Who Wins and Who Loses? Public Transfer Accounts for US Generations Born 1850 to 2090

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VIRTUALLY ALL industrial countries have instituted public-sector programs to provide public education, health care (at least for the elderly), and pay-as-you-go pensions on a nearly universal basis. Many developing countries are following their example. It is widely acknowledged that population aging will exert intense fiscal pressure on these programs. For the most part, countries have left in place programs that are fiscally unbalanced and in the long run demonstrably unsustainable. Although the clamor for reform grows louder each year, the public strongly resists any reduction in benefits.

While the need to reform public pensions and health care is undisputed, there is strong disagreement about how that reform should be designed. Some argue for a rapid reform, so that future generations are not unfairly burdened by large public debt. Others suggest that rapid reform would be unfair to current generations, especially those near retirement. The notion of fairness is therefore central to the discussion. Fairness is generally difficult to define, and the intergenerational nature of the dilemma makes it even more so. Various approaches have been suggested: utilitarianist, Rawlsian, generational accounting, among others. These approaches can substantially differ, but they share a longitudinal (that is, intertemporal) view. For most people, it would make little sense to discuss the fairness of pension benefits without considering personal contributions.

Surprisingly, discussions of one kind of transfer—public education—are persistently framed horizontally (that is, cross-sectionally) rather than longitudinally (that is, over the life cycle of generations). Public education is generally seen as an investment in human capital, but rarely as an intergenerational transfer (for exceptions, see Jensen and Raffelhüschen 1999 for Denmark;

Chojnicki and Docquier 2007 for the US). Economists argue about the optimal amount to be spent on education, but pay little attention to the questions of intergenerational equity that would naturally accompany the development of educational transfers. While we tend to think of the pension and health benefits we receive in old age as a kind of return earned on an earlier investment of contributions, we think of education cross-sectionally, not as a benefit we receive early in life and pay for later through school taxes.

Nonetheless, there are many reasons to include educational transfers in the debate on intergenerational equity and to consider public education transfers on the same basis as public pensions and health care. First, education is a vital public transfer. In the United States in 2008, education (including higher education) was the largest public transfer program at 5.2 percent of GNP, followed by OASI (Old-Age and Survivors Insurance—public pensions and survivor's benefits, labeled in the US as Social Security) at 3.5 percent and Medicare (public health care for those aged 65 and over) at 3.2 percent. Second, because of their timing in the life cycle, education transfers appear even more important when we take discounting into account. The benefits of public education are received on average about 30 years earlier than the average age of paying taxes, which is in turn about 30 years earlier than the average age of receiving old-age benefits. Each 30 years of discounting at 3 percent introduces a discount factor of 0.4, so that a dollar of education received as a child carries a relatively great weight in the longitudinal accounts. It is 2.5 times greater than the taxes paid for education later in life, and six times greater than a dollar of benefits received in old age. Taking survival probabilities into account, to a recipient a dollar of educational benefits can easily be worth 10 dollars of old-age benefits. Third, in contrast to Social Security and Medicare, education is a downward transfer, one that flows from older to younger members of the population. Consequently, it may offset some of the effects of upward transfers. For example, Becker and Murphy (1988) contend that, when considered separately, the introduction of Social Security and education transfers were not Pareto-improving reforms, but when considered in combination they might well have been a Pareto improvement.[1]

In Becker and Murphy's theory, altruistic parents choose to invest in the education of their children up to a point through private transfers. However, because parents also care about saving to provide for their own retirement, this point may be reached short of the optimal level of education. At the optimal level, the rate of return on an additional year of education would equal the rate of return on an additional unit of capital. Undereducated children might want to borrow the money needed to complete their education to the optimal level, but because there are no institutions to ensure repayment of these loans, the parents are unwilling to lend to them. Society and individuals are stuck at a sub-optimal level of well-being because overall levels of education are too low.

This sets the stage for the introduction of public education. The state taxes worker-parents to raise the revenues to provide the optimal amount of education for their children. The parents are now worse off than before, because they have been forced to spend more on education than they wished. To compensate the parents, the state taxes the children, once they have become workers, in order to pay their now elderly parents a public pension. The new public transfers for education from parents to children are balanced by new public transfers from adult children to their parents for retirement. If the timing of the introduction of these programs is just right, then all generations will be better off than before.[2] Of course, this story should not be taken too literally.

In this article we consider in a consistent framework the financial redistributions implied by the three main public transfer systems in the United States—education, Social Security, and Medicare—and assess the intergenerational impact of public transfers. For example, by looking at the timing and size of the various transfers, we can see whether Becker and Murphy's account might make sense in light of the public transfers as they have occurred in the real world. Our work also allows us to revisit the results of standard generational accounting, as developed by Auerbach, Gokhale, and Kotlikoff (1991) and currently used by many governments as a measure of budget balance. For a comparison of their approach with ours, see Appendix B.

Because our work focuses on financial redistribution, we are unable to draw definite conclusions about the welfare impact of intergenerational transfers. A welfare analysis would be much more complex since it would need to include three main elements: (1) a measure of the flows of transfers, (2) an estimate of the indirect effects of transfers (due to externalities, distortions, offsetting behavioral responses, and the like—see Fehr and Kotlikoff 1999), and (3) a widely accepted measure of individual welfare. We deal only with the first point without making any assumptions about the last two, which are controversial issues. Our conclusions, therefore, are by construction restricted in scope but robust.

We should comment on two other points. First, the public programs we consider surely crowded out private transfers and investments to some degree, displacing parental expenditures on their children's education, adult children's support for their elderly parents, and advance provision by adults for their own old age. We do not argue that without public education children would remain illiterate, nor that without Social Security and Medicare the elderly would starve or die for want of medical attention. Should we then treat the benefits as accruing to the former private providers? Suppose for the moment that we had some means of estimating these indirect benefits (that is, benefits accruing to someone other than the immediate recipient). How should we treat the further rounds of indirect flows of benefits, since parents or adult children who indirectly benefit will then have more funds to invest in their own children, and those children and indeed all descendants would then also be beneficiaries?

In our accounts each benefit is allocated to the face recipient. Our analysis here deals with the public sector, not with the full span of arrangements through which resources are transferred from one age group to another. For a fuller account for a single cross-sectional year, see Mason et al. (2009) and the National Transfer Accounts project at «http://www.ntaccounts.org/».

A second question is how these transfers should be valued. A year of education yields a high rate of return.[3] Should an in-kind educational transfer therefore be valued more highly than its cost of provision? If so, then we must also assess the efficacy of Medicare in raising the quantity or quality of remaining life, and we must assign a monetary value to these additional years of life in old age, two highly uncertain and controversial tasks. In our accounts in-kind transfers are valued at their cost of provision.

Some will argue that education is an investment, whereas Social Security is a transfer of consumption, and the two should not be combined. But what does it mean to say education is an investment? It is not an investment by parents, since they have no claim on the stream of income that results from their children's education. In fact, education is the transfer of an asset, namely human capital, to children, who subsequently own the income stream that their education generates.

Humans enjoy a long life span, but its length presents a challenge to researchers seeking to measure transfers from a longitudinal perspective. People may live 110 years or more, receiving education in the very early years of their lives, and pensions up to the very end of their lives. Thus, to measure a single cohort's transfers, one needs data on transfers occurring over more than a century. Because our aim is to compare what happens to different cohorts, we need data covering far more than a century. In practice this means that the data must reach as far as possible into the past, and be extended through projections far into the future. Such long-run projections are subject to great uncertainty.

Our main effort has been to collect, construct, and project data on Social Security, Medicare, and education for generations born from 1850 to 2090. Projections require particular assumptions about productivity growth, demographic change, and policy choices. The outcomes for each system of transfers are matrixes of the average value of benefits received and taxes paid by age, from 1850 through 2200, by single years of age and time. These matrixes can be analyzed cross-sectionally for each calendar year, or across time for any given age, or diagonally by generation. Because we take a longitudinal view, we focus mainly on the diagonals of the matrixes, which we summarize by calculating for each generation the present value at birth of survival-weighted benefits received minus taxes paid over the life cycle. This gives the net present value at birth. We have also calculated an age–earnings matrix for the same period, which we use to calculate the present value of survival-weighted lifetime earnings. We often express results relative to these present values for each generation.

