Population Aging

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March 2006

Abstract

Population aging is primarily the result of past declines in fertility, which produced a decades-long period in which the ratio of dependents to working age adults was reduced. Rising old-age dependency in many countries represents the inevitable passing of this "demographic dividend." Societies use three methods to transfer resources to people in dependent age groups: government, family, and personal saving. In developed countries, families are predominant in supporting children, while government is the main source of support for the elderly. The most important means by which aging will affect aggregate output is the distortion from taxes to fund PAYGO pensions.

David_Weil@Brown.edu. This article was written for the *Palgrave Encyclopedia of Economics*, second edition. I am grateful to Jagadeesh Gokhale for helpful comments.
JEL: J10, J11, H55

Population Aging

Population Aging is the shift in the distribution of a country's population toward older ages. An increase in the population's mean or median age, a decline in the fraction of the population composed of children, or a rise in the fraction of the population that is elderly are all aspects of population aging.

Population aging is occurring in most of the world, but is most advanced in the richest countries. Among the countries currently classified by the United Nations as more developed (which had a population of 1.2 billion in 2005), the median age of the population rose from 29.0 in 1950 to 37.3 in 2000, and is forecast to rise to 45.5 by 2050 The corresponding figures for the world as a whole are 23.9 for 1950, 26.8 for 2000, and 37.8 for 2050. In Japan, one of the fastest aging countries in the world, there were 9.3 people younger than 20 for every person older than 65 in 1950. By the year 2025, the ratio is forecast to be 0.59 people younger than 20 for every person older than 65 (United Nations, 2004).

The sources of population aging lie in two demographic phenomena: rising life expectancy and declining fertility. An increase in longevity raises the average age of the population by raising the number of years that each person is old relative to number of years in which he is young. A decline in fertility increases the average age of the population by changing

the balance of people born recently (the young) to people born further in the past (the old). Of these two forces, it is declining fertility that is the dominant contributor to population aging in the world today (Weil, 1997). More specifically, it is the large decline in the total fertility rate over the last half century that is primarily responsible for the population aging that is taking place in the world's most developed countries. Because many developing countries are going through faster fertility transitions, they will experience even faster population aging than the currently developed countries in the future.

While the economic underpinnings of the demographic processes that cause population aging -- in particular declining fertility -- are interesting topics in and of themselves, this essay will instead concentrate on how aging affects the economy.

