterba (2001) also reports findings that tend to support the claim that population age structure is an important determinant of U.S. stock market prices. Using detailed information about the age-specific demand for common stocks and net financial assets drawn from the Survey of Consumer Finances, Poterba derived annual estimates of the aggregate demand for such assets using information about the age distribution of the U.S. population between 1926 and 1999. These estimates reflect the age-pattern of asset demands shown in Figure 3, but they do not reflect the demand for assets in funded, defined-benefit pension plans. He then estimated the relationship between his measure of overall demand and the price-dividend ratio of common stocks. In spite of the fact that his measure of asset demand does not include the demands of defined-benefit pension plans, Poterba finds a large and statistically significant relationship between the predicted demand for assets, on the one hand, and stock market prices, on the other. To confirm this finding Poterba also estimated the same relationship using first differences. That is, he regressed annual changes in the price-dividend ratio against changes in the predicted demand for assets. Even using this more demanding specification, Poterba found a large and statistically significant impact of demographic shifts on the price-dividend ratio. In fact, as Poterba points out, the estimated effect may be too large to be plausible. If the estimates are accepted at face value, they do not imply that stock market prices will collapse after the baby boom generation retires, however. As we see in Figure 3, the demand for common stocks remain remains relatively strong even among people who are past the normal retirement age. If these microeconomic data are used to derive an estimate of demand for common stocks, they imply that aggregate demand for stocks will remain relatively strong even after the baby boom generation retires. Even though Poterba's (2001) findings tend to confirm other estimates of an important impact of the age structure on stock market prices, the implications of his findings for future stock market findings are not very alarming. They suggest that equity prices will remain strong even after the baby boom generation has retired.

Summary. Analysts have found evidence that population age structure affects stock market prices and the real returns of different asset classes, but so far the consistency of this evidence is not overwhelming. It is not clear whether the evidence shows that demographic influences on asset prices and returns are large relative to other and less predictable determinants of prices and returns. The estimated effects of demographic factors are often sensitive to the start and end dates of the period analyzed and to the countries included in the sample. Poterba

(2001) is rightly puzzled by the fact that estimated demographic effects sometimes have the opposite sign in different countries, even countries such as Canada and the United States which share similar demographic histories and financial institutions. Davis and Li (2003) offer some possible explanations of the differing effects of demographic factors in different countries, but the evidence in support of these explanations is weak.

Open-Economy Aspects of the Saving-Investment Balance

In this section of the paper, we indicate the main factors that have caused an increasing integration of national economies, identify key implications for the saving-investment balance for individual economies, and discuss the limited literature that has tried to study the cross-border and global dimensions of demographic change.

Enhanced Cross-Border Economic Integration. Many national economies were relatively closed to the rest of the world after the First World War and during the Great Depression, and even in the decade following World War II. As the second half of the 20th century progressed, however, the economies of developed nations returned toward 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 two secular trends in cross-border "substitutability." First, 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"). Second, savers and investors have shown a gradual increase in their readiness to respond across borders or currencies to changes in relative expected returns among financial assets and liabilities denominated in different currencies or originating from different national economies ("financial substitutability").

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 movement of financial funds. After World War II most governments began to lower their separation fences 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.[19]

By shrinking the economic and psychic distances among nations, changes in technology and behavioral changes in cross-border substitutability 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 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.[20]

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[19] The dramatic increases in cross-border capital mobility in the second half of the 20th century and the early years of the 21st century is 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).

[20] 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 once were. 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.

Implications for an Economy's Saving-Investment Balance. The progressive intertwining of national economies causes macroeconomic variables to be more closely linked and interdependent across national borders today than in earlier decades. Accordingly, a somewhat larger proportion of required macroeconomic adjustments tend to be channeled through external-sector transactions. Speaking loosely, cross-border and cross-currency adjustments have risen in importance relative to purely domestic adjustments.

Notably, the sizes and variations of economies' current-account balances with the rest of the world – representing any imbalance between national savings and domestic investment – have been strongly influenced by the lowering of national separation fences and by heightened goods and financial substitutabilities across borders. Typically, an economy's current-account balance relative to gross output may be larger and exhibit larger swings than would have occurred in earlier decades.

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.[21] The saving and investment decisions of individual economic agents could and would be taken independently. When measured after the decisions have been made and inconsistencies among them have been 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 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.

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[21] 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 (recall the discussion in the first section of the paper).

In the 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. Feldstein-Horioka and many subsequent authors interpreted this evidence 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 non-policy disturbances originating within a nation's economy – and some types of disturbances originating abroad – can influence national saving and domestic investment in the same direction independently of the flow of capital and goods 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.[22]

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

[22] Obstfeld and Rogoff (1996) review alternative interpretations of the Feldstein-Horioka empirical findings.

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 entails 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. As discussed by Alan Taylor (2002), 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.