Our approach permits us to identify the generations that received (or will receive) more public transfers than they paid (or will pay) in taxes directed to the transfer programs and generations that paid more than they received, and to quantify the net contributions of each generation in absolute terms or relative to lifetime earnings. As we will see, including public education substantially changes the picture. Some generations that are generally said to have received a large “free lunch” through the development of Social Security are also generations that paid for a much larger “lunch” than the one they consumed, because of developments in public education.

The net present values for Social Security, starting with the first generations to receive benefits, have been calculated by others (Leimer 1994; Schieber and Shoven 1999), but these differ from our calculations in important respects, for example in treatment of projected mortality. Calculations of net present value have also been made for Medicare (Cutler and Sheiner 2000), but these also differ from ours in some critical respects. Calculations of net present value for public education have not previously been made, and our calculations have required extensive analysis of historical data, as described in Appendix A. In what follows we present consistent calculations for all three public transfers, and for their sum, for the relevant generations, including some projections for the future.

Next we explain how we estimated and forecast public transfers. We then provide the results for each public transfer system and their combination, compare our results with those of generational accounts, and discuss the main insights derived from our work.

Estimation and forecasts of transfers

The historical data for these three public transfer programs come from a variety of sources, which we briefly describe along with our methods; further details are given in Appendix A. For public education, including higher education, age-specific benefit data were derived from census data on school enrollment rates and administrative data on total expenditures. Age-specific tax data were generated based on a balanced-budget assumption together with the expenditure totals. We assumed that education was paid for by property taxes and inferred the incidence of these taxes from census data on home ownership, renter status, and income (for a full report on our methods for estimating educational accounts, see Qian 2002). For Social Security, published and unpublished age-specific administrative data came from the Social Security Administration (SSA). Age-specific tax data were derived from survey data on taxation and administrative data on sources of Social Security revenue. For Medicare, age-specific benefits were derived from administrative data on the age distribution of benefits in 2000 and administrative data on total expenditures, except for Part D, which was extended from Congressional Budget Office projections.[4] Age-specific tax data were derived from survey data on taxation and administrative data on sources of Medicare revenue. For our historical series, we are more certain of the level of expenditures and taxation than of the details of their age-specific allocation, but we do not believe our results are affected by uncertainties related to these age-specific details.

For our projection, we assume a fixed cross-sectional age shape for benefits and taxes, and shift the levels of these age profiles upward at a fixed rate that depends on the rate of productivity growth. However, there are many exceptions. Health care costs are projected to rise more rapidly than productivity growth, following the assumptions of the Medicare Trustees and Actuaries. Social Security benefits are determined for each cohort at retirement and depend on the history of productivity growth, as well as on legislated changes in the normal retirement age. Education enrollment rates are assumed to continue at their level in 2000, although we experiment with other assumptions. Our simulation models have been carefully tested against official projections and other projections we have done, and they accurately reproduce these.

Our projections indicate that both Social Security and Medicare have major long-term fiscal imbalances and are unsustainable as currently structured. While we make one set of projections based on current program structure, we also specify three alternative adjustments to balance the programs: (1) raise taxes as necessary for period-to-period balance, once the trust funds are exhausted; (2) cut benefits to achieve balance; and (3) make equal adjustments to both taxes and benefits, *which is our baseline assumption*.

We assume an inflation-adjusted interest rate of 3 percent, and for projections we assume a productivity growth of 1.6 percent (real covered wage[5] growth of 1.4 percent, allowing for changes in hours worked, fringe benefits, and so forth, following Social Security Administration assumptions; see Board of Trustees 2004: Table II, C1). We assume that age-specific costs per Medicare enrollee grow 1 percent faster than productivity through 2080 and then trend down toward the rate of productivity growth. We forecast future mortality rates to be consistent with the Social Security Actuary's projections, which we then extend using Lee–Carter methods (Lee and Carter 1992). Consistent with the SSA Board of Trustees (2004), the long-run total fertility rate is assumed to be 1.95. Annual net immigration is set at 900,000 (Miller 2004).[6] For many of these assumptions we have performed sensitivity analyses (assuming variations in discount rates, educational enrollment growth, and budget-balancing policies).

On the basis of these data sources, procedures, projections, and policy assumptions, we have constructed a complete age–time matrix of benefits and taxes for each birth cohort from 1850 through 2200, providing the data necessary for life cycle accounts for generations born 1850 to 2090. This matrix is the basis of all the calculations reported below.

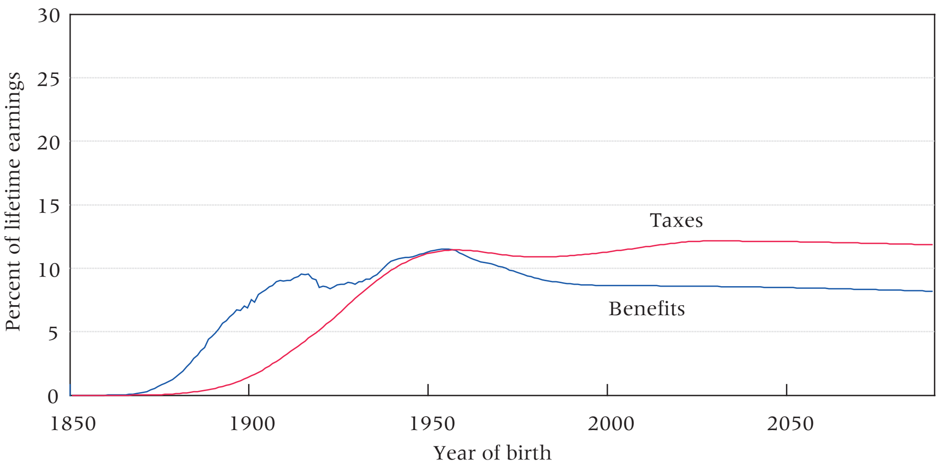
Empirical results

Net Social Security and Medicare benefits by birth cohort: 1850 to 2090

As noted earlier, we calculate the net present value for each transfer program and each birth cohort as the difference between the lifetime-discounted, survival-weighted benefits and the lifetime-discounted, survival-weighted tax payments for these programs. Figure 1 graphs the present values for Social Security benefits received and Social Security taxes paid by different generations under the baseline assumptions. Figure 2 does the same for Medicare. (Both figures give values as a percent of the present value of survival-weighted lifetime earnings. These present values are shown in Appendix Figure A1.) The values for all figures, including those in the Appendix, are available online at «http://www.ntaccounts.org/web/nta/show/WP04-02».

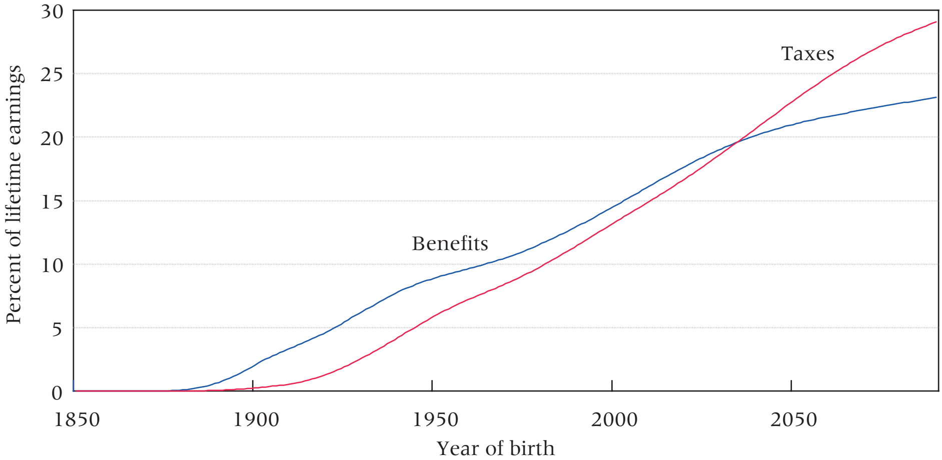
Figure 3 presents net present values for Social Security and Medicare as a percent of the present value of lifetime earnings. The creation of Social Security in the late 1930s (with regular benefit payments starting in 1950) and of Medicare in the mid-1960s led to large windfall gains[7] for the early participants in these pay-as-you-go systems. These early participants received benefits far in excess of the taxes they paid for these programs. The Social Security net present values are highest, at about +4 percent to +6 percent of

FIGURE 1 Present value at birth of Social Security benefits and taxes



NOTE: Calculated using the baseline assumption (see text).