The Economic Effects of Population Aging

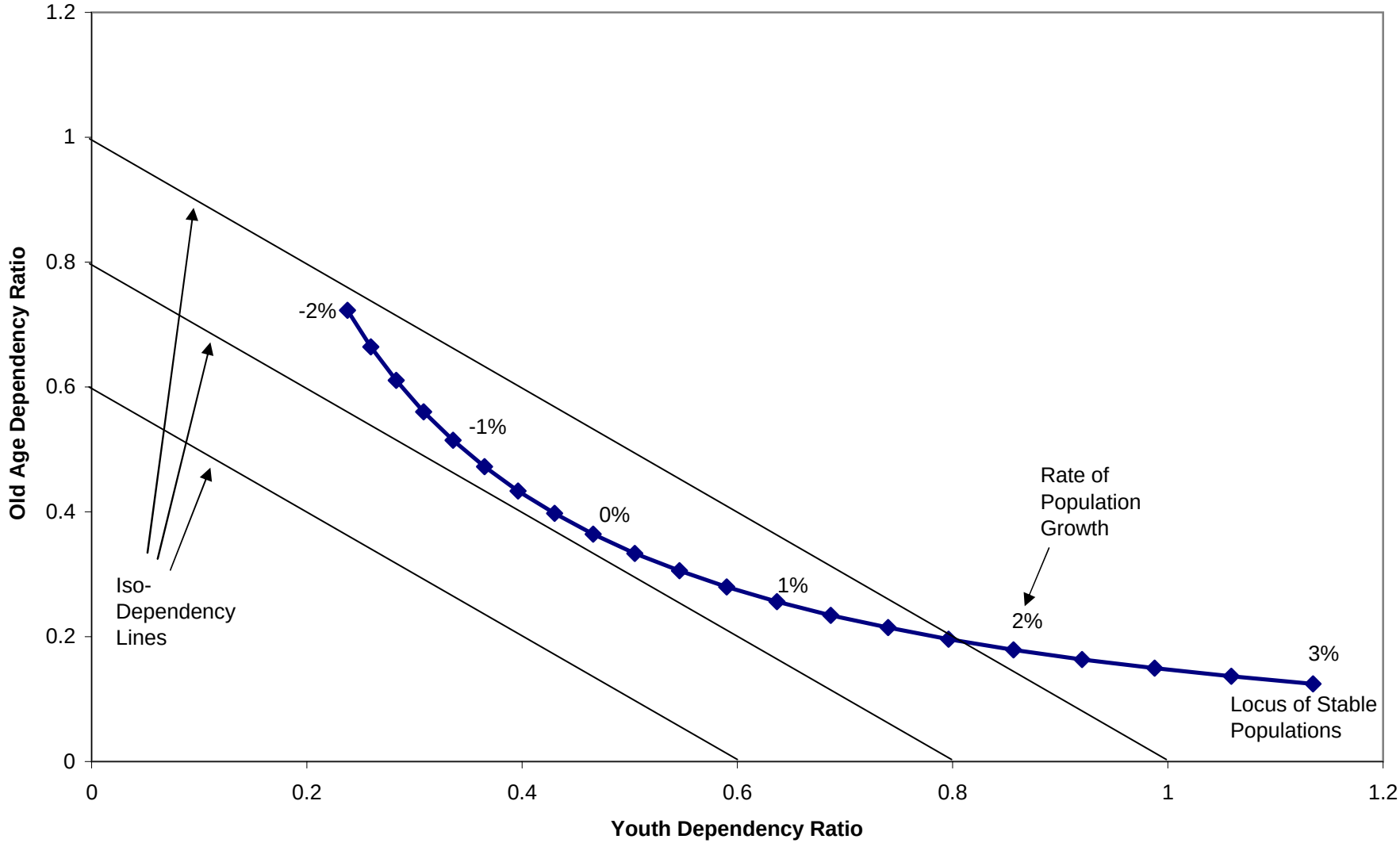
Population aging has economic effects whenever some economic interaction (the sale of a good or service, the provision of a government benefit, and so on) brings together people whose participation is a function of their age. In such a situation, a change in the relative size of two age groups will require a change in behavior by members of at least one group. For example, babies demand strollers, which are produced by working age adults. Thus a change in the ratio of babies to adults will mean more strollers per baby, fewer adults working in stroller production, or both. The changes in behavior required to restore equilibrium in the face of demographic change are induced through either prices or institutions. If individuals on at least

one side of the transaction respond elastically to price changes (as would be the case in getting working age adults to move from stroller manufacture into the wheelchair business) then the effects of population aging will be little worth commenting on. But when individuals on both sides of the interaction are not easily induced to change their behavior, the economic effects of population aging will be dramatic. Old-age pensions, child rearing, and the combining of old people's capital with young people's labor are all cases where a change in the relative numbers on either side of the equation will have important effects.

The simplest analysis of the economic effects of population aging starts with the notion of age-based dependency: people of some ages produce less than they consume, and are dependent on the rest of society for their support. Consider a division of the population into three age groups: working age adults, dependent youths, and dependent elderly. We temporarily ignore the question of how resources are transferred from working age adult to dependent children and elderly. For simplicity, we will assume that people of all ages have the same consumption, although the analysis can easily be extended to allow for age-varying consumption needs (see Weil, 1999). Finally, we assume that output is produced solely by the labor of working-age adults, with no additional factors of production such as capital.

