*First draft*

# Does Population Aging Represent a Crisis for Rich Societies?

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# Does Population Aging Represent a Crisis for Rich Societies?

A common view among policymakers is that population aging represents a crisis for industrialized countries. Because pensions and old age health insurance are largely funded out of public budgets, increases in the percentage of the population past retirement age must eventually cause steep increases in the fraction of government budgets devoted to old age consumption and a rise in the level of public spending. According to one view, either taxes or government debt will be pushed to unsustainable levels unless public programs are significantly reformed to curtail retirement benefits.

This way of viewing the problem of population aging is highly misleading because it treats aging within the narrow perspective of government budgets. In the United States, the perspective is often even more distorted, because many analysts focus solely on aging's impact on the federal budget. Yet population aging also has notable impacts on state and local budgets and an even bigger impact on private household spending. Some of these impacts represent offsets to the effect of aging on federal government budgets.

Population aging is the result of two developments, lower birth rates and longer life spans. Holding constant the mortality rate, lower fertility inevitably raises the fraction of the population past any given age, including the retirement age. However, it also reduces the percentage of the population below a given age, such as age 20. Both the old and the young are dependent populations that derive most of their support from the current output of active workers. Rich societies finance much of the consumption of the aged through public retirement programs, while most (though not all) of the consumption of the dependent young is financed out of private household budgets. Young labor force entrants also require public and private investments to equip them to earn as much as average members of the working-age population. Lower fertility reduces spending requirements for the young, a fact missed when observers focus narrowly on the budgets of government old age programs. The apparent crisis connected with population aging is partly an illusion stemming from a narrow focus on the spending needs of a handful of public programs. If the full span of private as well as public burdens is taken into account, the increase in the dependency burden appears much more modest.

Longer average life spans also increase the percentage of the population past a given age. If people value longer lives, this development unambiguously makes the population better off, regardless of whether it increases the percentage of lifetime income that must be devoted to consumption past the age of 65. If population aging represents a genuine crisis for present or future generations, it must be the case that those generations will suffer a loss in lifetime net income, possibly as a result of excess net contributions to support younger or older generations. The paper will attempt to show the circumstances under which this outcome could occur.

## The Burden of an Aging Population

The population of the United States, like that of all industrialized countries, is growing older. Between 1950 and 2000 the percentage of the U.S. population past age 65 increased by half, rising from 8.1 percent to 12.4 percent of the total population (Table 1). The Census Bureau predicts that Americans who are at least 65 years old will constitute more than one-fifth of the population by 2050. The increasing share of the aged in the population will place strains on the federal budget because the elderly finance much of their consumption with transfers from the federal government. The actuaries of the Social Security and Medicare programs make regular forecasts of the long-term spending needs of the two programs. Their mid-range forecasts published in 2001 suggest that combined outlays on the Social Security and Medicare programs will climb inexorably over the next 50 years, increasing from 6.4 percent of GDP in 2000 to 12.5 percent of GDP in 2050. Part of the predicted increase in spending is attributable to factors other than population aging.[1] Nonetheless, the rising share of the aged in the population will inevitably boost outlays on transfer programs in which eligibility and annual spending are closely linked to an applicant's age.

Partly offsetting higher spending needs for the dependent old is the shrinking need to furnish support to the dependent young. Some of this burden is financed through public budgets, primarily as spending on the nation's schools and universities. Government spending on education represented 5.1 percent of U.S. GDP in 2000, about one-half percentage point less than spending in 1975, when the fraction of the population between ages 5 and 24 was near a post-war high. Little of the budgetary saving after 1975 is reflected in federal outlays, because an overwhelming share of public spending on education is financed by state and local governments. Public support for the dependent young is much less important than support received through private household budgets, however. Most consumption of the young is financed out of the earned incomes of parents and other older relatives. If working age adults do not support as many children, their earned incomes can obviously sustain a higher level of consumption for themselves.

One way to measure the burden imposed by young and old dependents is to calculate the ratio of young and old to the number of working age adults. The Social Security Actuary has performed this calculation under the assumption that the working age population is between 20 and 64 years old. The Actuary's calculations imply that the peak dependency rate after World War II was attained in 1965, when there were 95 Americans under age 20 and past age 64 for every 100 adults between 20 and 64 years old. The 1965 dependency ratio was substantially higher than the ratio predicted for 2050, when the dependency ratio is expected to reach 80. On the other hand, the total dependency ratio in 2050 will be substantially higher than today's rate, which is 49. The youth dependency rate has fallen sharply since 1965 mainly because the fertility rate has declined. In the future, working age adults will support substantially more dependents than they do today, but fewer than they did in 1965. The crisis of supporting a large future dependent population will evidently involve a smaller burden than was borne by working age adults in the 1960s.

The Actuary's measure of the dependency burden implicitly assumes the cost of supporting an aged person is equal to that of supporting a person under age 20. If the aged have greater consumption needs than children, the future increase in dependency burdens is understated by the Actuary's calculations. Suppose an average child consumes $\alpha$ times the average adult's consumption, where $0 < \alpha < 1$. If aggregate output is $Y$, then the average consumption of an adult is

$$(1) \qquad C = \frac{Y}{\alpha \sum_{a=0}^{19} P_a + \sum_{a=20}^{89} P_a}$$

where $P_a$ is the population in age group $a$ and people aged 20 through 89 are assumed to be adults. The standard dependency measure implicitly assumes that all working-age adults are contributing to the support of the dependent young and old, whereas in fact labor force participation rates are considerably below 100 percent, even among adults who are in the middle of their potential work careers (see Table 1). If the fraction of the population that works at each age, $a$, is $\lambda_a$ and the longest lived person dies on his 90th birthday, then output is

$$(2) \qquad Y = W \sum_{a=0}^{89} \lambda_a P_a ,$$

where $W$ is the economy-wide average wage.[2]

Suppose that all adults share equally in consumption, while all children receive identical consumption allotments equal to $\alpha$ times the adult share. This distribution scheme requires each worker to give up part of his output to support dependents, that is, nonworking members of the adult and child populations. The portion of the wage that each worker must sacrifice, $\tau$, is one measure of the burden that aged and youth dependents impose on active workers:

$$(3) \qquad \tau_{Total} = \frac{W-C}{W} = \frac{\sum_{0}^{19}(\alpha-\lambda_a)P_a + \sum_{20}^{89}(1-\lambda_a)P_a}{\alpha\sum_{0}^{19}P_a + \sum_{20}^{89}P_a}.$$

The dependency burden can be further divided into the portions that are due to the young ($a$ = 0,20), nonaged adults ($a$ = 20,64) and the old ($a$ = 65,89):

$$(4a) \qquad \tau_{Young} = \frac{\sum_{0}^{19}(\alpha-\lambda_a)P_a}{\alpha\sum_{0}^{19}P_a + \sum_{20}^{89}P_a} ;$$

$$(4b) \qquad \tau_{Nonaged\ adults} = \frac{\sum_{20}^{64}(1-\lambda_a)P_a}{\alpha\sum_{0}^{19}P_a + \sum_{20}^{89}P_a} ; \quad \text{and}$$

$$(4c) \qquad \tau_{Elderly} = \frac{\sum_{65}^{89}(1-\lambda_a)P_a}{\alpha\sum_{0}^{19}P_a + \sum_{20}^{89}P_a}.$$

The intuition behind this measure of the dependency burden is straightforward. To the extent that the labor force participation rate of children falls below $\alpha$ or the labor force participation rate of adults falls below 100 percent, members of the age group will require greater support from the working population. The dependency burden rises along with the percentage of the population in age groups that have low labor force participation rates. It falls when these groups shrink as a percentage of the total population.