FIGURE 2 Present value at birth of Medicare benefits and taxes

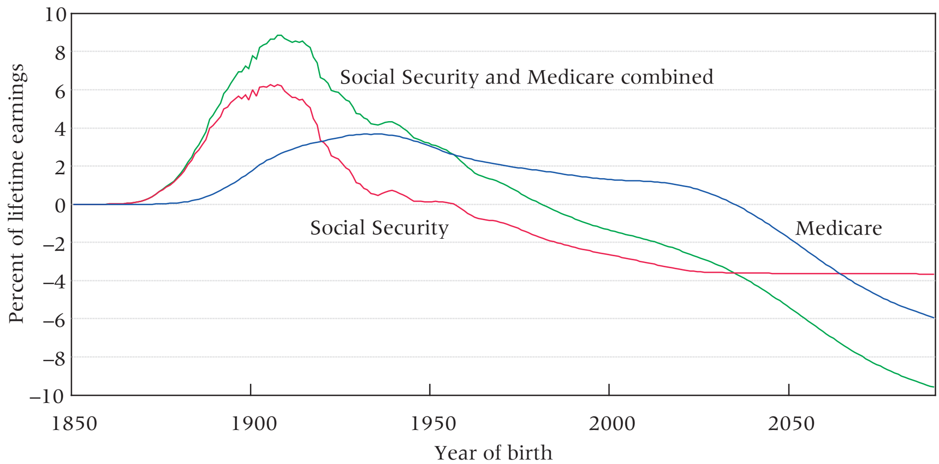


NOTE: Calculated using the baseline assumption (see text).

lifetime earnings, for the birth cohorts of 1890 to 1920; those born in 1914 experienced the greatest windfall gain, with their combined Social Security and Medicare net benefits amounting to 8.7 percent of lifetime earnings. Rates of return might be higher for earlier cohorts, but the net present value depends also on the scale of benefits received, not just on their relation to prior contributions.

For cohorts born after 1920, the present value of the combined Social Security and Medicare net benefits declines steadily to around –2 percent for

FIGURE 3 Net present value at birth of expected lifetime Social Security and Medicare benefits as a percent of lifetime earnings



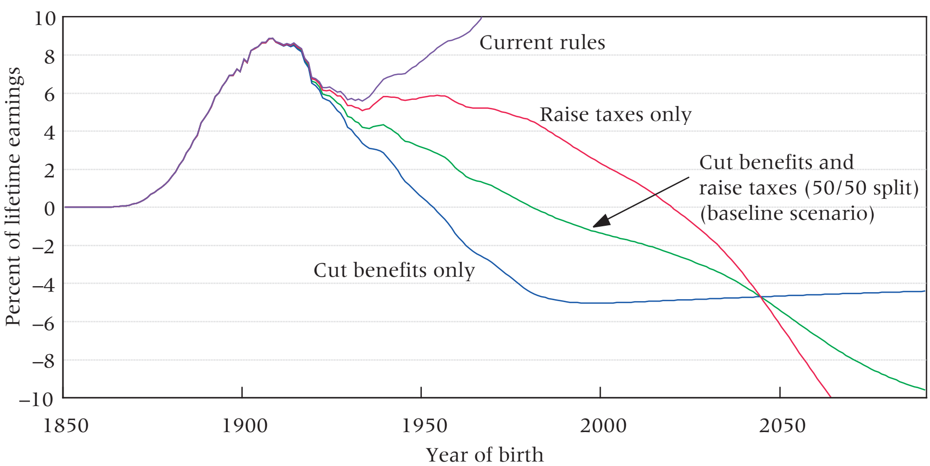
NOTE: Calculated using the baseline assumption (see text).

cohorts born in 2010, based largely on projections for the twenty-first century. The net present value for Medicare reaches a peak of around 4 percent for birth cohorts of 1930 to 1937 and declines for cohorts born after 1937, reaching about +1 percent for cohorts born in 2010.

Under our baseline budget-balancing scenario, the future shortfall in Social Security and Medicare is met in equal parts by raising tax rates and lowering benefit rates. In the case of Social Security, these adjustments begin in 2044 when the trust fund is exhausted (according to SSA projections in 2004, it will be exhausted in 2042). For Medicare, Part B (SMI) the adjustments begin immediately, while for Medicare, Part A (HI) the adjustments begin in 2023 when the HI trust fund is exhausted.[8]

Figure 4 also shows three other scenarios, two of them budget-balancing. In the first budget-balancing alternative, future shortfalls are met by cutting benefits. In this scenario, the net present values are negative beginning with cohorts born in 1956. In the second budget-balancing alternative, future shortfalls are met by raising taxes. In this scenario, net present values remain positive until the generation born in 2020, but the net present values for generations born beyond about 2050 are more negative when taxes rather than benefits are adjusted. Finally, we consider the scenario in which there is no adjustment and the systems are permitted to continue running deficits indefinitely. This course is not sustainable since it leads to levels of debt that would be unfeasible to finance or require supporting the programs at the expense of other government programs, a solution that would soon prove politically unacceptable. In this scenario, the net present value continues to

FIGURE 4 Net present value at birth of the combined expected lifetime Social Security and Medicare benefits as a percent of lifetime earnings under three alternative budget-balancing scenarios and under continuation of current rules on benefits and taxes



rise as a share of lifetime earnings for generations born after around 1960, since taxes are not raised, nor benefits cut. In principle, the benefits could be financed by the sale of bonds, but it is unlikely there would be any buyers since debt-to-GNP ratios would soar.

Net transfer benefits for public education by birth cohort: 1850 to 2090

An individual receives public education benefits at an earlier age than that at which the taxes to fund education are paid. Therefore, such systems create implicit transfer wealth for the government rather than implicit transfer debt (the signs are reversed when we take the perspective of individuals). Whereas the earliest participants in the Social Security system received a windfall gain, the first generation to make tax payments to support the public education system incurred a windfall loss because they paid for a level of public educational benefits that they themselves never received.[9]

The annual Trustees Reports of the Social Security Administration and Medicare contain projections of costs and revenues over a 75-year horizon, and methods for generating these projections are debated in the literature. However, we have been unable to locate any comparable long-term projections for education. Therefore we discuss our education projections in more detail.

Our projections of costs are based on the numbers of school-age children (derived from our general demographic projections, see earlier description), their enrollment rates by grade level, and the costs per enrolled student at each grade level. We project that costs per enrolled student at each broad grade level, including higher education, will rise with labor productivity in general, on the assumption that schools must compete for workers in the labor market. Further details of our educational projections are given in Appendix A.

Figure 5 gives the generational present values for educational taxes and benefits separately for the baseline scenario (enrollment growth ceases after 2000). Figure 6 shows the net present value for public education for each birth cohort from 1850 to 2090 for three projection assumptions: (1) baseline (no enrollment growth after 2000), and with enrollment growth continuing (2) according to the long-term trend or (3) at half of it (further details in Appendix A).