The consumption possibilities of our idealized society can be analyzed in a diagram like Figure 1. The horizontal axis plots youth dependency ratio (population aged 0-19 divided by population aged 20-64) and the vertical axis plots the old-age dependency ratio (population aged 65+ divided by population aged 20-64). A society's demographic structure is represented by a point in this space. For example, a newly-planted colony might be represented by a point in the

Figure 1


1.2
1
0.8
0.6
0.4
0.2
0
0
0.2
0.4
0.6
0.8
1
1.2
Old Age Dependency Ratio
Youth Dependency Ratio
-2%
-1%
0%
1%
2%
3%
Rate of Population Growth
Iso-Dependency Lines
Locus of Stable Populations

lower left hand corner, with youth and old age dependency ratios of zero. For a normal society, however, the demographic processes of aging, mortality, and fertility will determine predictable movements of the age structure through the space of Figure 1. A set of points of particular interest are what demographers call stable populations. These are populations in which age-specific mortality and fertility rates have been constant for sufficient time that the relative number of people of each age are constant. Figure 1 shows a typical locus of stable populations, generated using age-specific mortality rates for the U.S. in 2000 and varying the level of fertility. The labels show the population growth rate consistent with different points on the locus of stable populations.

We can also represent in this space the effect of demographic structure on the consumption possibilities of the society through a series of iso-dependency lines. These are lines along which the sum of youth and old age dependency is constant – in other words, combinations of old-age and youth dependency that yield constant levels of consumption per capita. Iso-dependency lines closer to the origin represent age structures which allow for higher consumption per capita. The tangency between the locus of stable populations and an iso-dependency line shows the stable population with the lowest dependency ratio.

Reductions in fertility will lead to clockwise movements of the point representing a country's demographic structure through the space of Figure 1. Falling fertility reduces the youth dependency ratio immediately, and only raises the old age dependency ratio with a lag of several decades. For this reason, a country experiencing fertility transition will be able to move temporarily below the locus of stable populations.

Figure 2 shows data on population age structure for the United States, Japan, and India over the period 1950-2050. In all cases, the clockwise motion and period of temporarily low dependency due to fertility transition are visible, although the countries differ in how far along they are and how severe the process of aging is forecast to be. In Japan, the total dependency ratio (youth plus old age) will rise from 0.64 to 1.17 over the period 2005-2050, implying, *ceteris paribus*, that GDP per capita will grow 0.6 percent per year more slowly than GDP per worker. [1] By contrast, India, like many developing countries, is in the process of receiving a large "demographic dividend" from reduced fertility (Bloom and Williamson, 1998).

The lesson from this analysis of dependency is that, from the point of view of society as a whole, the period of rapid increase in old-age dependency that is in store for the world's richest countries is to a large extent simply the passing of the transitory benefit derived from a decrease in fertility. A second lesson is that any change in fertility that will in the long run undo the effects of population aging will, in the short run, lead to an *increase* in total dependency by moving the point representing age structure above and to the right of the locus of stable populations.

The model discussed above ignores the means by which dependent members of society are supported. In practice, there are three mechanisms by which this takes place: through their own past savings; through institutions (primarily the government) that transfer resources

1 See Weil (2005, ch. 5) for details of this calculation. The key equation is :
growth rate of GDP per capita = growth rate of GDP per worker + growth rate of working-age fraction of population.