Cutler et al. (1990) estimate that the educational spending and consumption requirements of a child represent 72 percent of the consumption requirements of an adult, implying that $\alpha$ = 0.72. Using this estimate of $\alpha$ and information on the age structure and labor force participation rates in selected years, it is possible to construct estimates of the dependency burden imposed by nonworkers. Table 2 shows estimates of the U.S. dependency burden and its components in selected years between 1950 and 2050. Columns 1 through 3 display estimates of the 1950-2000 dependency burden under the assumption that age-specific labor force participation rates remained unchanged at their 1950 levels (see right-hand columns in Table 1). Entries in these columns show, as expected, that the youth dependency burden rose between 1950 and 1965 and then fell sharply. The burden imposed by elderly dependents rose over the full 1950-2000 period, but by less than the youth dependency rate declined. Consequently, the overall dependency burden was smaller in 2000 than it was in either 1950 or 1965.

Columns 4 through 6 show the 1965-2050 trend in dependency burdens under the assumption that the age-specific labor force participation rate observed in 2000 will remain in effect throughout the period. The entries in these columns show a steep drop in the youth dependency burden between 1965 and 2000 and a continued though more modest decline through 2050. Because the old-age dependency burden will climb much faster after 2000 than the youth dependency burden will fall, the overall dependency burden will rise almost 6 percentage points between 2000 and 2050. In spite of this rise, however, the overall dependency burden in 2050 will be only slightly higher than the one borne by American workers in 1965.

The trends just described are based on the assumption that participation rates remain unchanged. In fact, participation rates have varied significantly over the past half century. Female participation rates increased after 1950, and male participation rates fell, especially at older ages. The trend in female participation has produced the bigger impact on overall activity rates. Age-specific participation rates increased for Americans between ages 15 and 59 and declined for people past age 60. To see the impact of changing activity rates on dependency burdens, compare columns 3 and 5 in Table 2. If 1950 activity rates had remained unchanged, the overall dependency burden would have been virtually the same in 2000 as it was in 1950. Because labor force participation rates increased after 1950, the actual dependency rate fell more than one-fifth, declining to less than 44 percent. Almost all of the decline was due to a sharp drop in the burden of supporting nonworking nonelderly adults. Because the participation rate of working-age adults increased, the dependency burden of supporting nonworking prime-age adults shrank by almost half. The drop in participation rates among the aged slightly increased the burden of supporting the dependent elderly, but this effect was swamped by the impact of rising activity rates among nonelderly adults. If participation rates remain unchanged between now and 2050, the overall dependency burden in 2050 will remain well below levels observed in the 1950s and 1960s. Based on trends of the past couple of decades, it seems likely U.S. participation rates will continue to rise, although much more slowly than they did between 1950 and 2000. If participation rates continue to inch up, the future rise in the dependency burden will be smaller than implied in Table 2.

## Impact of Reduced Fertility and Mortality

At any given time, the population age structure is a complex product of past fertility, mortality, and migration patterns. As fertility and mortality rates change, the age structure will also vary, affecting dependency burdens. Most people who worry about the future burden of old-age dependency recognize it is the result of lower birth rates and longer life expectancy. I now consider the impact of reduced fertility and lower mortality on the dependency burden in the context of an initially constant population age structure. Such a structure would emerge after a sufficiently long period in which the age-specific fertility and mortality rates remain constant. To make the calculations meaningful, I begin by calculating the constant age structure that would emerge if the fertility rate and age-specific mortality rates of 1950 had remained unchanged for an indefinite period. Age-specific mortality rates for 1950 are displayed in the fourth column of Table 1. The total fertility rate between 1942 and 1965 averaged about 3.15. Had the 1950 fertility and mortality rates remained constant over an indefinite period, the ultimate population growth rate would have been slightly faster than 1.1 percent a year.[3] Using labor force participation rates observed in 1950, we can calculate the dependency burden associated with this constant age structure. The total dependency burden was 58 percent of workers' wages, consisting of $\tau_{Young}$ = 27 percent, $\tau_{Nonaged\ adults}$ = 24 percent, and $\tau_{Aged\ adults}$ = 7 percent.

*Changes in fertility.* Figure 1 shows how the dependency rate is affected if fertility falls after 1950. The solid line shows the trend in the total dependency burden if the total fertility rate drops from 3.15 to 2.06, which has been the average U.S. fertility rate since 1990. At mortality rates prevailing in 1950, a total fertility rate of 2.06 would eventually produce very slow declines in population. The broken line shows the dependency burden if the total fertility rate drops to 1.3, the approximate fertility rate of low-fertility-rate countries in the OECD. In the absence of immigration, this reproduction rate will eventually generate large and sustained declines in population. The ultimate rate of population decline is 1.4 percent per year, a rate of decline which would cut population size in half every 50 years.

Under either scenario, the immediate impact of a fertility decline is to reduce the dependency burden. Since the number of dependent young in the population falls sharply, the burden of supporting them must initially decline. Eventually, lower fertility will be reflected in slower rates of growth in the work force and higher required levels of support for the dependent elderly, who will represent a growing fraction of a shrinking population. Under the assumptions of this exercise, however, the extra dependency burden to support the aged and other nonworking adults will never be as large as the reduced dependency burden arising from a smaller number of dependent youths. The total dependency burden is ultimately lower when the fertility rate is 2.06 or 1.3 than it is when the fertility rate is 3.15. This fact will bring little comfort to a worker who focuses solely on the tax she must pay to support the retired elderly. The old-age dependency burden increases from 7 percent in 1950 to an ultimate rate of 12 percent when the fertility rate falls from 3.15 to 2.06. It rises to an ultimate rate of 18 percent when the fertility rate falls to 1.3. Nonetheless, the heavier burden of supporting a larger aged population is more than offset by the lighter burden of supporting a smaller number of children.

This basic finding is obviously affected by the assumptions of the exercise. Of special importance is the assumed value of $\alpha$, the ratio of child to adult consumption requirements. If $\alpha$ were assumed to be 0.38 instead of 0.72, the ultimate dependency burden associated with a fertility rate of 2.06 would be identical to the burden associated with a fertility rate of 3.15. With either fertility rate, the ultimate dependency burden represents 51 percent of a worker's gross wage.[4] Thus, if children's consumption requirements are small relative to those of adults, a substantial drop in the fertility rate is likely to result in a long-term increase in dependency burdens. Even in this case, however, the shrinking need to provide for the consumption needs of children will substantially offset the effects of a lower fertility rate on old-age dependency burdens.