Notwithstanding the complexities of interpreting the Feldstein-Horioka saving-investment correlation, 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.[23] 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 on the Feldstein-Horioka correlation 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 emphasized by Feldstein-Horioka were significantly unrelated to border barriers and cross-border financial substitutability, a strong correlation between investment and saving might be found within regions inside a nation. Conversely, if an important part of the Feldstein-Horioka correlation 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

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

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 for the United Kingdom (1993). 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 Feldstein-Horioka 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) cited 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 non-policy shocks have risen in importance relative to purely domestic adjustments.

The Effects of Demographic Shocks on an Open Economy's Saving-Investment Imbalance. The demographic transitions occurring in countries, instead of occurring symmetrically, vary widely in their pace and intensity. Japan and several European nations have experienced earlier and relatively larger declines in birth rates and are now experiencing faster population aging than developed nations such as the United States. Most developing nations are also experiencing lower fertility rates and higher life expectancy, although their demographic evolutions lag several decades behind those of developed nations (see, for example, the overview in Lee , 2003).

The generalization that cross-border and cross-currency adjustments have increased in importance relative to purely domestic adjustments applies at least as strongly to demographic shifts that occur asymmetrically across nations as to other types of macroeconomic shocks. For most countries, therefore, changes in external-sector transactions and exchange rates and

variations in the current-account balance are important parts of macroeconomic adjustments to demographic shifts.

Only a small number of studies have attempted to analyze the consequences of demographic developments for the current-account balances of individual nations or the global saving-investment balance. The studies that have been conducted find that large variations in a nation's youth-dependency or elderly-dependency rates tend to be correlated with variations of its current account balance. That finding reinforces the conclusion that international capital flows may offset the impacts induced by demographic change on savings and domestic investment.

For example, using a large panel data set of both developed and developing countries, Higgins (1998) found empirical evidence that demographic changes are correlated with the current account balances. He interpreted the evidence presented in his paper as suggesting that, at least for many Asian countries, access to surplus foreign savings has provided an important buffer, allowing some of the youth-dependency burden to be reflected in a negative current account balance rather than lower domestic investment.

At a later stage of the demographic transition, population aging occurs as the elderly-dependency rate markedly increases. The growing scarcity of labor implies, other things being equal, that less capital is required to work with the shrinking labor force. Desired national saving probably falls less than desired domestic investment. In a completely closed economy, domestic investment and national saving would have to decline together. In economies open to the rest of the world, however, rapidly aging countries can export some of their savings to less rapidly aging countries elsewhere in the world. The resulting current-account surplus and net capital outflows can partially offset the reduction in the rate of return to capital that would otherwise have to occur. To the extent that savings and capital are internationally mobile, in other words, the demographic effects of population aging can drive a large wedge between national savings and domestic investment that is the counterpart of sizable net capital flows. This general phenomenon is discussed and in varying degrees modeled by McMorrow and Roeger (1999, 2003), Borsch-Supan, Ludwig, and Winter (2003), Fehr et al. (2003), Brooks (2003), Bryant and colleagues (2004a, 2004b, 2004c), and McKibbin and Nguyen (2004). Earlier discussions in addition to Higgins (1998) include Auerbach et al. (1989), Borsch-Supan (1996) and Holzmann (2000).

Several of these studies suggest that considerable capital flows would emerge within the OECD area as a result of differences in the timing and pace of the aging process among OECD member countries. The various studies differ in detail about the demographic impacts on savings in individual countries, however, and therefore disagree about the likely direction of net capital flows.[24] The situation for OECD countries as a whole, furthermore, would dramatically change if large countries such as India and China became major localities for productive investments that are financed through a global capital market. In that event, those countries would absorb large amounts of capital from the OECD area (Borsch-Supan, 1996).

Most studies conclude that demographic divergence in the broader world economy could stimulate net-capital flows from the most rapidly aging regions (OECD developed countries) to less rapidly aging regions (emerging-market and other developing countries), where the capital-output ratio is lower and the rate of return to capital is higher. If investment demand remains strong in developing economies, for example, asset owners in the industrialized countries can continue to earn comfortable returns on their savings, avoiding the prospect of diminishing returns. This optimistic view is taken by Borsch-Supan (1996), Attanasio and Violante (2000), and Brooks (2003). It is also suggested, however, that while emerging-market and developing nations can provide new investment opportunities at the margin, they may not be able to absorb enough OECD savings to dramatically alter the saving-investment balance for the OECD as a whole. Investments outside the OECD bring potential advantages through enhanced risk diversification and higher rates of return, but for developed and developing nations together to capture these potential gains will require developing nations to make major progress in macroeconomic management, prudential supervision of financial markets, and greater security for contracts. Such improvements can feasibly be made only slowly over time (Holzmann, 2000).