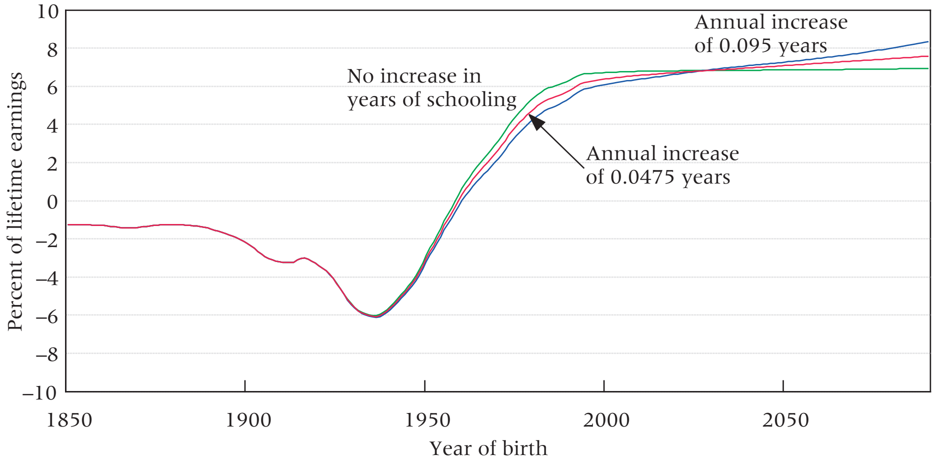
To interpret Figure 6, imagine that public education was introduced all at once in one calendar year. In this case, the initial birth cohorts would pay taxes for education but receive no education themselves, so all would show a negative net present value. The cohort born five years before the start of public education would be ready to start kindergarten at the inception of public education and would receive the complete education provided. Con-

FIGURE 5 Present value at birth of education benefits and taxes paid for education

NOTE: Calculated using the baseline assumption (see text).

sider the net present value for this cohort. The internal rate of return[10] for any mature stable transfer system must equal the rate of population growth plus the rate of productivity growth, that is to say, the rate of growth of GDP (Aaron 1966). Because the educational benefit is received before taxes are paid, we would expect the net present value to be negative if the discount rate is less than the growth rate of GDP, and positive if it exceeds the growth rate of GDP. A 3 percent discount rate is below the growth rate of GDP for the

FIGURE 6 Net present value at birth of expected lifetime education benefits as a percent of lifetime earnings under three alternative scenarios assuming different changes in years of schooling beginning in 2000



early part of the period and so should yield a negative net present value for the fully educated cohorts as well as the initial cohorts. The historical rates of interest are a bit higher than the growth rate of GDP, and so yield a positive net present value.

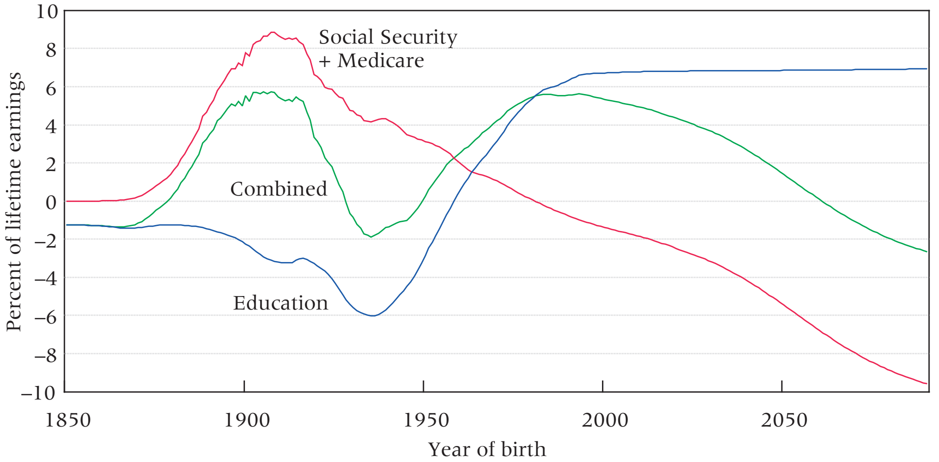
In practice, however, public education was phased in very slowly. As enrollments and median grade attainments rose, each generation of taxpayers funded a higher level of education than it received itself, so net present values were negative. The generations that funded the education of the baby boom cohorts were heavily taxed because there were so many students and relatively few taxpayers and because enrollment increases were particularly rapid. Those generations born between 1928 and 1942 experienced losses of at least 5 percent of lifetime earnings through the transfer effected by the educational system.

Figure 6 shows that the net present value becomes increasingly negative relative to lifetime earnings until it reaches its trough for the birth cohorts of 1935–36 at around –6 percent. After this it rises, but does not become positive until the birth cohort of 1959. It approaches a plateau for the cohorts born in the 1980s and ceases to rise in the 1990s after reaching a level close to 7 percent. Because this outcome is based almost entirely on values of taxes and expenditures projected far into the twenty-first century, we would expect the result to be sensitive to projection assumptions, but Figure 6 shows that it is not.

Combined accounts

Figure 7 shows the net present values for the combined upward transfer through Social Security and Medicare together with the net present value for the downward transfer through public education. The first generations to bear the cost of public education were too old to gain from the introduction of Social Security. To a considerable extent, however, those generations that benefited from the introduction of upward transfers were the same ones that bore the brunt of the intensification of the downward transfers associated with financing the education of the baby boom. For example, for the cohort born in 1926, net Social Security and Medicare benefits amounted to 5.5 percent of lifetime earnings, which were offset by a net public education benefit amounting to –4.6 percent of lifetime earnings, so that the net effect of all transfer systems was just +0.9 percent of lifetime earnings. Similarly, we forecast a future in which net public education benefits amount to +6.8 percent of lifetime earnings for the birth cohort of 2006, while Social Security and Medicare account for a net loss of only –1.7 percent. So, the net benefits from all transfer systems for children born now are projected to be +5.1 percent of lifetime earnings. All generations born between 1979 and 2000 will experience a greater net present value relative to earnings than the most fortunate generation born around 1900 (the generation born in 1908 received

FIGURE 7 Present value at birth of expected lifetime education, Social Security, and Medicare net benefits as a percent of lifetime earnings



NOTE: Calculated using the baseline assumptions (see text).

5.7 percent). All generations born between 1947 and 2060—that is, over the course of more than a century—are projected to attain positive net present values when all three transfer systems are considered together.

The current young and future generations are sometimes viewed as victims of profligate public policy in the United States and other industrial countries, whereby the current elderly cohorts live comfortably at their expense. In fact, however, an elderly person born in 1936 experienced a net loss of about 2 percent of lifetime earnings, while a baby born today is projected to realize a net gain of 5 percent. This is the opposite of the story we are accustomed to hearing. Evidently, adding education to the mix dramatically changes the generational equity picture.

While largely mirroring one another, differences in timing of the introduction and expansion of the three transfer programs mean that some cohorts received net fiscal benefits and others incurred net fiscal losses. There are two peaks in net benefits. The first was centered on the cohort born in 1908, which experienced the large windfall gains from the introduction of Social Security and avoided much of the windfall losses from the expansion of public education funding. The 1908 cohort received net transfers amounting to 5.7 percent of lifetime earnings. The second peak in net benefits is centered on the cohorts born in 1993–94, which experienced the positive benefits of the educational expansion funded by previous generations and which, given our baseline assumptions on cutting benefits from and raising taxes for Social Security and Medicare, are projected to avoid the looming net costs of paying the implicit debt associated with Social Security and Medicare. On net, these cohorts are forecast to receive net benefits amounting to 5.6 percent of lifetime earnings.

Three sets of cohorts experienced net losses through the public transfer systems. Those born before 1880 experienced net losses due to the expansion of the public education system. Those born between 1930 and 1947 also experienced net losses. While these cohorts received large windfall gains associated with the start-up periods for Social Security and Medicare, these were more than offset by windfall losses from the expansion of public education. Cohorts born after 2060 are expected to incur increasingly large net losses as debts associated with Social Security and Medicare benefits overwhelm the gains through education.

Balancing the budget—what options are feasible?

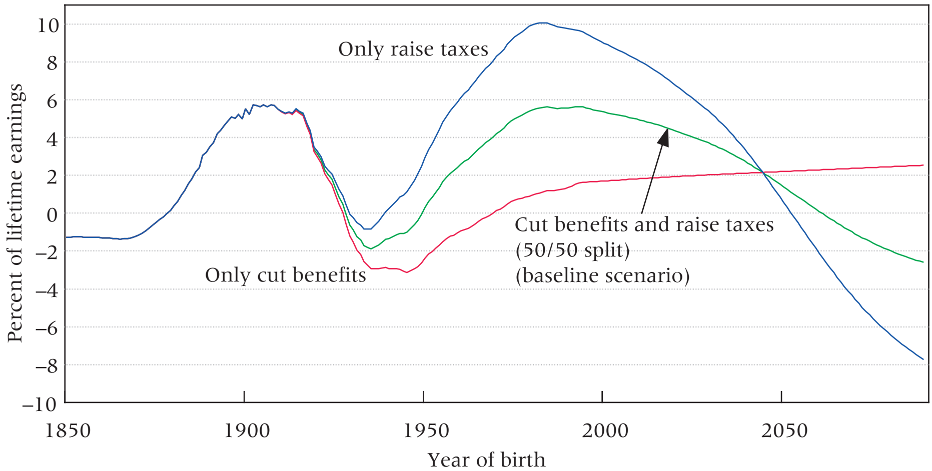
Balancing the budget for Social Security and Medicare entirely by cutting benefits is fiscally feasible, although probably too painful to be politically acceptable. Balancing the budget entirely by raising taxes to cover currently scheduled benefits would require 25 percent of GDP in 2080 (for the three transfer programs combined) and 38 percent of GDP by 2200, versus 12 percent today. This option does not seem politically or economically feasible, given the other costs of government. Our 50/50 mix of benefit cuts and tax increases would require 18 percent of GDP in 2080 and 23 percent in 2200 for the three programs, which, in view of corresponding current expenditures in some economically advanced countries other than the United States, does not seem out of the question.