*Longer life spans.* A second factor boosting old-age dependency is lengthening life spans. Age-specific mortality rates have declined substantially over the past half century, increasing life expectancy at birth by almost eight years. The trend has directly contributed to human happiness, regardless of its effect on workers' burden in supporting others or providing for their own old age. Figure 2 shows the impact of lower mortality rates on the total dependency burden. All of the calculations are based on an initial population that has the stable age structure implied by age-specific mortality and fertility rates observed in 1950. The solid line in the chart shows how the dependency burden is affected by a steady decline in age-specific mortality rates, holding constant the 1950 birth rate. To estimate the impact of longer life expectancy, I assume the decline in age-specific mortality rates mirrors the changes actually observed between 1950 and 2000 (see columns 4 and 5 in Table 1). For example, the mortality rate of persons between 65 and 69 fell 38 percent between 1950 and 2000. To calculate the annual rate of decline in mortality rates of 65-to-69 year-olds, I assume this rate of decline persists over the full period from 1950 to 2150, with the mortality rate of 65-to-69 year-olds falling 38 percent every 50 years.

This rate of mortality decline produces a major boost in average life spans. Age expectancy at birth in 1950 was 68 years. Under the assumptions of this exercise, the average life span of a person born in 2065 will be 84 years, adding almost one-quarter to the length of a typical life.[5] Perhaps surprisingly, this extension in life spans adds significantly to the number of years a person can be expected to work, even if the age-specific labor force participation rates of 1950 remain unchanged. Based on 1950 activity rates, a person facing the mortality rates in the 1950 life table would be expected to work for a total 28 years over an average life span. A person facing 2000 mortality rates would be expected to work for a total of 30 years, an increase in work years of about 8 percent. While this is less than the proportional increase in life spans implied by improvements in mortality between 1950 and 2000, it is large enough to offset much of the increase in old-age dependency burdens. A common view of life span improvements is that they add to the length of life after retirement, increasing the size of the population which requires support. Many deaths occur well before normal retirement age, however. To the extent that these deaths are postponed, the affected individuals can contribute for a longer period to their own support and the support of others. A child who dies before reaching adulthood contributes only trivially toward its own lifetime support. If its death is postponed for thirty years, its contribution toward its own self support increases dramatically.

To determine the effects of faster mortality improvements, I calculated the dependency burden when death rates decline twice as fast as the observed rate of improvement between 1950 and 2000. Under this assumption, the mortality rate of 65-to-69 year-olds falls 38 percent every 25 years. The dependency burden under this alternative assumption is reflected by the top broken line in Figure 2.

Under either assumption regarding the decline in mortality rates, the total dependency burden increases steadily but rather slowly after 1950. If mortality improves at the pace observed between 1950 and 2000 and labor force participation rates remain unchanged, the total dependency burden will increase from 57.7 percent in 1950 to 58.4 percent in 2000, to 59.0 percent in 2050, and to 59.8 percent in 2150. More rapid mortality improvement would increase dependency burdens faster, but even if mortality rates fall at twice the rate experienced in the past 50 years the total dependency burden will climb just 2.0 percentage points between 1950 and 2050. The increase will be more rapid if children require less support than assumed here, but it will be much less rapid if labor force participation rates of adults between 20 and 59 continue to rise.

*Combined impact.* The lowest line in Figure 2 shows the combined impact of a lower fertility rate and reduced mortality. It depicts the time pattern of dependency burdens if the total fertility rate falls from 3.15 to 2.06 in 1950 and age-specific mortality rates begin to decline at the same rate as actually observed during the 1950-2000 period. Under these assumptions, the total dependency burden falls sharply through 1965 and then trends upward, returning to its 1950 level by 2015 and gradually rising in a cyclical pattern over the following decades. In 2050 the dependency burden claims one-half percentage point more of wages than was the case in 1950, and by 2150 the burden is 1.6 percentage points higher than it was in 1950. The perceived "crisis" in supporting future dependents may nonetheless look serious in 1965. By that year workers have already benefited from a sharp drop in the burden of providing for children but they still face big future increases in the cost of supporting a larger aged population.

Even small increases in dependency burdens can look daunting if the gross wage remains constant or grows slowly. Figure 3 shows the trend in workers' net wages after subtracting support contributions to the dependent population. (Net compensation is measured in logarithms to make it easier to detect changes in the rate of growth.) The lower broken line in the figure shows the net wage after subtractions of the dependency burden for all nonworking members of the population, including children and prime-age adults as well as the elderly. The top broken line shows the net wage after subtracting the dependency burden solely for the dependent elderly. The light solid lines indicate the trend in net wages that would result if there were no demographic shock in 1950. These lines simply show the underlying rate of growth in gross wage rates, because dependency burdens do not change under a stable age structure.

In performing the calculations, I assume gross wages increase 0.4 percent a year. This is less than one-quarter the actual rate of U.S. wage growth between 1950 and 2000.[6] Even with this very conservative assumption regarding annual wage growth, net wages usually rise from year to year, though the rate of increase is sometimes extremely slow. The lower line in Figure 3 suggests that the initial impact of the demographic shock is to allow workers to enjoy faster net wage growth. Net wages climb faster than the gross wage between 1950 and 1965, because active workers support a shrinking number of child dependents. However, net wage growth slows dramatically after 1965. By 2040 workers obtain the same net wage as they would have received without a demographic shock in 1950. In years after 2040, the net wage grows 0.07 percent per year more slowly than would have been the case in the absence of the demographic shock. The trend in net wages looks considerably different if workers ignore their gains from a lower youth dependency rate and focus only on the tax contribution required to support the retired elderly. After subtracting higher contributions for the old-age dependency burden, net wages do not grow at all in the 45 years after 1970. In later years, the wage after subtracting the old-age dependency tax grows 0.08 percent per year more slowly than would have been the case without the demographic shock.

## Generational Burdens

The analysis so far has focussed on the dependency burden borne by active workers at a particular point in time. From this perspective, the burden of population aging can be summarized by the implicit tax paid by active workers to support child and adult dependents who do not work. This framework does not fully capture the influence of changing population structure on successive generations, for it fails to measure the lifetime net benefits that individuals derive from membership in relatively large or small generations. Individuals receive transfers when they are children and, if they survive to join the work force, eventually provide for their own support and contribute toward the support of others. If an individual retires in old age, he again becomes dependent on support from others. Depending on the relative size of the working-age and dependent populations over the course of an individual's life, workers may be net tax payers or net transfer recipients during their lifetimes. It is natural to ask how variations in fertility and mortality affect the net transfers received by successive generations.