Figure 2A: Demographic Dynamics in The United States

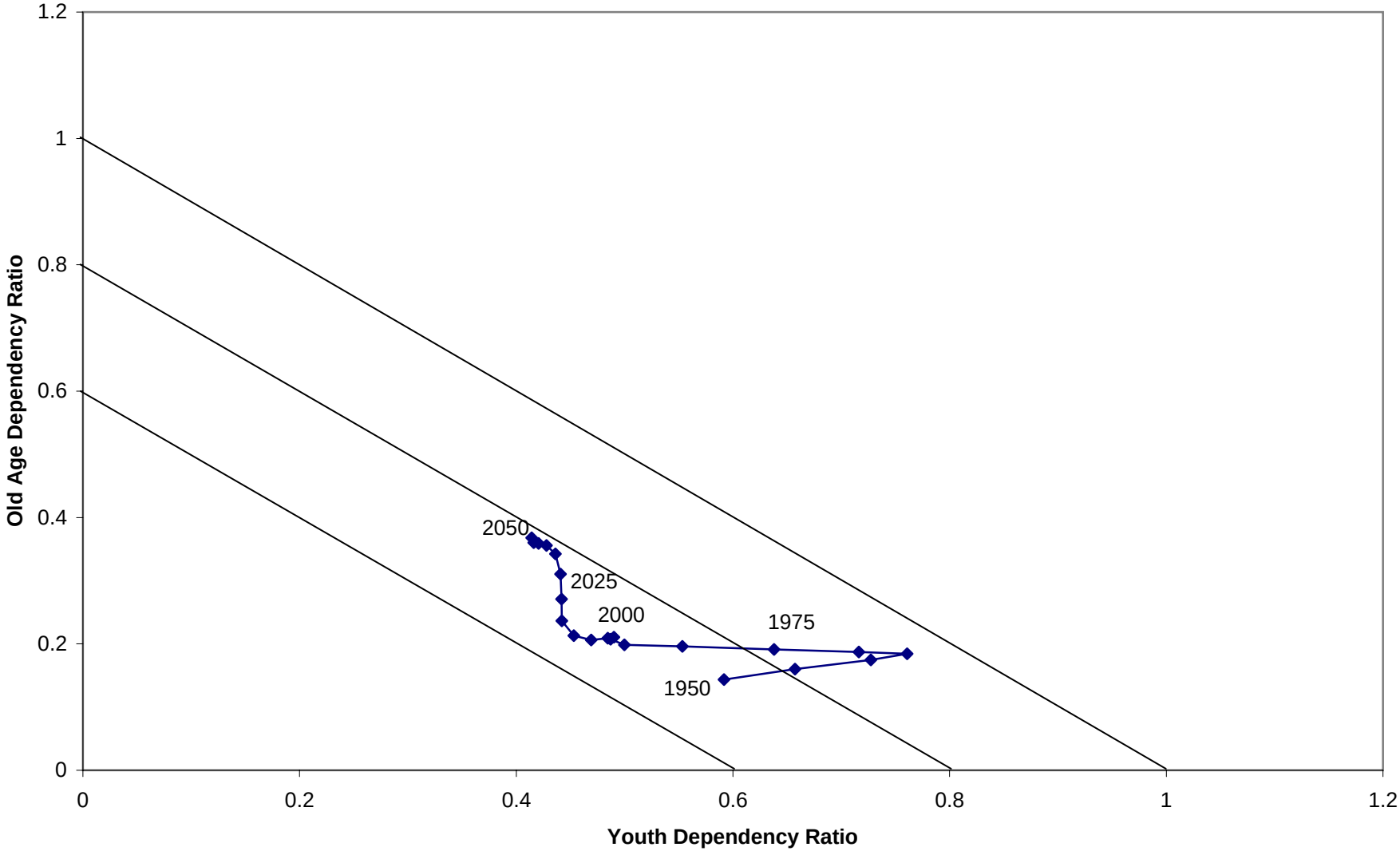