The most comprehensive of the existing studies is by McMorrow and Roeger (2003), though their main emphasis is on population aging as seen from the perspective of the European Union. They too emphasize the potential cushioning of the aging process for developed countries that could occur by investing their "excess" saving in emerging-market and developing nations. They also note, however, that limits exist on this cushioning process. Most basically, the developing countries themselves will eventually get to a population-aging stage in their own

[24] See for example Cutler et al. (1990); Borsch-Supan (1996), and Fehr et al. (2003).

demographic transitions. They also observe that, if capital accumulation in developing nations sparked by the flow of developed-nation savings does occur on a large scale, the marginal product of capital would eventually decline in developing nations too, rendering inward investments in those regions associated with current-account deficits less attractive than initially.

Cross-border and global issues about the consequences of demographic change can be addressed in a completely satisfactory manner only within general-equilibrium frameworks incorporating endogenous macroeconomic interactions among national economies. The analytical frameworks in the existing studies have sometimes been only cross-country regression studies (for example Higgins, 1998; Davis and Li, 2003). Even when frameworks move toward general-equilibrium modeling, they tend as yet not to treat exchange rates, external-sector transactions, and global interest rates as fully endogenous (Borsch-Supan, Ludwig, and Winter, 2003; Fehr et al., 2003). Most of the existing studies thus cannot adequately capture spillover effects from one national economy to another and the net consequences for global savings and investment.

McMorrow and Roeger (2003) are a partial exception. Their framework does permit examination of the global saving-investment balance and the world level of real interest rates as well as regional changes in exchange rates and current-account balances that result from shifts in the relative positions of regions caused by demographic changes. They normatively favor "more, not less, globalization" as a way of countries handling the international aspects of aging and argue that -- *if* large net capital flows to developing nations could occur -- sizable net benefits would accrue to both developed and developing nations and the world could experience an eventual increased convergence in regional incomes and wealths. In their optimistic scenario, worldwide investments would be more efficiently diversified; GDP and GNP measures of income would increasingly diverge for all world regions.

The research that comes closest to addressing the saving-investment and current-account issues in a full general-equilibrium framework is outlined in the papers by Bryant and colleagues (2004a, 2004b, 2004c) and McKibbin-Nguyen (2004). Bryant works with stylized models of the world economy containing two regions that are identical except for the demographic and policy shocks experienced. McKibbin and Nguyen experiment with implementing the modeling refinements in multi-region frameworks. The models used in those research efforts embody specific assumptions about unresolved issues of macroeconomic analysis, including the

demographic aspects of savings and investment issues identified earlier in this survey. The analysis therefore is only a first pass at studying the external-sector and global consequences of demographic changes. Nonetheless, the conclusions are likely to be robust across a wide range of analytical frameworks incorporating macroeconomic interactions among national economies. In what follows, we summarize some key analytical points emerging from those research efforts.

The openness of economies decisively influences the macroeconomic consequences of the demographic shocks. Domestic macroeconomic variables in both "home" and "foreign" economies are strongly influenced by cross-border transactions when demographic shocks are asymmetric. In an archetypal illustration, the home country experiences a large cyclical decline in fertility while foreign economies experience a smaller and more gradual fertility decline (both of which eventually result in population aging, but with much larger effects in the home country). The openness of the home and foreign economies causes home domestic variables to be partly cushioned from the full impacts of the larger demographic shock. As a counterpart, foreign variables are adversely buffeted by the larger demographic shock emanating from the home economy. An important component of these cushioning and buffeting effects is associated with changes in exchange rates. The permanent appreciation in the real value of the home currency enables the home economy to enjoy a large permanent 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 foreign economy.

Much conventional wisdom asserts that population aging causes unambiguously adverse economic consequences. At best, that conventional wisdom is simplistic. In important respects, it is fundamentally wrong for an open economy that is significantly ahead of other economies in its demographic transition. An economy that has experienced a faster and larger fertility decline and is currently experiencing population aging—for example the situation of Japan early in the twenty-first century—is able to diffuse part of its larger shock into other nations. In effect, it "shares" the shock with the rest of the world. In per capita terms, the outcome can be significantly better for that country's residents. Discussions of population aging pay far too little attention to this fundamental point.

It is essential when interpreting the implications of cross-border spillovers to differentiate carefully between aggregate levels of variables and their per-capita (or per-adult) values. A large demographic shock occurring in a home economy that reduces its population absolutely (such as

Japan's current prospect) will inevitably cause major negative effects on home aggregate output and consumption. Home aggregate real consumption must accordingly fall much further below baseline than real aggregate consumption abroad where the demographic shock is smaller, delayed, or absent. 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 large-cyclical shock through transactions with the rest of the world. The openness of the economy works to mitigate the size of the negative effects on the aggregates.

Now consider the per-adult or per-capita values of such macroeconomic variables. Notwithstanding the fact that the demographic shock in the home economy is much larger than abroad, home per-adult consumption will actually be *higher* than per-adult consumption abroad. The difference between the outcome in the home and foreign economies can be sizable in the initial decades of the shock. It can be even more marked in the long run. Moreover, the cushioning effects are so substantial when measured in per-adult or per-capita terms that individual adults in the home economy are significantly better off relative to baseline than individual adults in foreign economies. Indeed, adult consumption per adult in foreign economies is markedly *lower* than in the baseline.