Which generations benefit from cutting benefits versus raising taxes?

We consider the intergenerational consequences of these three alternative adjustment policies combined. In all three cases, the policy for education is left unchanged since that budget is balanced by design. The results are shown in Figure 8, which plots the net present values under each budget-balancing policy scenario. The policy of raising taxes to cover costs of benefits has intergenerational effects that are qualitatively similar to the baseline policy, although the quantitative differences are large: young generations of today have much higher net present values if benefits are maintained, while generations after 2050 suffer much greater losses relative to the 50/50 baseline budget-balancing policy. The third policy, of cutting Social Security and Medicare benefits increasingly severely so as to stay within tax revenue constraints, has a strikingly different outcome: all generations born after 1968 have a constant positive net present value, with values reaching about 2 percent for cohorts born in 2025.

We now consider the implications of these three policies for each generation alive today, by calculating their net present values looking forward

FIGURE 8 Budget-balancing policy options: Present value at birth of the combined expected lifetime education, Social Security, and Medicare net benefits as a percent of lifetime earnings under three alternative scenarios

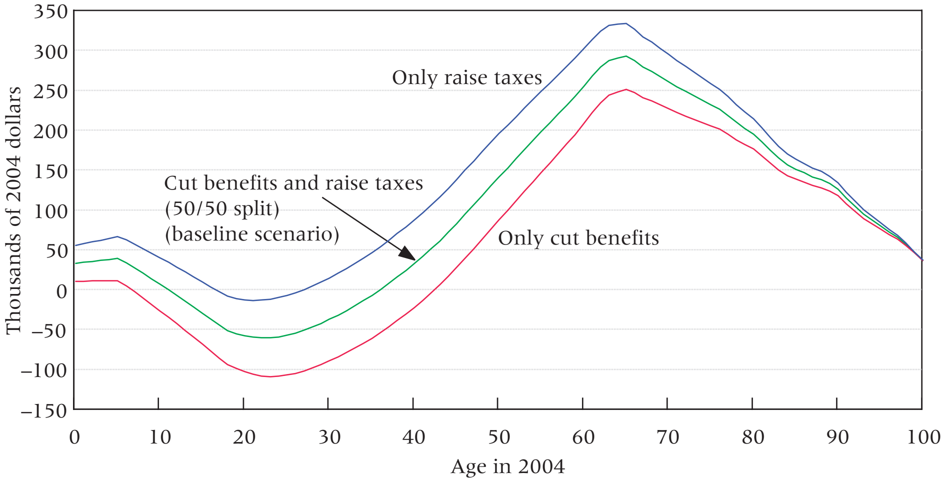


NOTE: Budget-balancing options do not apply to education, which is already assumed balanced.

from each generation's age in 2004, rather than from birth. Doing this indicates the effects of the different policy options on each generation's remaining interactions with the public-sector transfer programs, and thereby reveals their narrow self-interest in different policy options.[11] Figure 9 plots the results. First consider the baseline curve. We see that the net present values are positive at all ages except 12 to 35, with a peak loss of around \$60,000 in the early 20s. The net present values peak at age 65, with a value of \$290,000. Clearly and unsurprisingly, the elderly have the greatest stake in maintaining the current system.

Next consider the contrast between balancing the budget by raising taxes (the upper line) and cutting benefits (the lower line). Every generation alive today, even those just born, would gain from raising taxes. Those who would gain the most are the generations between ages 20 and 60 in 2004, for whom the difference in present value amounts to around \$105,000. Furthermore, by returning to Figure 8 we see that generations not yet born, up through those born in 2044, would also gain from the policy of raising taxes. Needless to say, however, these gains come at a great loss to later generations, with those born in 2090 losing 10 percent of their lifetime earnings relative to the option of cutting benefits, with the proportionate losses continuing to grow rapidly thereafter. According to this analysis, the gains from restricting benefits for the elderly in order to balance the budget would not be realized by any generation alive today, nor by any to be born in the next 35 years, but only thereafter.[12]

FIGURE 9 Net present value at each age in 2004 of participating in all transfer programs in three alternative future budget-balancing options



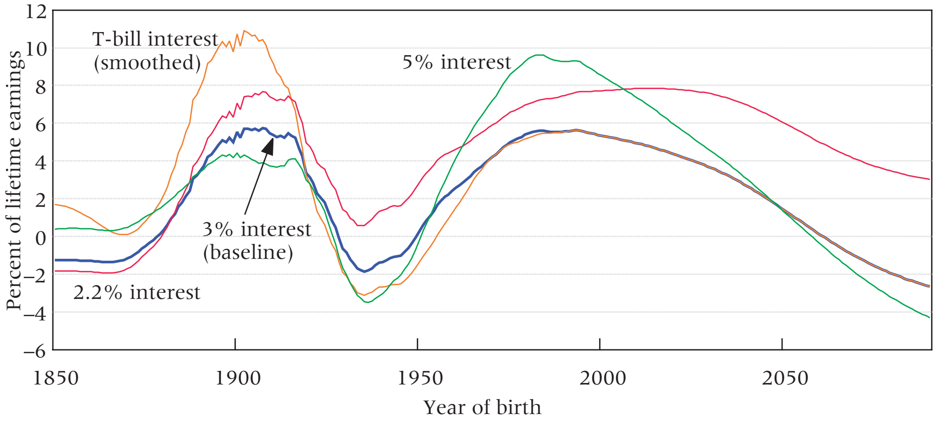
NOTE: Budget-balancing options do not apply to education, which is already assumed balanced. In order to measure changes in real rather than nominal dollars, the effect of price inflation in the historical series is removed by converting current-year dollars into constant year-2004 dollars using the GDP price-deflator.

Because the budgets for public education are already balanced by assumption, the age pattern of gains or losses from the budget-balancing options results entirely from the age pattern of effects of cutting benefits from or raising taxes on Social Security and Medicare. Appendix Figure A2 shows the results of the same calculations underlying Figure 9, but this time excluding public education. As expected, we see again that every age benefits from higher taxes and is hurt by lower benefits, and the contrast in present value for all ages from 20 to 60 is roughly $105,000.

Sensitivity to rates of discount

Because net present values are based on discounting over life cycles that last up to 110 years, one might expect our results to be highly sensitive to the discount rate used. Figure 10 displays the results of a sensitivity analysis in which calculations are carried out for our baseline discount rate of 3 percent per year (real) and for constant rates of 5 percent, 2.2 percent, and the time-varying historical rate of interest on short-term Treasury Bills. In general, higher rates of interest reduce the value of benefits received late in life relative to those received early, and lower rates have the opposite effect. Thus the 5 percent discount rate makes the windfall gains of the generations born around 1900 relatively smaller and the gains from education of those born around 2000 relatively greater, while the historical rate of interest has the opposite effect. However, the qualitative results are surprisingly robust.

FIGURE 10 Sensitivity tests of net present value at birth using various discount rates



We also investigated the sensitivity to variations in the discount rate of the results shown in Figure 9, the gains to each generation from the future balancing of the budget by raising taxes or cutting benefits. Lower discount rates strengthen the conclusion that all generations gain from raising taxes. However, discounting at 5 percent makes generations aged 18 or less in 2004 indifferent between raising taxes and cutting benefits, and the youngest generations would slightly prefer benefit cuts.