Figure 2B: Demographic Dynamics in Japan

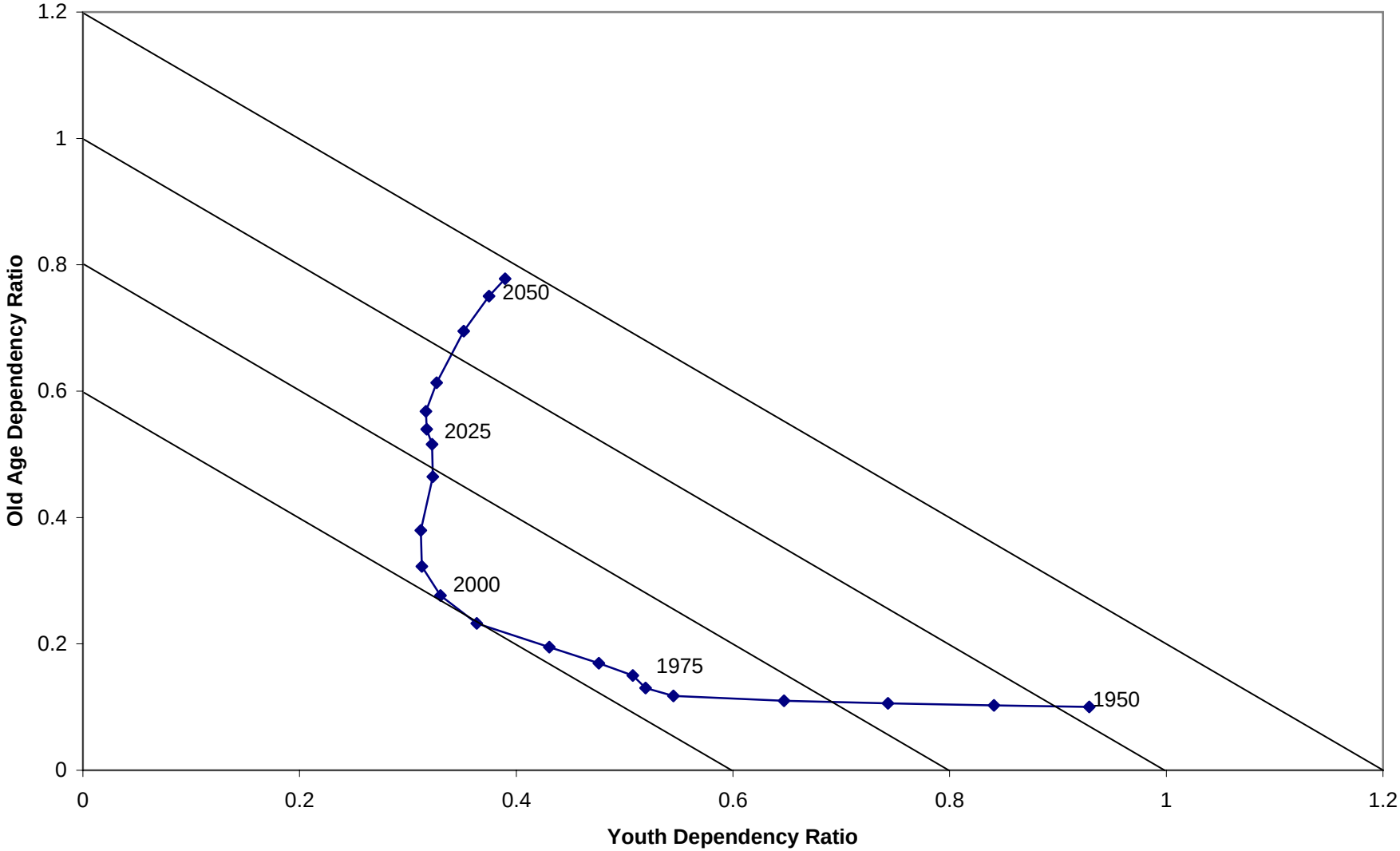
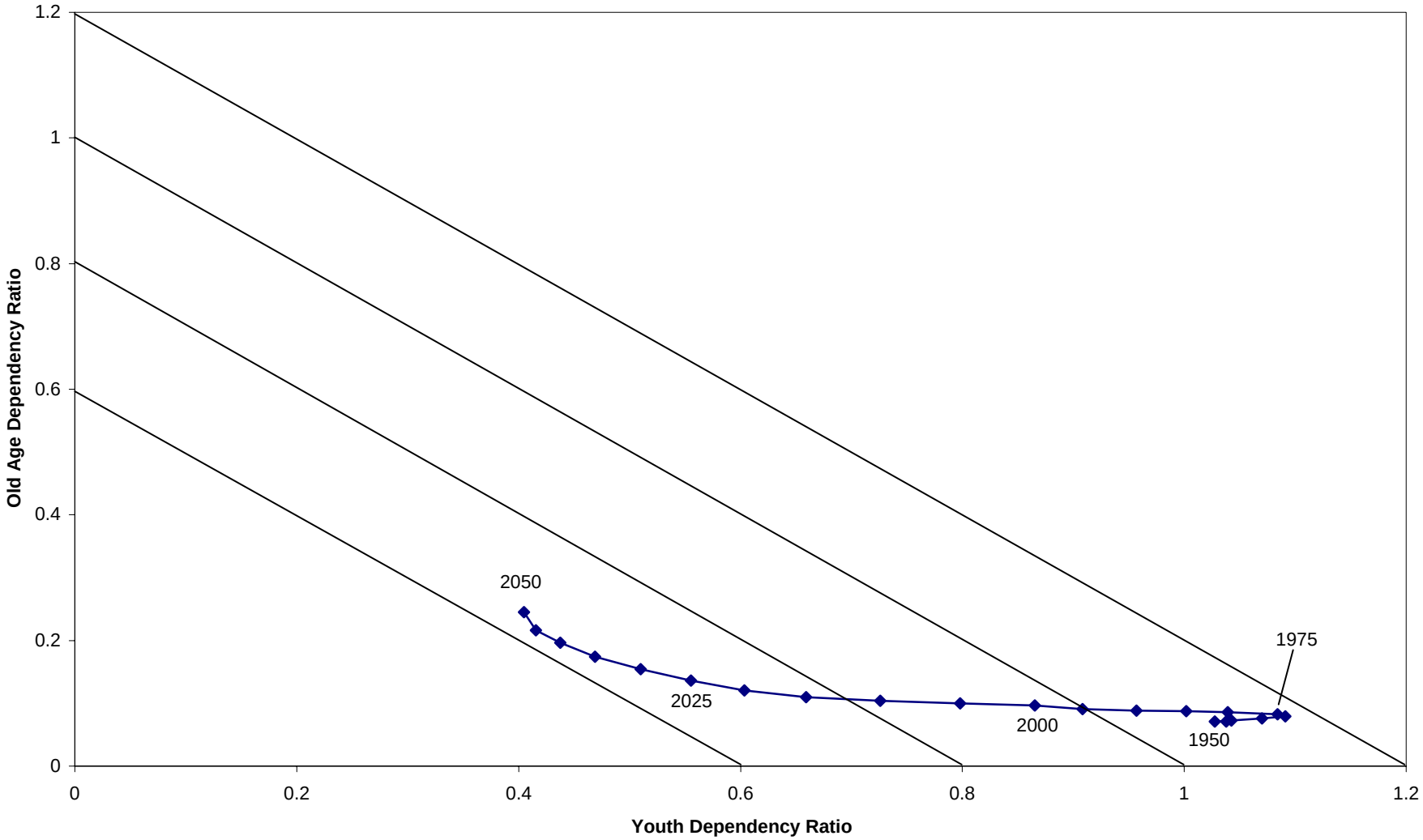


