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## Who wins and who loses? Public transfer accounts for US generations born 1850 to 2090

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### Abstract

Public transfer programs in industrial nations are thought to benefit the elderly through pension and health care programs at the expense of the young and future generations. However, this intergenerational picture changes if public education is also considered as a transfer program. We calculate the net present value (NPV) of benefits received minus taxes paid for US generations born 1850 to 2090. Surprisingly, all generations 1950 to 2050 are net gainers, while many current elderly are losers. Windfall gains from starting Social Security and Medicare partially offset windfall losses from starting public education, roughly consistent with the Becker-Murphy theory.

### Introduction

Virtually all industrial nations 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 Third World nations are following their example. It is well known that population aging will cause intense fiscal pressures for these programs. For the most part, nations have left programs in place that are seriously fiscally unbalanced and demonstrably unsustainable, but the clamor for reform grows louder each year, while the public strongly resists any reduction in benefits.

While the need to reform social security 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 saddled with the burden of a 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. It is generally difficult to define, and the intergenerational dimension makes it even more so. Various approaches have been

suggested: utilitarianist, Rawlsian, accounting, etc. These approaches can substantially differ, but they have in common that they adopt a longitudinal view. Actually, for most people, it would make little sense to discuss the fairness of pension benefits without considering contributions.

Surprisingly, discussions of one kind of transfer are persistently framed horizontally rather than longitudinally: education. 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 and 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, when it comes to education, we think of it cross-sectionally, not as a benefit we receive early in life and then pay for later through our 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 an extremely important public transfer. In the US in 2000, Education (including higher education) was the largest public transfer program at 4.6% of GNP, followed by OASI (that is, public pensions and survivor's benefits) at 3.7% and Medicare (that is, public health care for those age 65 and over) at 2.3%. Second, due to 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 thirty years earlier than the average age of paying taxes, which is in turn about thirty years earlier than the average age of receiving old age benefits. Each 30 years of discounting at 3% introduces a discount factor of .4, so 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, a dollar of educational benefits can easily be worth ten dollars of old age benefits. Third, in contrast to Social Security and Medicare, Education is a downward transfer: a transfer that flows from older to the younger members of the population. Consequently, it may offset some of the effects of upward transfers and give rise to interesting results. The most striking example is that of Becker and Murphy (1988) who explain 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.<sup>1</sup>

In the Becker and Murphy (1988) theory, altruistic parents choose to invest in the education of their children up to a point through private transfers. However, because the 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 education is too low.

This sets the stage for the start of public education. The state taxes the worker-parents to raise the revenues to provide the optimal amount of education for the children. The parents are now worse off than before, because they have been forced to spend more on education than they

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<sup>1</sup>A Pareto improving change is one in which at least one generation is better off and no generation is worse off.

wished. To compensate the parents, the state taxes the children, once they are grown into workers, in order to pay their now elderly parents a public pension. The new transfers for public education from parents to children, through the state, are balanced by new 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.<sup>ii</sup> Of course, this story should not be taken too literally.

In this paper we focus on the US. We consider in a consistent framework the financial redistributions implied by the three main public transfer systems: Education, Social Security and Medicare, providing useful information for assessing 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 story might actually 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 comparative discussion, see Appendix B.

Our work focuses on financial redistribution and therefore is 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: (i) a measure of the flows of transfers, (ii) an estimate of the indirect effects of transfers (due to externalities, distortions, offsetting behavioral responses, etc—see Fehr and Kotlikoff, 1999) and (iii) a widely accepted measure of individual welfare. We chose to deal only with the first point without making any assumptions about the last two, which are very controversial issues. Our conclusions are by construction of restricted scope, therefore, 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 ages. We are certainly not arguing that without public education children would remain illiterate, and without Social Security and Medicare the elderly would starve and die for want of medical attention. Should we then treat the benefits as accruing to these former private providers? Supposing for the moment that we had some means of estimating these indirect benefits, how then should we treat the further rounds of indirect flows of benefits, since these 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. This paper is about the public sector, and not about 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.<sup>iii</sup> 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

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<sup>ii</sup>Some recent contributions have drawn on Becker and Murphy's idea. Rangel (2002) shows that, if generations are punished when they do not contribute, there exist equilibria 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.

years of life in old age, both 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? An investment by whom? Not the parents, since they have no claim on the stream of income that results from their children's education. In fact, it is a transfer of an asset, namely human capital, to the children who do own the income stream that their education generates.