Discussion

Human capital is one of the main generators of economic growth, and public funding of education is an effective way to ensure that human capital grows quickly. But public funding for education results in "downward transfers" viewed either cross-sectionally or longitudinally. Historical data show that these downward transfers have been very costly for some generations. For example, transfers for public education in the United States have cost more than 5 percent of the lifetime earnings of the cohorts born between 1928 and 1942. Was it legitimate to ask these generations to give up more than 5 percent of lifetime earnings for future generations in order to give them a better life? Or should we see the introduction of public upward transfers, which gave windfall benefits to these same generations, as a legitimate counterpart to the financial sacrifices they were asked to make for the development of public education? Without judging what is or is not legitimate, our results simply show that the cohorts born between 1928 and 1942 have been more or less repaid, through Social Security and Medicare, for the costs they incurred for the development of public education.

Nonetheless, some generations have paid (or will pay) more than they received and others less. The three kinds of intergenerational transfers we consider do not fully cancel out and are the source of some financial redistribution between generations.

Generations born between 1850 and 1878 paid more than they received. These generations lived at the beginning of the development of public intergenerational transfers and were perhaps not compensated by externalities arising from a better-educated society. For them the development of the welfare state may well have been costly. The cost remained moderate, however, peaking at 1.4 percent of lifetime earnings.

Generational accounts turn positive for cohorts born between 1879 and 1927 and then remain above –1.8 percent and for the most part positive for all cohorts we consider in this analysis until 2078. But it is clear that the growth in human capital facilitated by the development of public education from the middle of the nineteenth century had an effect through economic growth that largely compensated for or reversed this minor loss. These externalities are not included in our accounts. In other words, even if some generations born after 1930 paid slightly more than they received in public transfers, they all benefited from the transfer. Thus, apart from the generations born before 1879, our data are consistent with the argument of Becker and Murphy that the introduction of the three public transfers considered together represent Pareto-improving reforms.

Nonetheless, Figure 7 does raise some questions. First, were upward transfers developed only to compensate for downward public transfers for education? Our results do not support such a view, since generations born between 1880 and 1930 actually received significantly more from Social Security and Medicare than they paid for public education. Intergenerational transfers considered as a whole redistributed resources from generations born in the two decades after 1930 more than from those born earlier. The higher lifetime incomes of those born after 1930 might justify doing so, but this redistribution should not be ignored.

The question that naturally follows is why the negative net present values for generations born between 1930 and 1947 were followed by increasingly positive values for subsequent generations through 2052, who are richer or are expected to be so. The rationale for this redistributive aspect of public intergenerational transfers is therefore not obvious. It may be that externalities, and economic growth in particular, were greater for those born in the 1930s and 1940s and that the overall gains have a different shape than the net present values, but it is difficult to make such a statement without having a clear understanding of what actually drove economic growth.

Finally, we cannot ignore the fact that for generations born after 2052, the projected net present values turn increasingly negative, with no end in sight to the trend that has lowered the net present value below –4 percent by the end of our projection. These negative net present values might easily be counterbalanced or even overwhelmed by positive externalities to education, but we have no evidence on this point.

It is widely acknowledged that the long-term budgets of both Social Security and Medicare are seriously out of balance, a problem that must be addressed in one way or another. Abstracting from deadweight loss,[13] our analysis suggests that all current generations would gain from policies that preserve benefit levels by raising taxes, as opposed to those that lower benefits and keep taxes constant; and that is also true for their children and most grandchildren. The big gainers from benefit cuts are generations farther in the future—in the absence of such reform, the losses to those future generations may be enormous.

Appendix A: Methods and data sources for estimates of generational accounts

The necessary inputs for the calculation of net present values at birth are an interest rate, r (or a series of interest rates, $r(t)$, for the lifetime of the cohort); survival probabilities to age x for each birth cohort, $l(x,t)/l(0)$ in life table notation; and the cost of the average benefits received by age, $\beta(x,t)$, and taxes paid for this benefit, $\tau(x,t)$, also over the full life cycle. Given these inputs, the net present value for the generation born in year s, with constant discount rate r, is given by:

$$NPV(r) = \int_0^{\omega} e^{-rx}\left(l(x,s+x)/l(0)\right)\left(\beta(x,s+x)-\tau(x,s+x)\right)dx$$

Methods for estimating net present value for public education, Social Security, and Medicare

Data on population, education expenditure, and taxes come mainly from the US Census (Integrated Public Use Microdata Series, or IPUMS; Ruggles and Sobek 2003, «http://www.ipums.org»). Data are available at the micro level for each census year between 1850 and 2000, except 1890 and 1930. Between available census years, we use interpolation and smoothing to obtain estimates for single calendar years.

Calculating the cost of educational services received by age

The estimation of the historical education accounts is described in detail in Qian 2002. Here we summarize these calculations. The IPUMS census data do not provide educational expenditures. To calculate the public expenditure per capita for each year, we use public expenditure per pupil, which is either directly available or is derived from total expenditures and total enrolled students (taken from Carter et al. 2006, *Historical Statistics of the United States*, and National Center for Education Statistics, *Digest of Education Statistics*, various years). The total enrollment in public schools was calculated by multiplying the enrollment rates from IPUMS by the proportion of total enrollment that attended public schools (that is, we adjusted to remove private school enrollment). When day care and nursery school enrollments were reported, we eliminated all enrollments under age 5. Expenditure data did not distinguish between elementary and high school. For future years, we assume that the expenditure per pupil for public education will grow at the same rate as the projected labor productivity growth rate, which we assume to be 1.6 percent per year (in real terms, consistent with Board of Trustees 2004). Incomes by age are likewise assumed to grow at this rate.

Calculating taxes paid for education, by age

Property taxes, collected in the US at the local level, have always been a dominant source of funding for public education; in the US, educational services are also organized and provided primarily by government below the Federal level. We take property taxes to be proportional to property value. In the census, this value is reported by respondents who own their own homes. Renters report their average monthly rent, which we assume is proportional to the value of the property. We use census data from 1940 to 1990 to derive the age profile of home value for household heads who own their homes and the age profile of monthly rent for heads who pay rent. Data from the Bureau of Economic Analysis give the aggregate value of residential housing by tenure (owned and rented) from 1925 to 1990. We use these data to adjust the levels of the two age profiles. We assume that 70 percent of property taxes on rental properties are passed on to renters in the form of higher rents. The age profile of the value of landlord-owned homes takes the same shape as the age profile of owned-home values.

We assume a balanced education budget for each year, so that total taxes paid for education exactly equal total public expenditure on education. The level of the age profile of tax payments is adjusted so that, given the population age distribution, the appropriate total of tax payments is generated. Finally, using the survival rates for each cohort, and an interest rate or set of interest rates, we calculate the net present value according to the equation given earlier.

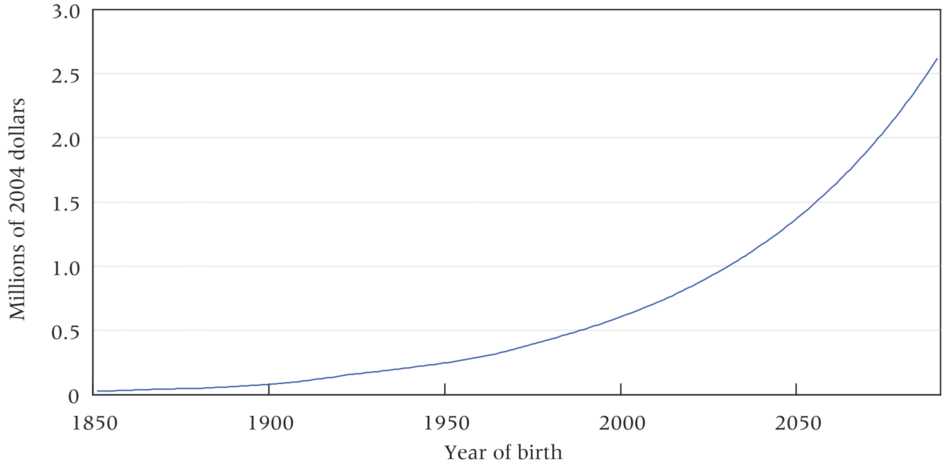
Projecting educational enrollments

Our projections of enrollment rates are based on the sum of enrollment proportions across ages for each calendar year, which we call the Total Enrollment Rate, or TER (analogous to the Total Fertility Rate, or TFR). The TER should correspond to the average years of schooling for each synthetic cohort, had it lived its life exposed to the enrollment rates of a single calendar year. The TER rises roughly linearly from 1850 to 2000, with a slight deceleration in recent years.[14] We have projected the TER in three ways. First, at the average of the historical trends for the United States and France from 1960 to 2000 (which removes the effects of the recent slowdown in the US), at .95 years of increased schooling per decade until 2150, and flat thereafter. Second, at one half this rate, or .475 years of increased schooling per decade. And third, as our baseline assumption, at a continuation of the level in 2000, that is, with no further enrollment gains. These alternative projection assumptions have only a small effect on our results, as is shown by the net present values in Figure 6.