Figure 2C: Demographic Dymamics in India



between unrelated people of different ages; and through their own families. Lee (2000) refers to these various means by which resources are transferred among age groups as a "reallocation system." We shall see that the nature of the reallocation system affects the overall burden of aging as well as the distribution of that burden.

Aging, Savings, and Capital

Capital is important in analyses of population aging for two reasons. First, accumulation of capital allows either individuals or society as a whole to break the temporal link between production and consumption: an individual, for example, can save some of her wages when she is working, and then use the accumulated capital to fund consumption during retirement. Second, as a factor of production complementary to labor, capital helps determine the quantity of output to be divided among workers and dependents. Analyses of aging and capital accumulation proceed down both normative and positive channels.

The normative approach asks how society should respond to a looming change in demographics. Although there is in practice no social planner who makes saving decisions for society as a whole, the solution to the social planner's problem can inform the response of a government that influences national saving through fiscal policy and tax incentives. Common sense would suggest that a country that is undergoing population aging should "save for its old age," that is, accumulate extra capital during the period of low dependency in order to maintain a smooth path of consumption into the period of high dependency. As stressed by Cutler *et al*. (1990), however, there is a countervailing effect: population aging due to lower fertility implies

that the working age population will grow more slowly, reducing the amount of investment required to supply new workers with capital. The flip side of this decrease in required investment is that if a country did attempt to save sufficient capital to smooth consumption in the face of aging, the result would be a rise in the capital/labor ratio, lowering the return on capital, which would lead households (or a social planner) to want to raise consumption. Elmendorf and Sheiner (2000) calculate that an optimizing social planner would want to make relatively small changes in saving rates in response to the population aging currently forecast in the United States.