Humans enjoy a long life span, but its length is a nightmare for researchers trying 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 last day of their life. Thus to measure a single cohort's transfers, one needs data on transfers occurring over more than a century. Since 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. It goes without saying that 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 are matrices of the average value of benefits received and taxes paid by age, from 1850 through 2200, by single years of age and time. These matrices can be analyzed cross-sectionally for each calendar year, or across time for any given age, or diagonally by generation. Because we are interested in a longitudinal view, we focus mainly on the diagonals of the matrices, 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 (NPV) 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 life time earnings. Results will often be expressed relative to these present values for each generation.

Our discussion makes it possible to identify the generations who received (or will receive) more transfers than they paid (or will pay) and those who 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 NPVs for Social Security, starting with the first generations to receive any benefits, have been calculated by others (Leimer, 1994; Schieber and Shoven, 1999), but these differ in important respects, for example in treatment of projected mortality. For Medicare, NPV calculations have also been made (Cutler and Sheiner, 2000) but these also differ in some important respects. NPV calculations for public education have not previously been made, and these have required extensive analysis of historical data, as described in the Appendix. Here

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<sup>iii</sup>The cost of providing education is closely linked to the salaries of teachers, which rise due 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. Some 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.

we will present consistent calculations for all three, and for their sum, for the relevant generations, including some projections for the future.

The structure of the paper is as follows. In section 2 we explain how we estimated and forecast public transfers. Section 3 provides the results for each transfer system, and their combination, and compares our results with those of generational accounts. Section 4 discusses the main insights derived from our work. Section 5 concludes.

## Estimation and forecasts of transfers

### Data and Methods

The historical data for these three programs come from a variety of sources which we will briefly describe, along with our methods; further details are in the appendix. 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 the 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.<sup>iv</sup> 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 the details of their age-specific allocation, but we believe our results do not depend on these age-specific details.

For the projection, our general technique is to assume a fixed cross-sectional age-shape for benefits and taxes, and to shift the levels of these age profiles upwards at a fixed rate which 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, where these are available, and they accurately reproduce these.

Projections indicate that both Social Security and Medicare have major long term fiscal imbalances, and they are unsustainable as currently structured. While we do one set of projections based on current program structure, we also have specified three different 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 a real (that is, inflation adjusted) interest rate of 3%, and for projections we assume a productivity growth of 1.6% (real covered wage<sup>v</sup> growth of 1.4%, allowing for changes in

<sup>iv</sup>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.

hours worked, fringe benefits, etc., following Social Security Administration assumptions, see Board of Trustees, 2004, Table II, C1). We assume that age-specific costs per Medicare enrollee grow 1% 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 Board of Trustees (2004) the long-run total fertility rate is assumed to be 1.95. Annual net immigration is set at 900,000 per year (Miller, 2004).<sup>vi</sup> For many of these assumptions we have performed sensitivity analyses (discount rates, educational enrollment growth, and budget balancing policies).

Based on 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 program and each birth cohort as the difference between the lifetime discounted, survival-weighted benefits and the discounted, survival-weighted tax payments. Figure 1 displays the present values for Social Security benefits received and taxes paid by different generations under the baseline assumptions. Figure 2 does the same for Medicare. (Note that both figures give values as a percent of the present value of survival weighted lifetime earnings. These present values of lifetime earnings are shown in Appendix figure A2. The values for all figures including those in the appendix are available online at <http://www.schemearts.com/proj/nta/web/nta/show/WP04-02>. We will not discuss Figures 1 and 2 in detail at this point, but instead turn to the Net Present Values, or NPVs.