Calculating the costs and benefits for Social Security and Medicare

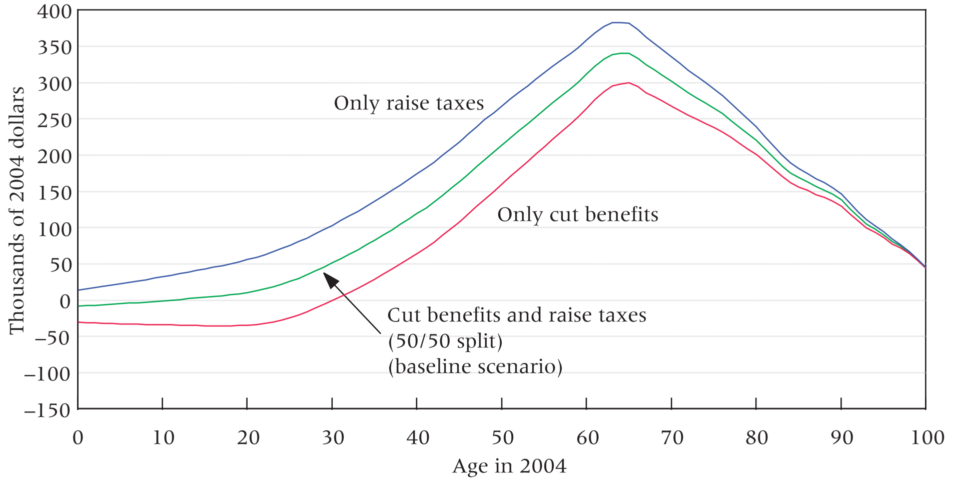
For Social Security and Medicare, we rely on administrative data for the historical period. For the projection period, we rely on simple age-based projection models. These models quite closely match the official financial projections issued by the Social

FIGURE A1 Present value at birth of lifetime earnings



Security and Medicare Trustees. We must use our own models rather than rely on official projections for two reasons. First, age profiles of average benefits and taxes are not included in the official projections. Second, we want to perform sensitivity analyses by altering the assumptions about the demographic and economic future.

FIGURE A2 Net present value at each age in 2004 of participating in Social Security and Medicare combined, in three alternative future budget-balancing options



NOTE: In order to measure changes in real rather than nominal dollars, the effect of price inflation in the historical series is removed by converting current-year dollars into constant year-2004 dollars using the GDP price-deflator.

Appendix B. Consistency with generational accounting and other accounts

Although the methodology we use is very similar to generational accounting as developed by Auerbach, Gokhale, and Kotlikoff 1991 (henceforth AGK), our objectives are different. The aim of AGK is to evaluate to what extent a current transfer system is sustainable. For that purpose, (1) AGK assume that the generations already born will contribute and benefit according to the transfer systems under current law or with specified changes; (2) they assume that the implicit debt created by such transfer systems will be uniformly spread over future generations; hence, (3) the comparison of the net contribution of the most recently born cohort to the net contribution of the next birth cohort provides a measure of the non-sustainability of the current transfer system. But, apart from the most recently born generation, AGK do not tell us the lifetime contribution of any given cohort. In particular, they do not use the retrospective data that would be necessary to compute the net contribution of cohorts born in the past. Furthermore AGK's assumption that future generations will have the same net contribution (once rescaled by a discount factor) is to be considered as a thought experiment to provide a general result, but not as a realistic projection even of the medium-term future. Thus AGK's results are informative about the global sustainability of the transfer system but do not help to answer the questions we address—who gains and who loses from the actual and plausibly projected development of public intergenerational transfers?

With our dataset we can also reproduce the calculations by Gokhale and Smetters (2003) and compare our results to theirs. They report the net present value of expected future benefits minus taxes for the population age 15 and over in 2002, under current program rules with no future budget-balancing adjustments (this value plus initial trust funds equals their measure of Generational Imbalance, GI). They calculate a net present value of $15.4 trillion for Medicare and $10.1 trillion for Social Security. Under our "current law" assumptions, and restricting our calculation to the population 15 and over in 2002, we derive $17.9 trillion for Medicare and $16.5 trillion for OASI. Our assumptions differ in several respects. Most notably, Gokhale and Smetters assume a discount rate of 3.6 percent, a growth rate of GDP per capita of 1.7 percent, and do not include Medicare receipts from general revenue in calculating the net present value for Medicare. We assume a discount rate of 3 percent and a productivity growth rate of 1.6 percent (with covered earnings growing at 1.4 percent). In calculating the net present value for Medicare, we include future income from general revenues. Given these differences, the agreement between their estimates and ours is quite good.

Appendix C. Robustness to inclusion of veterans' benefits and other transfers to the elderly

Our baseline analysis includes only three public transfer programs: education, OASI, and Medicare. But a number of programs for the elderly predated Social Security, including Public Employees Retirement, Railroad Retirement System, and Veterans' Pensions. Of these, expenditures on Veterans' Pensions were by far the most important, exceeding the sum of the other two for every year during our study period except 1942 (Comelatto 2005). Expenditures on veterans' benefits have long been an important component of federal government expenditures. Veterans' benefits were larger than OASI payments in every year prior to 1957. To assess the impact of these programs on our net present value accounts, we conducted a detailed analysis of veterans' benefits, as described below. Benefits peaked around 1950 at about 2 percent of GDP and have been steadily declining since. In 2008 they amounted to 0.3 percent of GDP.

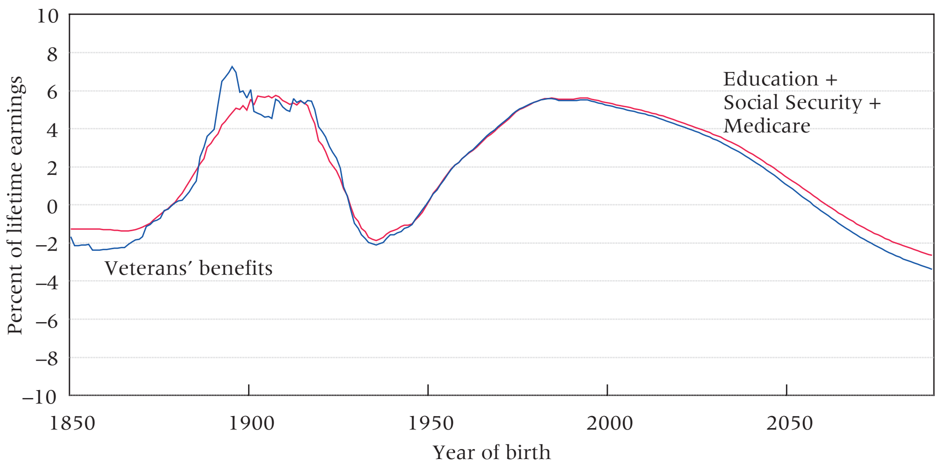
Veterans' benefits are defined to include pension, medical benefits, and readjustment benefits consisting of education, training, vocational rehabilitation, and unemployment benefits. Control totals are taken from two principal sources: for 1790 to 1961 from the US Statistical Abstract, Series Y984-997; and for 1962 to 2005 from the Budget of the US Government: Historical Tables, Fiscal Year 2007, Table 3.2 Federal Outlays by function and sub-function 1962 to 2011.

The age profiles of veterans' benefits are based on both administrative data and the US Census. Lacking information on the receipt of veterans' benefits by age, we assume that readjustment benefits (consisting of education, training, vocational rehabilitation, unemployment allowances) are received by veterans under age 35, while pension and medical benefits are paid to veterans over age 55. We assume that the age profile of benefits shifts upward at 1.6 percent per year from 2005 onward, our assumed rate of productivity growth. We make no allowance for the likely expansion of veterans' benefits following the Iraq and Afghanistan Wars. Benefits are assumed to be fully funded in each year from general taxes.