A positive alternative to the social planner approach is to consider the equilibrium of an economy in which consumers make privately optimal saving decisions taking as given the expected paths of interest rates and wages as well as taxes and government benefits. Forecasting the effects of demographic change on output or capital per worker, interest rates, etc. requires a fully articulated, rational expectations general equilibrium model. Kotlifoff, Smetters, and Walliser (2001), use such a model to analyze demographic change in the United States, under the assumption that the Social Security benefit regime does not change, and that payroll taxes adjust accordingly. They find that the capital deepening that would normally accompany a shift of the population into its peak asset holding years is undone by rising payroll taxes. They forecast "capital shallowing" that will raise the real return on capital by one percentage point by 2030 and a further two percentage points over the rest of the 21st century, as well as a dramatic slowing of real wage growth.

Rather than fitting an optimizing model of saving, another approach is to look

empirically at the age pattern of actual behavior. Poterba (2005) shows that individual net worth follows a hump-shaped path over the course of the lifetime, peaking between ages 65 and 69. Unlike the classical life cycle model, however, the decline in average net worth is relatively slow, so that average net worth at death is significant. This life cycle pattern of asset accumulation in turn implies that shifts in demography will shift asset demands, and potentially asset prices. In particular, the movement of the baby boom generation into its high accumulation years was widely cited as a potential explanation for the run-up in stock prices during the last decades of the 20th century (Abel, 2003). Similarly, some analysts have suggested that as the balance between age groups actively accumulating and deccumulating wealth shifts in the period after 2010, there will be a corresponding meltdown of asset prices. However, Poterba (2005) finds little evidence of demographic effects on asset returns in time series data from the United States, Canada, and the United Kingdom. Lim and Weil (2003) show that in a forward-looking asset pricing model, it would require an unreasonably large adjustment cost for capital to produce a large asset price meltdown in response to projected population aging. The shift in population toward the elderly will also lead to a significant increase in the flow of bequests relative to either income or wealth of the younger generation; Weil (1994) argues that this increased flow of bequests will reduce the saving of the receiving generation.

The above discussion implicitly considered the case of an economy closed to international capital flows. In an open economy, the mismatch between the demographically induced demand for asset holding and the capital requirements of the labor force can be channeled into capital flows abroad. For example, a country like India, where the working age population is forecast to grow an annual rate of 1.8% per year between 2000 and 2025, would be

a natural recipient of investment from Japan, where the working age population will shrink at an annual rate of 0.6% per year over this period. In practice, however, net financial flows among countries tend to be far smaller than a model of perfectly open capital markets would imply, and movements in current accounts seem to bear little resemblance to those predicted by demographic change (see Brooks, 2003).

Aging and Government

In the developed countries that are aging most rapidly, government transfer programs are a major source of support for dependent elderly. In Germany, for example, transfers net of taxes and inclusive of public health benefits make up 65% of the income of people aged 65 and older (Burtless, 2006). Correspondingly, one of the most important functions of government is transferring resources to elderly people. In 2005, U.S. federal outlays were 18.9% of GDP. Almost 60 percent of that amount was spent on direct transfers attributable to specific age groups (Medicare for the elderly, unemployment insurance for working age, and so on). Of such transfers, 58 percent (6.5% of GDP) were directed toward those aged 65 and older. On a per-person basis, the elderly received close to $8 in direct transfers for every dollar of transfers received by working-aged persons. In sharp contrast, children received just 35 cents per dollar of transfers awarded to workers. Assuming constant transfers per person by age group, a shift of 10% of the population out of the workforce and into retirement would increase federal transfer outlays by 4.7% of GDP (calculations based on data underlying Gokhale and Smetters, forthcoming). In addition to raising spending, population aging also reduces government

revenue. Putting these tax and spending effects together, Burtless (2006) calculates that the effect of population aging would raise the tax rate required to pay for government transfers on a PAYGO basis in from 16% in 2000 to 21% in 2030 in the US. In Germany, where transfers are larger and aging more extreme, the increase in the tax rate would be from 28% to 40%. In the United States, the effect of aging on the government budget is greatly exacerbated by the fact that the *price* of health care for the elderly is rising at the same time as the fraction of the population that is elderly (Elmendorf and Sheiner, 2000).