To analyze this question, I have calculated the ratio of a birth cohort's lifetime consumption to its lifetime gross wages:

$$(5) \qquad \frac{\text{Lifetime consumption}_a}{\text{Lifetime wages}_a} = \frac{\alpha \sum_{a=0}^{19} C_{B+a}\, p_a + \sum_{a=20}^{89} C_{B+a}\, p_a}{\sum_{a=0}^{89} \lambda_a W_{B+a}\, p_a}.$$

Favored birth cohorts receive a higher ratio of consumption to wages than less favored cohorts. I have calculated this ratio for successive cohorts affected by a demographic shock. As before, I assume the nation begins with a stable age structure in which mortality probabilities are the U.S. rates prevailing in 1950 and the total fertility rate is 3.15. Immediately after 1950 age-specific mortality begins to decline at the rate observed in the United States between 1950 and 2000 and the total fertility rate drops to 2.06, the average U.S. fertility rate in the 1990s. Age-specific labor force participation rates stay unchanged before and after the demographic shock, remaining at their 1950 levels (see Table 1).

The top panel in Figure 4 shows the net transfers received by three broad age groups before and after the demographic shock. Net transfers are calculated for youth (people aged 0-19), nonaged adults (people aged 20-64), and the elderly (people 65 and older). In 1950, immediately before the shock occurs, 22.0 percent of aggregate output is transferred to youth and 4.5 percent is transferred to the elderly. Working-age adults pay net taxes equal to 26.5 percent of aggregate output. As a result of the drop in fertility, transfers to children decline while transfers to the elderly gradually increase. Note that the initial impact of these two trends is to reduce the amount of aggregate output that must be transferred from working-age adults. The percentage of aggregate output taken from 20-to-64 year-olds shrinks from 26.5 percent in 1950 to 23.4 percent in 2000 before rising to 27.1 percent by 2150. For people who are between 20 and 64 years old in 2000, the temporary reduction in dependency burdens can improve the ratio of lifetime consumption to lifetime wages.

To see this, consider the lifetime net transfers received by three birth cohorts (middle panel of Figure 4). The oldest cohort is born in 1860 and dies before the start of the demographic shock. To compute the exact transfers received by each cohort, I assume that the economy-wide gross wage remains constant in every period. Members of the oldest cohort receive annual net transfers equal to 21 percent of the gross wage when they are children. In their working-age years, they pay annual dependency taxes equal 16 percent of the gross wage.[7] In old age, they receive annual net transfers amounting to 7.5 percent of the gross wage. The transfers they receive as children are much greater than those they receive as old people, because relatively few of them survive long enough to collect substantial transfers in old age. The lifetime consumption of the 1860 birth cohort is just 96 percent of its lifetime gross wages. When the population is growing rapidly and is relatively short-lived, each generation contributes more to the support of young and aged dependents over its life span than it receives in transfers during youth and old age.

Readers who are familiar with the Samuelson (1958) and Aaron (1966) expositions of the overlapping generations model may be surprised to find that members of a growing population consume less over their lifetime than they produce, even though they receive transfers from younger and larger generations when they reach old age. Samuelson and Aaron focus on the problem of financing consumption of the aged. They do not consider the problem of supporting the dependent young. If the cost of supporting each young person is sufficiently large, a growing population can impose youth dependency burdens on workers which are high in relation to the gains workers obtain in old age from being supported by a large working-age population. A critical parameter in this calculation is $\alpha$, the ratio of per capita child to adult consumption. In the calculations shown in Figure 4, $\alpha$ is equal to 72 percent. If it is half this large ($\alpha = 0.36$), then under the other assumptions of this exercise the generation born in 1860 consumes almost exactly what it produces. If $\alpha = 0$, each generation in a steadily growing population consumes 6 percent *more* than its lifetime gross wages.

The situation of the cohort born in 1910 is noticeably different from that of the older cohort. Each member of the cohort receives exactly as much net transfers in childhood as people born in 1860, because the age structure and dependency burden are assumed to remain unchanged until the 1910 cohort reaches adulthood. At age 40, however, members of the 1910 cohort are affected by the drop in fertility. Lower fertility reduces the number of children supported by each wage earner, lessening the overall dependency burden. As a result, the 1910 cohort pays lower net taxes during its working-age years than earlier cohorts. When it reaches retirement age the 1910 cohort receives more transfers than older cohorts, in part because it enjoys a longer average life span. Over its lifetime, the 1910 birth cohort enjoys consumption equal to 100.6 percent of its lifetime gross wages. This is a substantially higher ratio than obtained by earlier cohorts.

The youngest cohort, born in 2060, receives slightly more transfers in childhood than older cohorts and also receives substantially more transfers in old age. Both changes are due to improvements in longevity. Compared with earlier generations, a larger percentage of the cohort born in 2060 survives through childhood and a much bigger fraction survives to advanced old age. The combination of a lower youth dependency rate and higher old-age dependency rate modestly increases the net taxes the cohort must pay between ages 20 and 64. On balance, the consumption enjoyed by the cohort exceeds the gross wages it earns by 1.2 percent of its lifetime wages. Thus, when $\alpha = 0.72$ the long-term effect of lower fertility and gradual mortality decline is to improve the consumption / wage ratio.

The assumption of zero wage growth is not very realistic. The bottom panel in Figure 4 shows the impact of steadily rising wages on the calculations. I assume that the rate of wage increase, $\omega$, is 1.69 percent a year, the 50-year U.S. average since 1950. To calculate net transfers in a meaningful way, I measure each year's net transfer in relation to the economy-wide real wage rate, specifically, the prevailing real wage when the cohort reaches adulthood (age 20). When the wage rises throughout each generation's life span, net annual transfers received in old age can be substantially larger than annual transfers received as a child, because they are financed out of much bigger annual output. Of course, a rising wage also means that the net transfers a cohort must pay during its working years will be substantially larger than the net transfers it receives in youth. Because generations are relatively short-lived in decades before the 1950 demographic shock, the beneficial impact of wage growth on transfers received in old age is more than offset by the adverse impact on real transfer dependency burdens during a cohort's prime working years. When real wages are climbing 1.69 percent a year, the generation born in 1860 consumes 95 percent as much as it produces. Most of the difference between lifetime wages and lifetime consumption is transferred to youthful dependents, who are very numerous when the total fertility rate is 3.15. The ratio of lifetime consumption to lifetime wages becomes much more favorable for cohorts which enter the work force after the birthrate falls and mortality rates decline. For example, the generation born in 2060 receives lifetime income, including net transfers, that amounts to 107 percent of its lifetime gross wages. This ratio is considerably more favorable than that obtained by the cohort born in 1860.