Analyses of national welfare of course cannot rely exclusively on per capita measures of economic variables. For some 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 become smaller proportions of the world total. In effect, the economy as a whole shrinks in relative size after its larger demographic shock. With relatively fewer real resources available for investment or consumption, the government and the nation as a whole might well be supposed to have lessened influence in the world. To use Japan again as a illustration, the Japanese economy with its earlier and faster fertility decline, leading to faster population aging and a relative shrinking of its population and GDP, may conceivably experience diminished effects on its power and security position in the world.

Thus one should not ignore the consequences of population aging for a nation's aggregate macroeconomic variables. But neither should one forget the powerful 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. Again, for an open economy asymmetrically experiencing faster fertility declines and population aging, negative consequences accompanying the demographic shifts are typically cushioned because the negative effects are shared with the rest of the world. That cushioning and sharing may not be desirable as seen from the perspective of foreigners, but it can produce sizable welfare gains for home residents.

Research Agenda

We conclude our survey with a brief assessment of potential avenues for further research. Although the discussion follows the order of the paper, our particular focus is on steps needed to advance the understanding of cross-border and global effects.

Saving and Domestic Investment. The most striking feature of our review of the effects of aging on saving is the sharp contrast between the microeconomic and macroeconomic analyses. Both approaches find that the age profile of saving is generally in accord with the life-cycle model. The magnitude of the effects in the most recent microeconomic studies, however, is small relative to the range of observed fluctuations in aggregate household saving rates. In contrast, the macroeconomic analyses suggest relatively large age effects on private and total national saving. One reason for the discrepancy may be that the microeconomic analyses often fail to incorporate fully pension fund saving.

A careful study of panel data for a large sample of countries using aggregate data offers great potential for improving our knowledge of the effects of population aging. A substantial number of countries offers much greater variation in the population age structure over time than a single country. The aggregate data also deal correctly with pension funds and their effect on income and saving. That is, if an employer pays $100 in wages and $10 in contributions to a defined benefit pension, the full $110 shows up in the aggregate data, whereas household surveys report only the $100 in wages. Of course, this assumes normal times when plan sponsors make contributions for accruing benefits. During periods when the stock market booms, pension regulations may preclude contributions so that pension accruals would not be reflected in the aggregate data. If this effect were random, it should wash out in a multi-country panel study.

But if stock market booms were related to demographics, this effect would need to be addressed to assess the impact of demographics on saving.

The alternative is to improve the microeconomic data to incorporate defined benefit accruals as part of total income and saving. At least for the United States, pensions are likely to be the source of much of the life-cycle dimension of saving. Thus, it would be valuable to make a major effort to incorporate such information into a microeconomic data set, even if the information were limited to allocating the saving over cohorts, rather than individuals.

Empirical explorations of the implications of demographic changes for investment expenditures have been limited largely to aggregate data. The greater variation in investment experiences through time available in panel data for a large sample of countries might generate more refined estimates of demographic effects. It might also be useful to focus on data for private-sector and public-sector investment disaggregated by industry. This information will be important for assessing whether saving and investment demand are in sync or not. If the elderly demand a lot of capital in the form of big houses and hospitals with fancy equipment, then investment demand would be stronger and they would not be dissaving as rapidly as life-cycle theory suggests.

An alternative for forecasting investment demand could involve an analysis of states within the United States that currently have large elderly populations. Two examples are Florida, which is rapidly growing, and South Dakota, which is not. Of particular interest would be potential changes in the composition of capital stock and the ways in which that capital is financed. That is, how will the shift from schools to hospitals change the demand for saving?

Finally, the long-run linkage between labor force growth and technological change is a relatively unexplored area, but the rate of technological change is an important determinant of the demand for capital. Some think that an aging labor force might be less innovative, but some studies suggest the opposite might be true. This is clearly an area where more work needs to be done.

Asset Prices. Some of the most powerful evidence of a demographic influence on asset prices and returns is obtained when analysts use microeconomic evidence to infer the differential demand for assets across age groups. This microeconomic evidence is then used to derive an estimate of aggregate demand for past years. Analysts including Mankiw and Weil (1989) and Poterba (2001) then show a strong statistical time series correlation between their measure of

asset demand and some measure of asset prices or returns. That kind of exercise has been performed mainly for the United States, but it could usefully be repeated for other countries where appropriate microeconomic survey data are available to derive plausible estimates of asset demand.

Of course, even the U.S. microeconomic evidence lacks some crucial information about asset demand. The existing estimates are based on surveys that measure households' asset holdings outside of defined-benefit pension plans. The assets held in employer-sponsored defined-benefit pension plans should also be included in the estimates, even if this requires analysts to impute rough estimates of the portfolios that back defined-benefit pension promises.