We found two distinct peaks in the net present value for generations of veterans' benefits that correspond to the mass military conscriptions during World War I (cohorts born in the mid-1890s) and World War II (cohorts born around 1920). For the vast majority of cohorts, net transfers to veterans represent less than 0.5 percent of lifetime earnings.

As seen in Figure C1, the inclusion of these benefits does not significantly alter our findings. Net present values as a percent of lifetime earnings are 0.6 percent

FIGURE C1 Net present value at birth of expected lifetime public benefits as a percent of lifetime earnings



lower when veterans' benefits are included in the calculation for cohorts born 1850 to 1885. Net present values are 2.1 percent higher for cohorts born 1891 to 1896, reflecting the large veterans population of these cohorts. After 1926, the inclusion of veterans' benefits makes very little difference: on average, net present values are about 0.3 percent lower.

Notes

Figures in this article are available in color in the electronic edition of the journal.

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1 In this intergenerational context, a Pareto-improving change is one in which at least one generation is better off and no generation is worse off.

2 Some recent contributions have drawn on Becker and Murphy's idea. Rangel (2003) shows that, if generations are penalized when they do not contribute, equilibria exist for intergenerational renegotiable contracts where all generations contribute, and that in such equilibria the net present value of benefits received minus taxes paid cannot be negative. Boldrin and Montes (2005) formalize Becker and Murphy's argument, showing, under strong assumptions, that a system of taxes and transfers can replace the missing market for human capital loans, and reproduce the market equilibrium that would arise if credit markets worked perfectly.

3 The cost of providing education is closely linked to the salaries of teachers, which rise in response to productivity increases in other sectors of the economy. Therefore the cost of education over time is not a good indicator of its quantity or quality. At the same time, the value of education is heavily influenced by the growth in complementary inputs such as technology and capital per worker. Similar issues arise in the valuation of Medicare and health care services. In any event, in our accounts we value both education and health care at the public cost of provision.

4 The Medicare program has three parts. Part D subsidizes purchases of prescription drugs. Part A pays for in-patient hospital expenses and is sometimes referred to as HI for hospital insurance. Part B pays for outpatient expenses including doctors' services; it is also referred to as Supplemental Medical Insurance, or SMI. Part C provides further options.

5 Covered wages are wages subject to payroll tax.

6 The budget is balanced each period using the full population age distribution, and assuming that immigrants are economically identical to natives at each age. This sets the level of taxes and benefits according to the specific budget-balancing assumptions used. Then, based on these age schedules of taxes and benefits, we calculate the net present values for the native-born population, since it would not make sense to calculate these values at birth for immigrants who arrive at later ages.

7 In common usage a windfall gain is an unexpected gain and a windfall loss is an unexpected loss, although here the gains and losses cannot be said to be unexpected.

8 See endnote 4.

9 To be sure, children received education through private parental expenditure before the advent of public education. Similarly, the elderly received support from their adult children with whom they often coresided before the advent of Social Security retirement benefits. They received health care before Medicare. As noted earlier, here we present accounts for the public sector and do not attempt an overall treatment of public and private transfers together.

10 The "internal rate of return" or "implicit rate of return" is the discount rate that

makes equal the present value of the costs and the returns from an investment or a transfer system.

11 These net present values are also useful for comparisons to Generational Accounting, which presents numbers of this sort for living generations, rather than the net present values at birth that we have so far considered.

12 Bergstrom and Hartman (2005) explore similar questions and reach broadly similar conclusions, but they analyze a stylized pay-as-you-go pension system, whereas we analyze OASI plus Medicare in full detail. With a 3 percent discount rate, they find that voters over the age of 33 or so would favor increased benefits. We find that all individuals, including generations born through 2045, would favor increased benefits. Our inclusion of Medicare is partly responsible for the difference.

13 In this context, deadweight loss is the inefficiency caused by higher taxes.

14 The TER is higher than the median educational attainment for several reasons. First, it includes kindergarten years. Second, it is a mean rather than a median. Third, it includes both part-time and full-time enrollment. Fourth, it includes time spent repeating grades.

References

Aaron, Henry. 1966. "The social insurance paradox," *Canadian Journal of Economics and Political Science* 32(3): 371–374.

Auerbach, Alan J., Jagadeesh Gokhale, and Laurence J. Kotlikoff. 1991. "Generational accounts: A meaningful alternative to deficit accounting," in David Bradford (ed.), *Tax Policy and the Economy*. Cambridge, MA: MIT Press, for the National Bureau of Economic Research, pp.55–110.

Becker, Gary S. and Kevin Murphy. 1988. "The family and the state," *Journal of Law and Economics* 21: 1–18.

Bergstrom, Theodore C. and John L. Hartman. 2005. "Demographics and the political sustainability of pay-as-you-go Social Security," UCSB, Department of Economics, 1 January.

Board of Trustees, Federal Old-Age and Survivors Insurance and Disability Insurance Trust Funds, Social Security Administration. 2004. *The 2004 Annual Report of the Board of Trustees of the Federal Old-Age and Survivors Insurance and Disability Insurance Trust Funds*, USGPO.

Boldrin, M. and A. Montes. 2005. "The intergenerational state: Education and pensions," *Review of Economic Studies* 72: 651–664.

Carter, Susan B. et al. (eds.). 2006. *Historical Statistics of the United States: Millennial Edition.* Cambridge University Press.

Chojnicki, Xavier and Frédéric Docquier. 2007. "Fiscal policy and educational attainment in the United States: A generational accounting perspective," *Economica* 74(294): 329–350.

Comelatto, Pablo. 2005. "Report on public spending on retirement programs before 1950," research note of the National Transfer Accounts Project at the University of California, Department of Demography, available on request.

Cutler, David and Louise Sheiner. 2000. "Generational aspects of Medicare," *American Economic Review* 90(2): 303–307.

Fehr, Hans and Laurence J. Kotlikoff. 1999. "Generational accounting in general equilibrium," in Alan J. Auerbach, Laurence J. Kotlikoff, and Willi Leibfritz (eds.), *Generational Accounting Around the World.* The University of Chicago Press.

Gokhale, Jagadeesh and Kent Smetters. 2003. *Fiscal and Generational Imbalances: New Budget Measures for New Budget Priorities*. Washington, DC: American Enterprise Institute.

Jensen, Svend E. Hougaard and Bernd Raffelhüschen. 1999. "Public debt, welfare reforms, and intergenerational distribution of tax burdens in Denmark," in Alan J. Auerbach, Laurence J. Kotlikoff, and Willi Leibfritz (eds.), *Generational Accounting Around the World.* The University of Chicago Press.

Lee, Ronald and Lawrence Carter. 1992. "Modeling and forecasting U.S. mortality," *Journal of the American Statistical Association* 87(419): 659–671.

Leimer, Dean R. 1994. "Cohort-specific measure of lifetime net Social Security transfers," ORS Working Paper No. 59, Office of Research and Statistics, Social Security Administration.

Mason, Andrew et al . 2009. "Population aging and intergenerational transfers: Introducing age into national income accounts," in David Wise (ed.), *Developments in the Economics of Aging.* National Bureau of Economic Research, University of Chicago Press, pp. 89–122.

Miller, Tim. 2004. "A simple projection model of OASI finances," University of California–Berkeley, Department of Demography, manuscript.

Qian, Wenlan. 2002. "Education project report," University of California–Berkeley, Department of Demography, manuscript. Available as a National Transfer Accounts working paper at «http://www.schemearts.com/proj/nta/web/nta/show/WP09-07».

Rangel, Antonio. 2003. "Forward and backward intergenerational goods: Why is Social Security good for the environment?," *American Economic Review* 93: 813–834.

Ruggles, Steven and Matthew Sobek. 2003. "Integrated Public Use Microdata Series: Version 3.0" «http://www.ipums.org». Minneapolis: Historical Census Projects, University of Minnesota.

Schieber, Sylvester J. and John B. Shoven. 1999. *The Real Deal: The History and Future of Social Security*. New Haven: Yale University Press.