These results are summarized in Figure 5, which shows the ratio of lifetime consumption to lifetime gross wages for successive birth cohorts over a two century period under four different sets of assumptions about the long-term fertility rate and wage growth. To clarify the exposition, I have modified the earlier assumption regarding the value of $\alpha$. I now assume that $\alpha = 0.36$, exactly half the level suggested by Cutler et al. (1990).[8] If (a) the total fertility rate is 3.15, (b) mortality rates and labor force participation rates remain stable and equal to U.S. rates in 1950, (c) wage growth, $\omega$, is zero, and (d) $\alpha = 0.36$, then under the assumption of a stable population structure, each generation will enjoy precisely as much lifetime consumption as it earns in gross wages: The ratio of lifetime consumption to lifetime wages is 1.00. The two lower lines in Figure 5 show the impact of a demographic shock that begins in 1950. In both cases the age-specific mortality rate is assumed to begin falling after 1950 according to the U.S. pattern observed over the 1950-2000 period, and this pattern of decline continues steadily from 1950 through 2150. In one case I assume that the total fertility rate drops to 2.06 after 1950, approximately the fertility rate observed in the United States since 1990. In the alternative case I assume that the total fertility rate drops to 1.30, approximately the fertility rate in low-fertility-rate countries in the OECD.

Not surprisingly, the bigger drop in fertility initially produces bigger gains for the cohorts already in the work force when the birth rate falls. The cohort born in 1920 enjoys \$105.30 in lifetime consumption for every \$100.00 it earns in lifetime wages. However, the generation born in 1965 receives slightly less in lifetime consumption that it earns in lifetime wages, and the ratio of consumption to wages grows less favorable in every succeeding generation. For the generation born in 2060, lifetime consumption is just 94.2 percent of lifetime gross wages. When fertility is extremely low and the average life span is already long (and labor force participation rates remain stable), declining mortality rates can reduce the consumption possibilities of successive cohorts. Even though annual wage rates are assumed fixed in this scenario, it is not obvious whether the generation born in 2060 would consider itself worse off than the generation born in 1920, which obtains a much more favorable ratio of lifetime consumption to wages. The cohort born in 1920 has an expected life span of 71.4 years; the cohort born in 2060 can anticipate living for 83.7 years, a gain of 12.3 years or about 17 percent.

When the birthrate after 1950 falls to 2.06 rather than to 1.30, the long-term prospects of successive generations are considerably brighter. Generations born between 1865 and 1930 obtain a less favorable ratio of lifetime consumption and wages than would be the case if the fertility rate dropped to 1.30, but generations born after 1930 obtain a much more favorable ratio. Even the generation born in 2060 receives a surplus of lifetime consumption over lifetime wages, implying that the transfers it receives from other generations are larger than those it pays to support other generations. This outcome is possible because population growth is slightly positive, implying that each generation can be supported in old age by a slightly larger population of active workers.[9]

The top two lines in Figure 5 show the effects of faster wage growth on these calculations. I assume that gross wages rise 1.69 percent a year, the average rate of U.S. wage growth after 1950. I consider two fertility scenarios, one in which the total fertility rate drops to 1.3, and the second in which it falls only to 2.06. As was the case when assumed wage growth was zero, a higher long-term fertility rate produces a more favorable long-term ratio of lifetime consumption to lifetime wages. However, even a very low fertility rate still produces a favorable long-term ratio of lifetime consumption to lifetime wages. The generation born in 2060 receives $104.80 in lifetime consumption for every $100.00 it earns in lifetime wages. This is virtually identical to the ratio obtained by the generation born in 1850, when life spans were much shorter and population growth was significant and positive. The long-term outlook is even more favorable if the population growth rate drops to 2.06, as it has in the United States, rather than to 1.3, as has been the case in Japan and much of Western Europe.

## Conclusions

This analysis suggests that the extra burdens connected with population aging are considerably smaller than commonly supposed. Under plausible assumptions, the trend toward an older population may actually reduce the lifetime consumption sacrifice that each generation must make in order to support other generations. To be sure, population aging implies that the tax rate needed to support the retired elderly must rise, a fact which has been highlighted in most popular discussion. But this extra burden will be at least partly offset by a reduced need to provide support to the young, who will become less numerous relative to the active workforce than has been the case in the past. Even if adults provide only modest consumption support to the dependent young, the large drop in the youth dependency ratio implied by current birth rates will offset much of the extra burden of supporting a larger retired population. The extra burden of an older population will be smaller still if wage growth remains positive and if labor force participation rates among the working-age population continue to rise.

Three factors may account for widespread pessimism concerning the support burdens implied by current demographic trends. First, as noted by Cutler et al. (1990), the rich countries have already derived much of the consumption benefit to be gained from a lower youth dependency rate, but they have not yet experienced the full impact of higher old-age dependency burdens. In terms of Figure 5, recent generations of active workers and retirees have enjoyed the consumption advantages associated with a rising ratio of lifetime consumption to lifetime wages, but future workers will face the inevitable unwinding of part or all of this advantage. If future wage and population growth rates are low, future workers may have to transfer more to the retired elderly than they can ever expect to receive themselves as transfers in old age. Disregarding the considerable improvement in their own life span compared with that of earlier generations, future generations may consider themselves worse off than earlier generations that had the opportunity to consume more than they produced during their lifetimes.

Second, many pessimists may believe the public and private transfers needed to support an aged adult are much greater than those needed for a dependent child. For example, Cutler et al. (1990) estimate that the medical and non-medical consumption needs of a person older than 64 are 1.27 times those of a 20-64 year-old and 1.76 times those of a child. Even under this assumption, however, the extra dependency burden of a larger elderly population will be substantially offset by a relatively smaller population of dependent children. Moreover, the ultimate burden of old-age support does not depend on the amount of support needed to make an aged adult as well off as a nonaged adult. It depends on the actual level of support provided to the aged. It may be the case that an aged adult requires 1.27 times as much income as a nonaged adult to satisfy the same medical and non-medical consumption needs. However, if society enforces a distributional rule that provides an identical consumption share to every adult, whether aged or nonaged, the retired elderly must accept a consumption allotment that does not fully satisfy their consumption needs (assuming their “needs” require them to receive 1.27 times the nonaged adult allotment to attain the same level of happiness). I see little evidence that

OECD countries provide enough support to their retired elderly so that the average income of the elderly is 27 percent greater than that of nonaged adults. The best evidence is that the equivalent income of the elderly in rich societies is approximately equal to or less than that of the nonaged (Bosworth and Burtless, 1998).

Finally, workers view tax contributions to support the retired elderly in a very different light than they regard most transfers to the dependent young. On the one hand, most Americans regard public transfers to the elderly more favorably than public transfers to children and nonaged adults. However, they regard public transfers in a much less favorable light than they do their private transfers to nonworking dependents within their own families. Family breadwinners derive greater satisfaction in providing for the consumption needs of their own spouses and child dependents than they do in paying taxes to support the comfortable retirement of strangers. Even though breadwinners in rich countries have enjoyed sizable consumption gains from lower fertility, they do not view these gains as an offset to the higher taxes they must pay to support the retired elderly. The perceived “crisis” of population aging may be a natural result of the different ways we support aged and nonaged dependents. This should not obscure the fact that the true economic burden of an aging population is far different – and less worrisome – than popularly supposed.