Another approach is to see what can be learned by looking at the changes in asset prices – specifically housing – across states as population profiles have changed. As indicated above, such a study would have to take into account economic growth and other variables commonly associated with price changes in an attempt to isolate the impact of demographic developments. For most families, their home is their major asset, and many enter retirement with more housing than they will need later on in life. An attempt to sell unneeded housing by a large cohort of older people could severely depress housing prices and put the economic security of the baby boomers at risk. The analysis is complicated because most experts expect returns to capital to decline as the population ages, which suggests interest rates may eventually decline, and lower rates could have a positive impact on future housing prices.

Cross-Border and Global Dimensions. Data problems inhibit progress in understanding the international as well as the domestic aspects of demographic change. Data for cross-border capital flows, and for stocks of cross-border assets and liabilities ("International investment positions") defined consistently with the flows, have improved only marginally in the last several decades. See for example the discussion in Lane and Milesi-Ferretti (2001). But the gaps are still huge. For many countries, data are not available at all for their international investment positions. The IMF staff has been asked to improve the data for international investment positions in conjunction with the general effort at the IMF to improve the quality of national

data.[25] Improved empirical research on capital flows and the cross-border aspects of countries' saving-investment balances is in important respects hostage to the data.[26]

Apart from more reliable data, satisfactory progress in empirical studies of the cross-border consequences of demographic change and the macroeconomic interactions among national economies requires examination of multiple channels of interdependence. As indicated earlier, progress requires that interest rates, exchange rates, and external-sector transactions be analyzed within a framework explicitly allowing for "world" general-equilibrium effects. This need in turn requires researchers to improve existing multi-country macroeconomic models. Such research is difficult and expensive. Refinements come slowly. Unfortunately, no shortcuts can substitute for the effort to conduct analyses incorporating general-equilibrium effects. Explicit multi-country models, despite their weaknesses, are unambiguously preferable to alternatives for conjecturing about the complex behavior of economies that rely on partial-equilibrium or implicit, unsystematic methods.

The agenda facing researchers working with multi-country models is to try to incorporate "best-practice" knowledge from research on domestic macroeconomics—in which closed-economy issues are typically deemphasized or ignored—and then adapt that knowledge to the multi-country, cross-border context. But vexing tradeoffs are always present. For example, the heterogeneity of nations argues for separate specifications of countries or regions differing in their institutions and economic behavior. Yet incorporating realistic heterogeneity across countries in a model can quickly become complex, computationally burdensome, and difficult to interpret. The general dilemma confronting researchers is to embed best-practice "domestic" specifications without allowing the multi-country framework to become so complicated that analytical transparency is sacrificed.

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[25] IMF (2003) and website: http://dsbb.imf.org/Applications/web/sddshome/

[26] In principle the flow data in the balance of payments exclude capital gains and losses stemming from revaluations of asset prices and exchange rates. The capital-flow data thus are compatible with the NIPA conventions for defining saving. Stock data for international investment positions should in principle include revaluation gains and losses, but with the disaggregated categories of outstanding assets and liabilities measured consistently with the categories used in the balance-of-payments flow data. Unfortunately, much of the international-investment-position data have so far been estimated by cumulating balance-of-payment flows, which thus precludes identifying revaluation gains and losses.

Even for domestic analysis of demographic effects, research can be plagued by a tradeoff between the amount of disaggregation required to capture compositional changes versus practical solutions for approximating these changes in aggregate macroeconomic relationships. Decisions about this tradeoff become even more difficult in a multi-country setting where disaggregation within each of the national economies necessarily greatly increases the complexity of the model.

The preceding section mentioned papers from all the existing research projects in the world known to us in which researchers are trying to contribute to an understanding of demographic effects through use of multi-country models. The relevant projects are at the European Commission in Brussels (McMorrow, Roeger, and others); at the University of Mannheim (Borsch-Supan, Ludwig, Winter, and others); at the University of Wurzburg and Boston University (Fehr, Jokisch, Kotlikoff, and others); the multi-country modeling group at the IMF (Research Department staff); and at the Brookings Institution/Australian National University (Bryant, McKibbin, and others). Significant progress in understanding the cross-border and global dimensions of demographic change is likely to come out of one or more of these groups—or alternatively out of new groups formed for a similar purpose.

We do not have enough information to describe the research priorities and agendas of all the existing groups. What follows is only a summary of the agenda currently envisaged by the Brookings/ANU group.

The Brookings/ANU research has so far successfully achieved an integration of the later and the early stages of the aging process in a single modeling framework. The key exogenous demographic variables are fertility rates and mortality rates for adults and children. Other demographic variables, and of course the major macroeconomic variables, are determined endogenously. Most of the research so far has focused on illustrative declines in fertility. The effects of falling youth-dependency ratios with implications for adult support of child consumption and of rising elderly ratios resulting in pension-system pressures have been combined in the Brookings work to show that fertility declines have first-order consequences for the determination of exchange rates, external imbalances, and global saving and investment flows. It has also been shown that the timing and sizes of macroeconomic effects from demographic shifts vary significantly across different types of pay-as-you-go public pension-system operations. The ANU team of researchers has focused on incorporating the theoretically

improved specifications of demographic evolution into a four-region multi-country model (for the United States, Japan, the rest of the OECD, and a developing-nation rest-of-world region).