One important way in which transfers to dependents (either children or elderly) that are channeled through the government differ from those mediated by either the family or through ones own saving is in how workers perceive the benefits resulting from their forgone consumption. People give money and other resources to their children or aged parents because they care about them. And when people save for their own old age, it is because they care about their future selves. But few people are so altruistic that they value the taxes that are taken from their paychecks in order to fund transfers to the elderly. For this reason, there is an efficiency loss associated with government support of the elderly that is not present for other forms of transfers to dependent age groups. Prescott (2002) argues that differences in marginal labor tax rates explain large cross sectional differences and changes over time in labor supply among the G-7 countries. For example, in the early 1990s, his calculations show the French average marginal tax rate (inclusive of consumption taxes) being 48% percent larger than that in the US; correspondingly, French adults aged 15-64 worked only 68% as many hours as their US counterparts. The large elasticity of labor supply that Prescott estimates implies that deadweight losses will increase dramatically as populations age, as long as government old-age pensions

continue to be funded through taxes that are largely divorced from the benefits that the individuals paying them will receive. Thus an economy that could function smoothly with a high level of youth dependency funded through family transfers, or a high level of old-age dependency funded through savings, might collapse if a similar level of old-age dependency were funded through taxes.

Because government transfers are so heavily weighted toward the elderly, the adjustment in government finances that will be required to deal with population aging will be proportionally much larger than the overall change in consumption in the economy as a whole. Roughly put, aging is a much bigger problem for the government than for the economy as a whole. Most conceivable reforms in government old-age pensions will represent net losses to cohorts who are near or beyond retirement at the time of reform. Bohn (2005) calculates that, based on current participation rates, the fraction of voters aged 65 and over in the United States will rise from 19.8% to 30.5% between 2003 and 2030; over the same period the age of the median voter will rise from 47 to 52. Thus as the fiscal strain from population aging becomes acute it will be increasingly difficult for policy makers to solve their problems by reducing transfers to the elderly

Aging and Families

Transfers within families represent the final channel by which dependents are supported. For the large majority of old people in developed countries, family transfers are the second or

third most important source of support, behind their own past savings and/or transfers from the government. This is a relatively new pattern. Prior to the 20th century, the period of old-age dependency was much shorter, government transfers to the elderly were minimal, and cohabitation of elderly with their children was the norm. In the United States, for example, the fraction of elderly widows who lived with their adult children fell from 67% in 1920 to 20% in 1990 (McGarry and Schoeni, 2000). Only 2.7% of people aged 60 and over in the United States reported support from children as their main source of income in 2001. Even in Japan, where such transfers have traditionally played a much larger role, the fraction of people 60 and over reporting their children as their main source of support fell from 29.8% to 12.0% between 1981 and 2001 (United Nations, 2005, Table I.2). In contrast to the elderly, the burden of supporting young dependents lies foremost on their own families. Mason *et al.* (2005) calculate that 57% of consumption of people under 20 in the United States in 2000 was financed by transfers from family members. Thus, unlike governments, families headed by working age adults find their budget constraints relaxed by the low fertility that causes population aging.

An important distinction between support for elderly dependents and support for child dependents regards the degree of choice that those doing the support have. Working age adults cannot choose how many siblings they share the burden of supporting their parents with, much less the size of the working age cohort relative to the elderly population, which determines the level of taxation required to fund public pensions. But working age adults *can* choose the number of children they produce and support, and their choices about fertility may respond to economic conditions. Of particular interest in the present context, population aging itself may feed back to affect fertility. The best known mechanism by which population age structure

affects fertility was identified by Easterlin (1987), who hypothesized that members of large birth cohorts would suffer from labor market crowding, earn wages that are low relative to the standard of living that they had grown up with, and would adjust fertility downward to partially restore their standard of living. The rise in taxes required to fund transfers to the elderly that will result from population aging could have effects on after tax income that are as large or larger than those from Easterlin-style generational crowding, and thus aging could lead to lower fertility and, down the road, even more aging (Hock and Weil, 2006).

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