ENDNOTES

[1] Because of the increased sophistication, utilization, and cost of medical goods and services, federal health care spending would be expected to increase faster than national income, even if the population age structure remained unchanged.

[2] If the wage rate varies by age, $\lambda_a$ may be re-defined to designate the product of group *a*'s participation rate and the ratio of the group's wage relative to the economy-wide wage.

[3] To simplify the calculations, I assume the potential life span has up 18 periods corresponding to the 5-year intervals shown in Table 1. The maximum potential life span is thus assumed to be 90 years.

[4] If the fertility rate falls to 1.30 rather than to 2.06, the ultimate dependency burden rises slightly compared with the dependency burden when fertility is 3.15 or 2.06. If $\alpha = 0.38$, the extra consumption needs of a larger elderly population can outweigh the cost savings from reduced spending on children. Even in this case the change in dependency burdens is small, however. The ultimate dependency burden with total fertility rates of 3.15 or 2.06 is 51 percent of the gross wage. When the total fertility rate falls to 1.3, the total dependency burden ultimately rises to 52 percent.

[5] Because I use the simplifying assumption that a life span can extend no longer than 90 years, my calculations understate the increase in life expectancy that will occur if mortality rates continued to decline for the next 150 years. Some of the improvement in mortality rates will improve life expectancy at age 90, and this improvement is ignored in the calculations.

[6] Real final consumption per active worker in the United States increased 1.69 percent a year between 1950 and 2000. Real NNP per active worker increased at the same annual rate. Even though the pace of real wage growth slowed after 1975, the annual rate of increase in consumption per worker increased more than three times faster than the 0.4 percent rate of growth assumed in Figure 3.

[7] Note that this is substantially less than the dependency burden faced by a *working* adult. Under the assumptions of the model, working-age adults who do not work receive transfers from the people who work. The net transfer shown in Figure 4 indicates the difference between transfers received by members of an age group and support contributions made by working members of that group.

[8] If we assume a higher relative consumption level among children, the effect of a lower total fertility rate on the ratio of lifetime consumption to lifetime wages is even more favorable to future generations.

[9] Although a total fertility rate of 2.06 is consistent with a stable or slightly declining population under the mortality rates in effect in 2000, predicted future declines in the mortality rate will reduce the number of children needed to ensure a stable or slightly growing population. An increasing proportion of each generation will survive through the child-bearing ages, so each woman will not need to bear as many children in order to maintain a fixed population.

REFERENCES

Aaron, Henry J. (1966) "The Social Insurance Paradox," *Canadian Journal of Economics* 32 (August), 371-74.

Bosworth, Barry, and Gary Burtless (1998) "Population Aging and Economic Performance," in Barry Bosworth and Gary Burtless, eds., *Aging Societies: The Global Dimension* (Washington: The Brookings Institution), 1-32.

Cutler, David M., James M. Poterba, Louise M. Sheiner, and Lawrence H. Summers (1990) "An Aging Society: Opportunity or Challenge?" *Brookings Papers on Economic Activity* (Spring), 1-73.

Samuelson, Paul A. (1958) "A Exact Consumption-Loan Model of Interest with or without the Social Contrivance of Money," *Journal of Political Economy* 66 (December), 467-82.

**Table 1. U.S. Population Age Structure, Mortality, and Labor Force Participation, 1950 and 2000**

Percent

| Age group | Percent of U.S. population 1950 | Percent of U.S. population 2000 | Percent of U.S. population Difference | Mortality rate a/ 1950 | Mortality rate a/ 1996 | Mortality rate a/ Difference | Activity rate b/ 1950 | Activity rate b/ 2000 | Activity rate b/ Difference |
|---|---|---|---|---|---|---|---|---|---|
| 0-4 | 10.7 | 6.5 | -4.2 | 3.4 | 0.9 | -2.6 | -- | -- | -- |
| 5-9 | 8.8 | 7.0 | -1.8 | 0.3 | 0.1 | -0.2 | -- | -- | -- |
| 10-14 | 7.4 | 7.0 | -0.4 | 0.3 | 0.1 | -0.2 | -- | -- | -- |
| 16-19 | 7.1 | 6.9 | -0.2 | 0.5 | 0.4 | -0.2 | 35 | 42 | 7 |
| 20-24 | 7.6 | 6.5 | -1.1 | 0.7 | 0.5 | -0.2 | 62 | 78 | 16 |
| 25-29 | 8.1 | 6.7 | -1.4 | 0.8 | 0.5 | -0.3 | 61 | 85 | 24 |
| 30-34 | 7.6 | 7.1 | -0.5 | 1.0 | 0.7 | -0.3 | 61 | 85 | 23 |
| 35-39 | 7.5 | 7.9 | 0.4 | 1.4 | 0.9 | -0.5 | 64 | 84 | 21 |
| 40-44 | 6.8 | 7.9 | 1.1 | 2.2 | 1.3 | -0.9 | 65 | 85 | 21 |
| 45-49 | 6.0 | 7.1 | 1.1 | 3.4 | 1.8 | -1.6 | 64 | 85 | 21 |
| 50-54 | 5.5 | 6.3 | 0.8 | 5.1 | 2.7 | -2.3 | 60 | 80 | 20 |
| 55-59 | 4.8 | 4.9 | 0.1 | 7.5 | 4.2 | -3.3 | 56 | 69 | 13 |
| 60-64 | 4.0 | 4.0 | 0.0 | 10.9 | 6.6 | -4.3 | 50 | 47 | -3 |
| 65-69 | 3.3 | 3.6 | 0.3 | 15.7 | 9.7 | -6.0 | 35 | 24 | -11 |
| 70-74 | 2.3 | 3.5 | 1.2 | 22.8 | 14.6 | -8.2 | 22 | 13 | -9 |
| 75-79 | 1.4 | 3.0 | 1.6 | 33.2 | 21.1 | -12.2 | 13 | 10 | -4 |
| 80-84 | 0.7 | 2.2 | 1.5 | 45.1 | 31.8 | -13.3 | 7 | 5 | -2 |
| 85+ | 0.4 | 2.1 | 1.7 | 100.0 | 100.0 | -- | 3 | 1 | -2 |

a/ Percent of persons alive at the first indicated age who die within five years after attaining that age.
b/ Persons who are employed or seeking work as a percent of all persons in age group.
*Source:* Author's tabulations of data from U.S. Census Bureau, Bureau of Labor Statistics, and *National Vital Statistics Reports* (Vol. 47, no. 13).