A modest next step is to conduct a systematic examination of increases in life expectancies, occurring asymmetrically across nations. Those results will be contrasted with the analysis already done for fertility changes. When the effects of each type of demographic change are well understood separately, it is then expected to study various "combination" scenarios for demographic shifts (fertility changes combined with increases in life expectancy).

The models underlying the existing Brookings/ANU analysis have important strengths relative to the multi-country models used in other projects, but they also have notable weaknesses. Some possible improvements appear to be relatively manageable and could be accomplished over a fairly short horizon. For example, it should be possible to refine further the treatment of the simplified public pension systems now incorporated in the models (for example, permitting variation over time in the definition of "elderly" individuals and the "retirement age"). Improvements can be made in the manner of specifying initial conditions for simulation experiments and stylized empirical differences across model regions. The behaviors of central banks in implementing monetary policy and of fiscal authorities in implementing intertemporal budgetary policies can and should be refined further.

Other types of improvements are even more desirable but also promise to be more difficult. First, rather than using the familiar Blanchard-Weil-Yaari specification that presumes age-invariant mortality rates for adults and that permits easy aggregation across individuals, it would be preferable in the tradition of theoretical overlapping-generation models to incorporate explicit multiple age cohorts with separate mortality rates for each cohort; this change will greatly complicate the models and will have to be made without giving up the ability to focus on general-equilibrium aggregate macroeconomic interactions that are already captured in the existing framework. Second, it would be desirable to modify the existing simplified treatment of youth dependency and adult support of children to better reflect the incentives of adults to have children and to finance children's consumption; if feasible, this change would require a major revision of the sectors of the models that proximately determine consumption, saving, and wealth accumulation. Third, it would strengthen the realism and relevance of the models to incorporate people migration flows across national borders (in a manner consistent for the world as a whole, such that immigration of persons into one region is matched exactly by emigration from other

regions). Fourth, refinements are needed for how “home”-produced and “foreign”-produced goods are treated in consumption and investment specifications, and hence in the underlying assumed utility functions; this change will in turn require altered specifications for cross-border trade transactions (paying particular attention to alternative specifications of income elasticities and “substitutability” elasticities among home and foreign prices). A final set of difficult but important modifications would be to incorporate more explicit and realistic treatment of developing-country regions and of the macroeconomic and demographic interactions among industrial and developing regions.