Figure 3 presents these NPVs 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 first regular benefit payments starting in 1950) and Medicare in the mid-1960s led to large windfall gains<sup>vii</sup> for the early participants in these pay-as-you-go systems. These early participants received benefits far in excess of the taxes they paid. The Social Security NPVs are highest, at about +4% to +6% of lifetime earnings, for the birth cohorts of 1890 to 1920, with those born in 1914 experiencing the greatest windfall gain with their combined social security and Medicare net benefits amounting to 8.7% of their lifetime earnings. Rates of return might be higher for earlier cohorts, but the NPV depends also on the scale of benefits received, not just on their relation to prior contributions.

For cohorts born after 1920, the NPV declines steadily to around -2% for cohorts born now, based largely on projections for the 21<sup>st</sup> century. The NPV for Medicare reaches a peak of around 4% for birth cohorts of 1930 to 1937. The NPV declines for cohorts born after 1937 reaching about -1% for cohorts born now.

Under our baseline 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

<sup>v</sup>Covered wages are wages subject to payroll tax.

<sup>vi</sup>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 (NPVs) for the native born population, since it would not make sense to calculate NPVs at birth for immigrants who arrive at later ages.

<sup>vii</sup>A windfall gain is an unexpected gain. A windfall loss is an unexpected loss, although this usage violates the analogy.

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.

Here we consider three alternative scenarios shown in Figure 4. In the first alternative, future shortfalls are met by cutting benefits. In this scenario, the NPVs are negative beginning with cohorts born in 1956. In the second alternative, future shortfalls are met by raising taxes. In this scenario, the NPVs remain positive until the generation born in 2020, but the NPVs for future generations are more negative than when benefits are adjusted rather than taxes. Finally, we consider the scenario in which there is no adjustment, and the systems are permitted to continue running deficits indefinitely. This is not a sustainable course since it leads to an explosion of debt. In this scenario, the NPV just keeps on rising as a share of life time earnings for generations born after 1960 or so, since taxes are not raised, nor benefits cut. Presumably the benefits are 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 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 initial participants in the social security system received a windfall gain, the first generation to make tax payments to support the public education system received a windfall loss as they paid for a level of public educational benefits which they themselves never received.<sup>viii</sup>

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 are debated in the literature. However, for education, we have been unable to locate any comparable long term projections. Therefore we will discuss these in a bit more detail.

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

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 NPV for public education for each birth cohort from 1850 to 2090, for three different projection assumptions: baseline (no enrollment growth after 2000), and enrollment growth continues on long term trend or at half of it (further details in the Appendix).

To interpret Figure 6, first imagine what it would look like if public education were suddenly introduced all at once in one calendar year. In this case, the initial birth cohorts would pay taxes but receive no education themselves, so all would show a negative NPV. The cohort born five years before the start of public education would be ready to start kindergarten at the inception

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<sup>viii</sup>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 a synthetic treatment of public and private transfers together.



of public education, and would receive the complete education provided. Consider the NPV for this cohort. We know that the internal rate of return<sup>ix</sup> for any mature stable transfer system must equal the rate of population growth plus the rate of productivity growth, or the rate of growth of GDP (Aaron, 1966). Since the educational benefit is received before the taxes are paid, we would expect the NPV 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% discount rate is below the growth rate of GDP for the early part of the period, and so should yield a negative NPV for the fully educated cohorts as well as the initial cohorts. The historical rates of interest should be a bit higher than the growth rate of GDP, and so yield a positive NPV.

In practice, however, public education was phased in very slowly. As enrollments and median grade attainments rose, each generation of tax payers funded a higher level of education than it received itself, so NPVs were negative. The generations that funded the education of the baby boom generation were hit particularly hard because there were so many students, and relatively few tax payers, and because of the timing of rapid enrollment increases. Those generations born between 1928 and 1942 all experienced losses of at least 5% of life time earnings through the educational system.