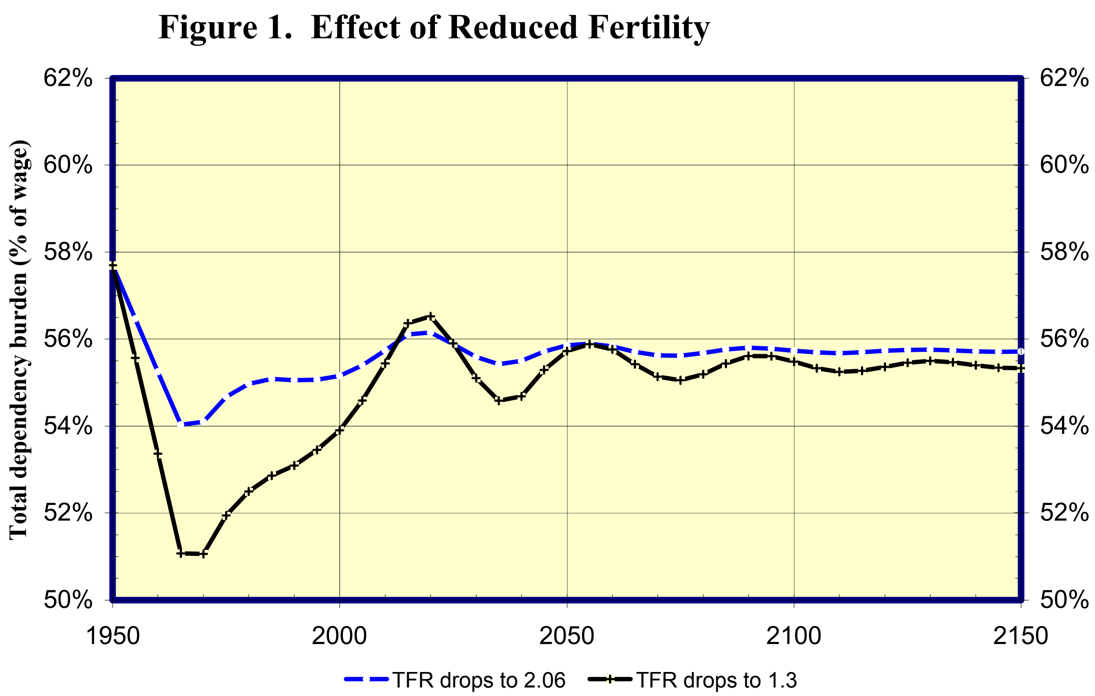
**Table 2. U.S. Dependency Burden under Alternative Assumptions Regarding Labor Force Participation, 1950-2050**

Percent

| Dependency burden | 1950 Activity Rate 1950 (1) | 1950 Activity Rate 1965 (2) | 1950 Activity Rate 2000 (3) | 2000 Activity Rate 1965 (4) | 2000 Activity Rate 2000 (5) | 2000 Activity Rate 2050 (6) |
|---|---|---|---|---|---|---|
| $\tau_{Young}$ | 24.3 | 28.3 | 19.6 | 27.6 | 19.1 | 17.5 |
| $\tau_{Nonaged\ adults}$ | 25.0 | 22.6 | 24.9 | 12.1 | 12.9 | 12.6 |
| $\tau_{Aged\ adults}$ | 6.9 | 8.3 | 10.9 | 9.1 | 11.8 | 19.5 |
| $\tau_{All\ dependents}$ | 56.1 | 59.2 | 55.5 | 48.8 | 43.8 | 49.6 |

*Source:* Author's calculations as explained in text.