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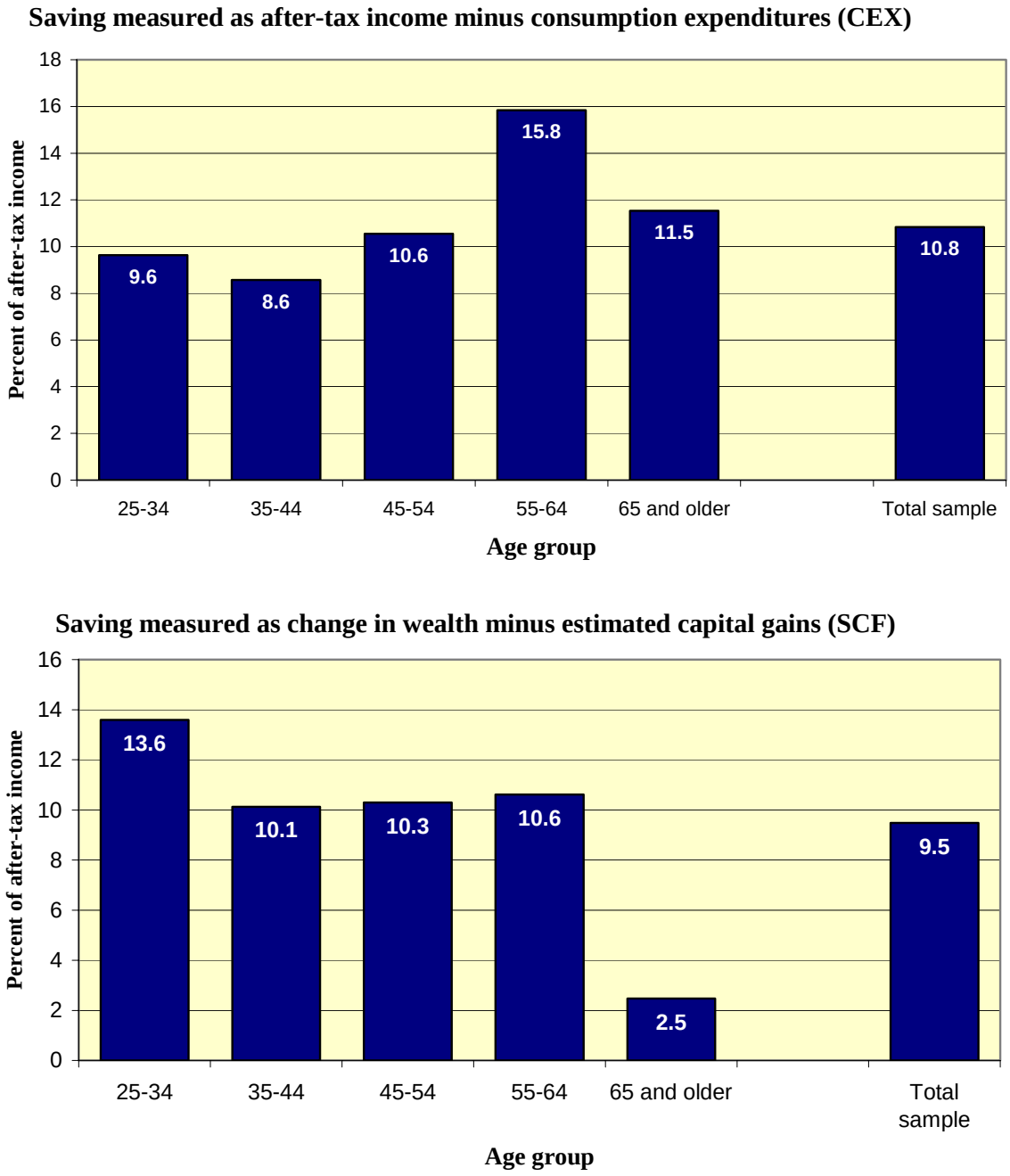
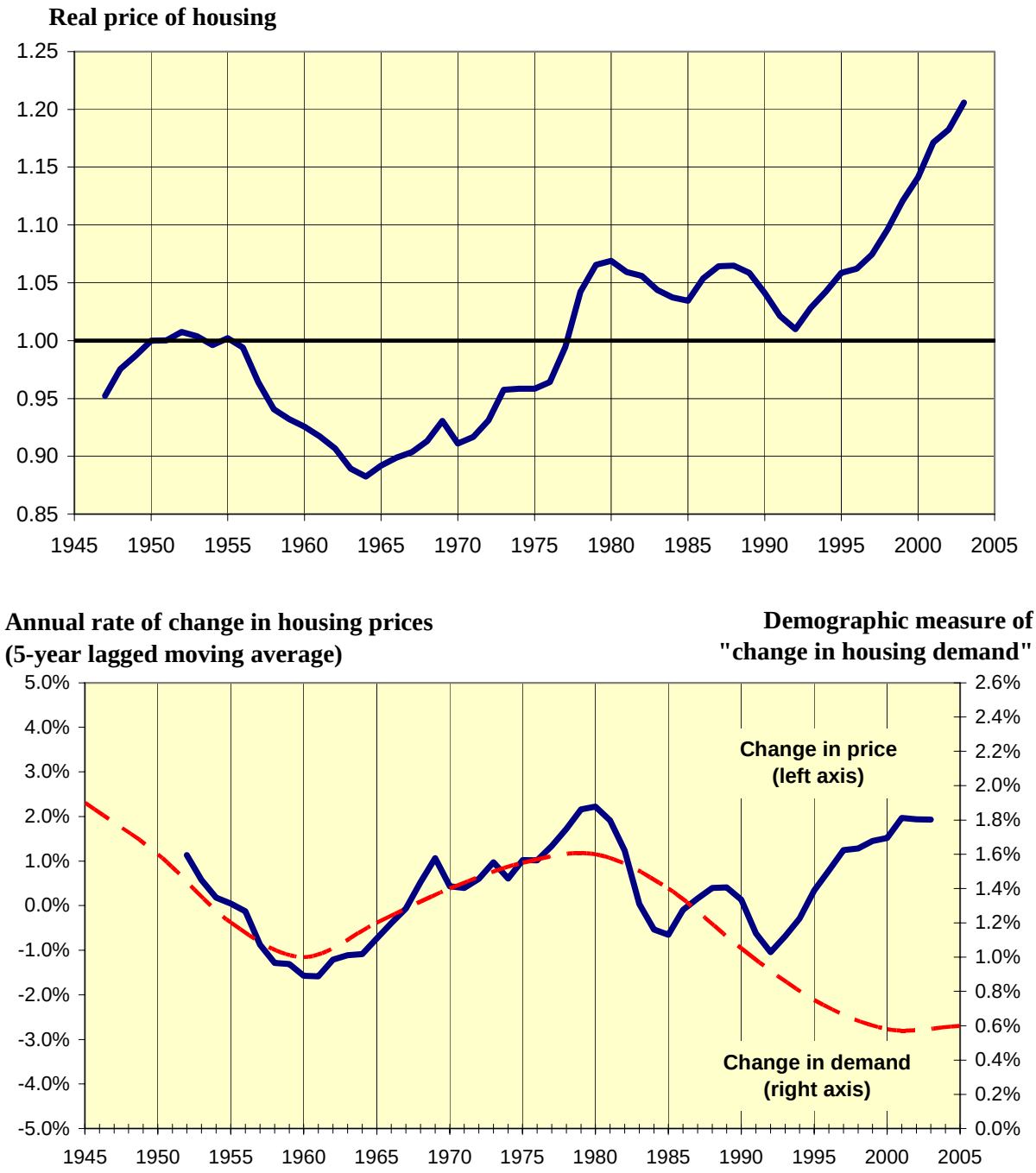
Figure 1. U.S. Saving Rates by Age Estimated with Wealth Survey and Consumption Survey Data, 1982-1985