Figure 6 shows that the NPV becomes increasingly negative relative to life time earnings until it reaches its trough for the birth cohorts of 1935-36 at around -6%. After this it rises, but does not become positive until the birth cohort of 1959. It approaches a plateau in the 1980s, and ceases to rise in the 1990s after reaching a level close to +7%. Since this outcome is based almost entirely on values of taxes and expenditures projected far into the 21<sup>st</sup> 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 NPV's for the combined upward transfer (through Social Security and Medicare) together with the NPV 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. However, to a considerable extent we see that those generations that benefited from the start-up of the 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% of lifetime earnings which were offset by net public education benefit amounting to -4.6% of lifetime earnings, so that net effect of all transfer systems was just +.9% of lifetime earnings. Similarly, we forecast a future in which net public education benefits amount to +6.8% of lifetime earnings for the birth cohort of 2006, while social security and Medicare account for a net loss of only -1.7%. So, the net benefits from all transfer systems for children born now are projected to be +5.1% of lifetime earnings. All generations born between 1979 and 2000 will experience a greater NPV relative to earnings than the most fortunate generation at the turn of the century (the generation born in 1908 received 5.7%). All generations born between 1947 and 2060, that is over the course of more than a century, are projected to attain positive NPVs when all three systems are considered together.

The current young and future generations are sometimes viewed as victims of our profligate public policy, by which the current elderly live high on the hog at their expense. However, a now elderly person born seventy years ago, in 1936, experienced a net loss of about two percent of life time earnings, while a baby born today is projected to realize a net gain of 5%! This is

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<sup>ix</sup>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.

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 each other, the difference in timing of the introduction and expansion of these transfer programs means that some cohorts received net fiscal benefits and others net fiscal losses. There are two peaks in net benefits. The first peak was centered on the cohort born in 1908 which experienced the large windfall gains from the start-up of social security but missed much of the windfall losses from the expansion of public education funding. On net, the 1908 cohort received net transfers amounting to 5.7% of lifetime earnings. The second peak in net benefit is centered on the cohorts born in 1993-94 which experienced the positive benefits of the educational expansion funded by previous generations and which are projected to avoid the looming net costs of paying the social security and Medicare implicit debt. On net, these cohorts are forecast to receive net benefits amounting to 5.6% of lifetime earnings.

There are three sets of cohorts which experienced net losses through the 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 did receive 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 the public education system. Cohorts born after 2060 are expected to incur increasingly large net losses via the public transfer systems as Social Security and Medicare 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 certainly 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% of GDP in 2080 (for the three programs combined), and 38% of GDP by 2200, versus 12% today. This 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% of GDP in 2080, and 23% of GDP in 2200 for the three programs, which does not seem out of the question.

### **Which generations benefit from cutting benefits versus raising taxes?**

It is also interesting to consider the intergenerational consequences of these three different adjustment policies. In all three cases, the policy for education is left unchanged since that budget is balanced by construction. The results are shown in Figure 8, which plots the NPVs under each 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 NPVs if benefits are maintained, while generations after 2050 suffer much greater losses, relative to the “share the pain” baseline policy. The third policy, of cutting benefits increasingly severely so as to stay within tax revenue constraints, has a strikingly different outcome: generations born after 1968 all have a constant positive NPV, with values reaching about 2% for cohorts born in 2025.

Now let us consider the implications of these policies for each generation alive today, by calculating their NPVs looking forward from each generation's age in 2004, rather than from birth. Doing this indicates the effects of the different policy options on their remaining interactions with the public sector transfer programs, and thereby reveals their narrow self-interest in different policy options.<sup>x</sup> Figure 9 plots the results.<sup>x1</sup> First consider the baseline

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<sup>x</sup>These NPVs are also useful for comparisons to Generational Accounting, which presents numbers of this sort for living generations, rather than the NPVs at birth which we have so far considered.

curve. We see that the NPVs are positive at all ages except 12 to 35, with a peak loss of around \$60,000 in the early 20's. The NPVs peak at age 65, with a value of \$280,000. Clearly and unsurprisingly, the elderly have the greatest stake in maintaining the system.