# Figure 1. Impact of Lower Fertility and Lower Mortality on Dependency Burden, 1950-2150



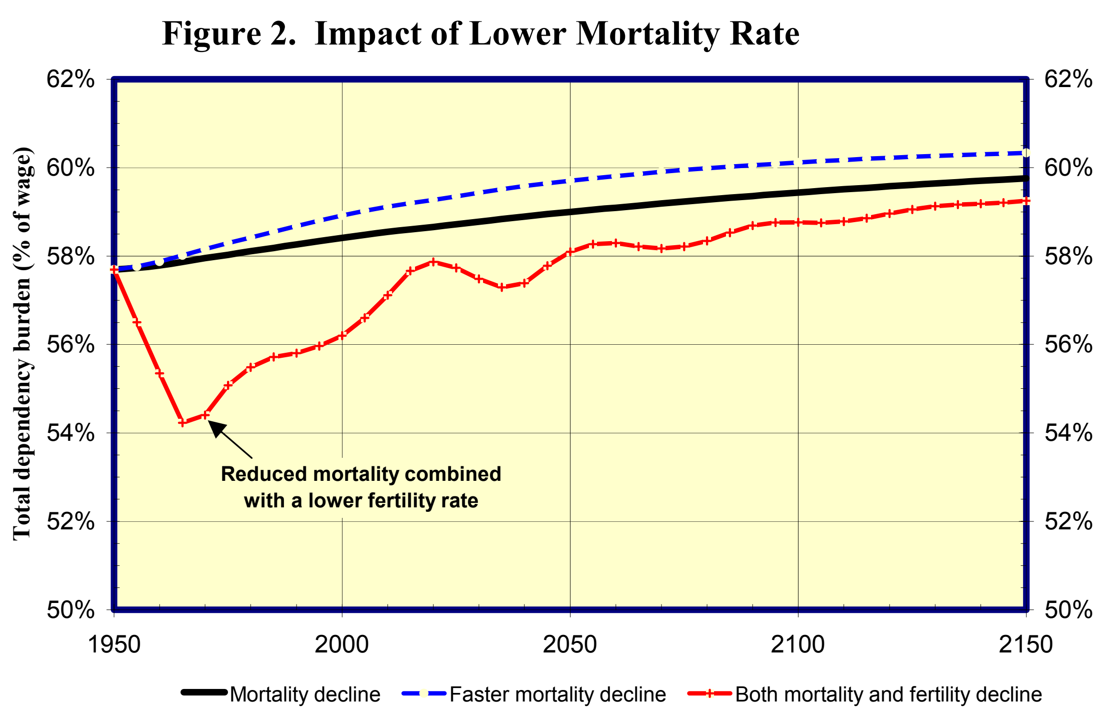



**Figure 3. Trend in Net Wage after Demographic Shock**

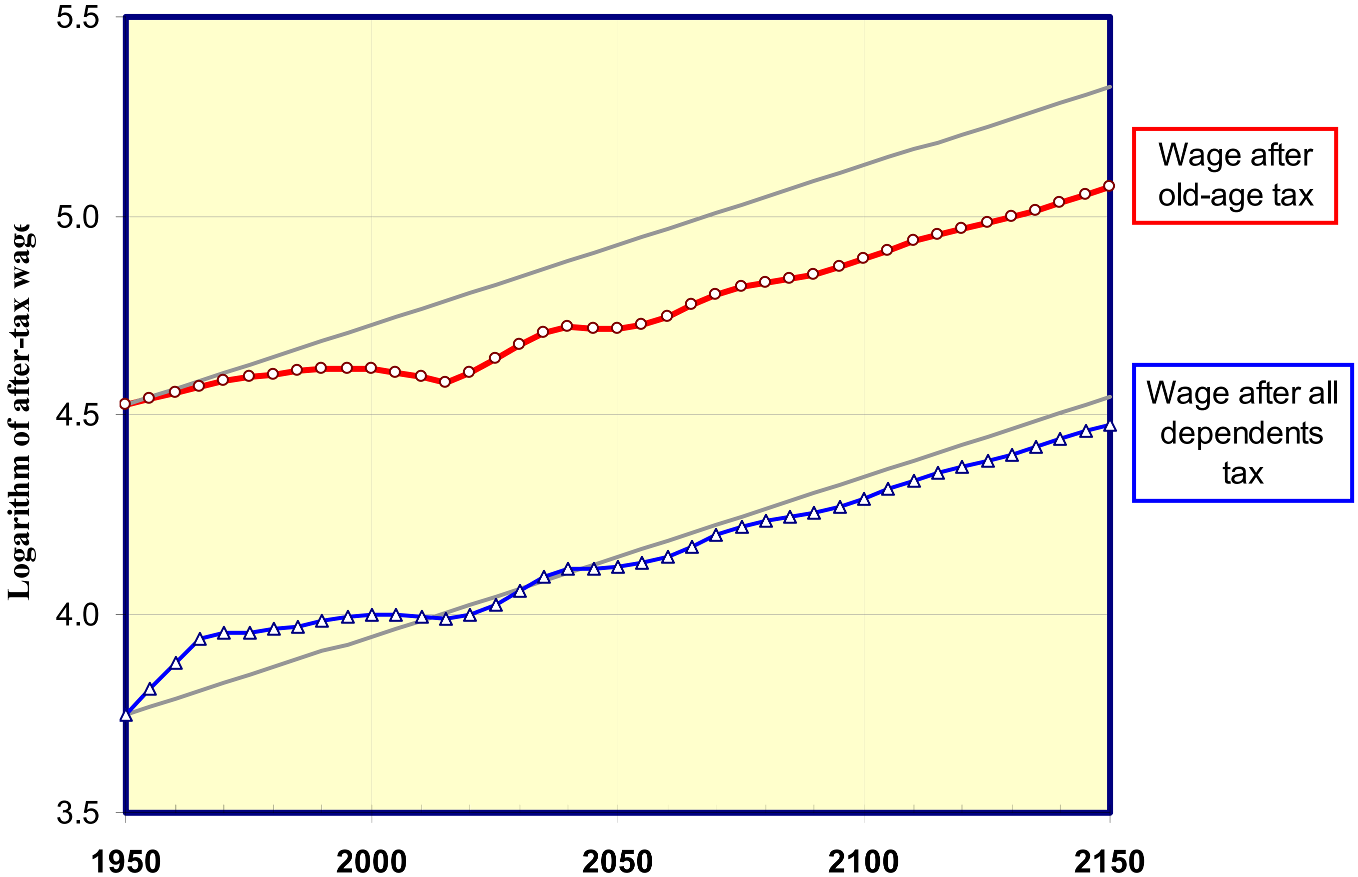
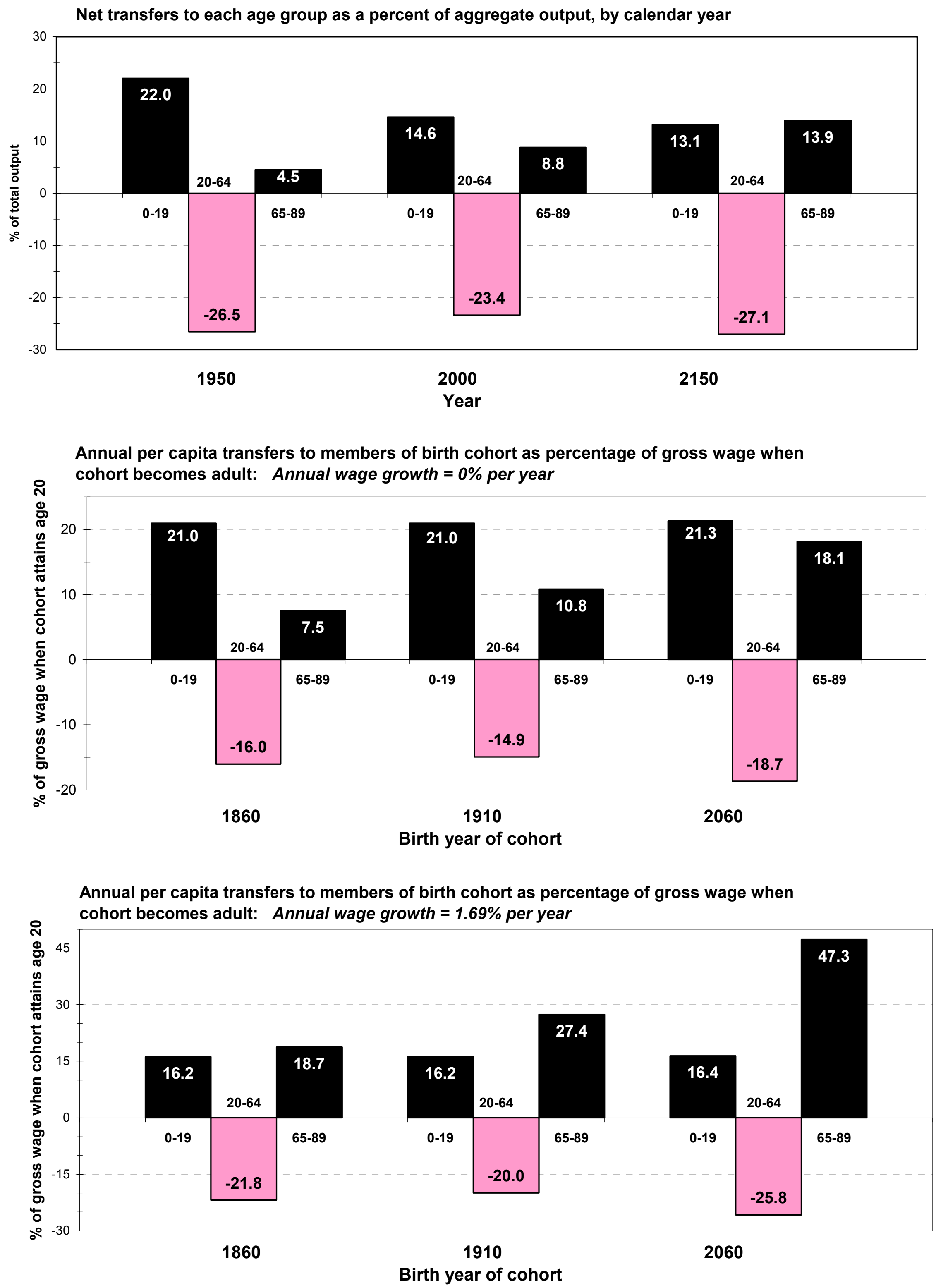


**Figure 4. Age Pattern of Net Transfers to Dependents, Before and After Demographic Shock**



## Figure 5. Ratio of Lifetime Consumption to Lifetime Wage in Successive Birth Cohorts ($\alpha$=0.36)