Source: Bosworth, Burtless, and Sabelhaus (1991), Table A4. Estimates in the top panel were obtained using household income and consumption data reported in the 1982-1985 Consumer Expenditure Survey (CEX). Estimates in the bottom panel were obtained using changes in household wealth, less estimated capital gains, reported in the 1983 and 1986 Survey of Consumer Finances (SCF).

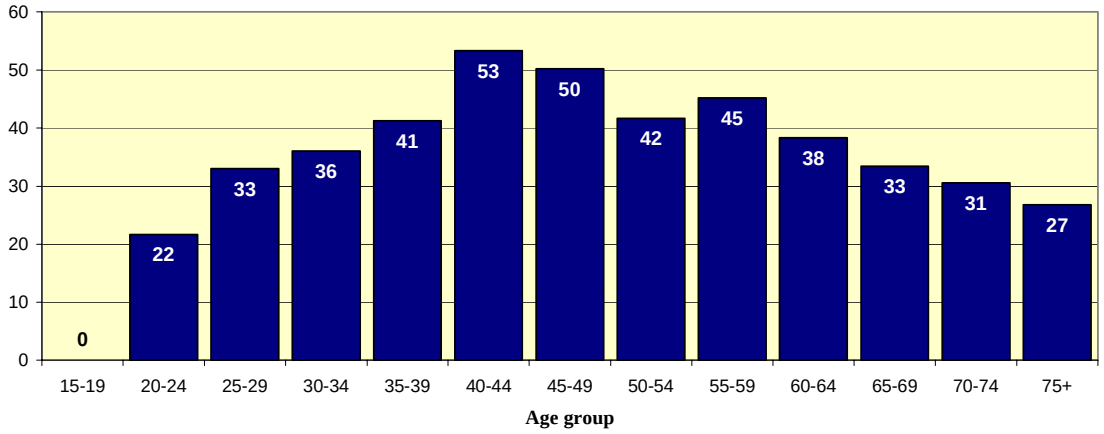
Figure 2. Relative U.S. Housing Prices and Housing Demand, 1947-2003



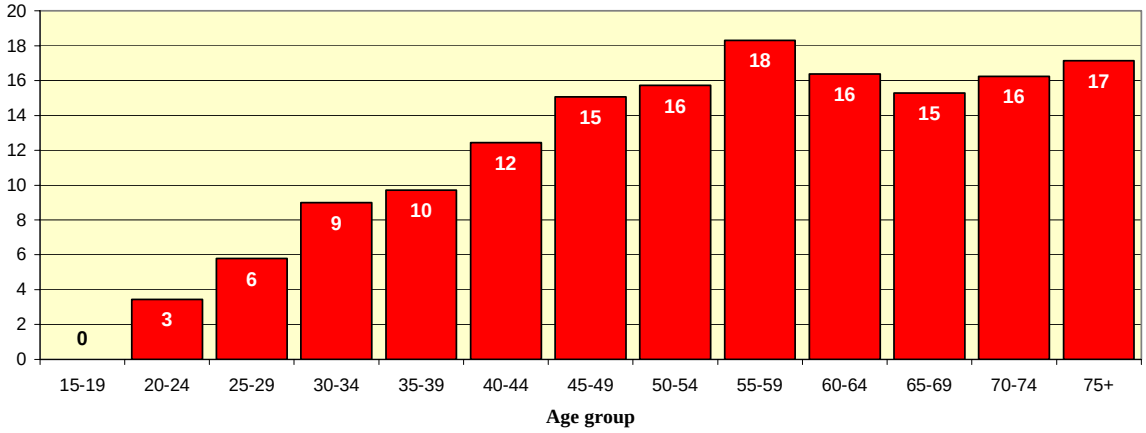
Source: Authors' tabulations based on National Income and Product Accounts (NIPA) estimates of GDP price deflator and fixed investment residential price deflator. "Change in housing demand" is from Mankiw and Weil (1989), Figure 7.

Figure 3. U.S. Common Stock and Asset Ownership by Age Group, 1983-1995

Common stocks as a percent of net financial assets



Common stocks as a percent of net worth



Net worth (1995 dollars)