Now consider the contrast between raising taxes (the upper line) and cutting benefits (the lower line). We see that every single generation alive today, even those just born, would gain from raising taxes. Those who would gain the most are the generations between age 20 and 60 in 2004, for which the difference in present value amounts to around \$100,000. Furthermore, by returning to Figure 8 we can see that generations not yet born, all the way 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% of their life time earnings relative to the benefit-cut option, and with the proportionate losses continuing to grow rapidly thereafter. According to this analysis, the gains from restricting benefits for the elderly would not be realized by any generation alive today, nor by any to be born in the next thirty five years, but only thereafter.<sup>xii</sup>

Because the budgets for public education are already balanced (by assumption), the age pattern of gains or losses from the budget balancing options result entirely from the age pattern of effects of cutting benefits or raising taxes on Social Security and Medicare. Appendix Figure A3 shows the results of the same calculations underlying Figure 9, but this time excluding public education.<sup>xiii</sup> As expected, we see again that every age benefits from higher taxes and is hurt by lower benefits, and that contrast in present value for all ages from 20 to 60 is roughly \$100,000.

### Sensitivity to rates of discount

Because the NPVs are based on discounting over life cycles that last up to 110 years, one might expect that our results would be very 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% per year (real), but also for constant rates of 5%, 2.2%, and the time varying historical rate of interest on short term Treasury Bills. In general, higher rates of interest reduce the importance of benefits received late in life relative to those received early, and lower rates have the opposite effect. Thus the 5% rate makes the windfall gains of the generations born close to 1900 relatively smaller and the gains from education of those born around 2000 relatively bigger, while the historical rate of interest has the opposite effect. However, the qualitative results are surprisingly robust.

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

<sup>xi</sup>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 2002 dollars using the GDP price-deflator.

<sup>xii</sup>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% 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.

<sup>xiii</sup>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 2002 dollars using the GDP price-deflator.

## Discussion

Human capital is one of the main generators of economic growth. As shown by past experience, as well as the on going situation in developing countries, public funding of education is an effective way to insure that human capital grows quickly. But “public funding” for education translates into “downward transfers” viewed either cross-sectionally or longitudinally.

Historical data on transfers show that these downward transfers have actually been very costly for some generations. For example transfers for public education have cost more than 5% of their lifetime earnings to the cohorts born between 1928 and 1942. Was it legitimate to ask these generations to give up more than 5% of their life time earnings for future generations who, hopefully, will also have a better life? Or should we see the development of public upward transfers, that did give a free lunch to these same generations, as a legitimate counterpart to the financial efforts 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, there are some generations that have paid (or will pay) more than they received and vice versa. The three kinds of intergenerational transfers we consider do not exactly cancel out and are the source of some financial redistribution between generations.

The first point to notice is that generations born between 1850 and 1878 paid more than they received. These generations were at the beginning of the development of public intergenerational transfers and were perhaps not compensated by externalities arising from a more educated society. For them the development of the welfare state may well have been costly. The cost remained moderate, however, peaking at 1.4% of life time earnings.

Generational accounts turn to positive for cohorts born between 1879 and 1927 and then remain above minus 1.8% for all cohorts we consider in this analysis until 2078. But it is clear that the growth in human capital that was facilitated by the development of public education from the middle of the nineteenth century had an effect through economic growth that largely compensated 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 for public transfers, they all benefited from them. Thus, apart from the generations born before 1879, our data are consistent with the Becker and Murphy argument.

Nonetheless, Figure 8 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. Actually, intergenerational transfers considered as a whole did redistribute resources from generations born after 1930 to those born earlier. The higher life time 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 NPVs for generations born between 1930 and 1947 were followed by increasingly positive ones 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 the case that externalities, and in particular economic growth, were greater for those born in the 1930s and '40s, and that the overall gains have a different shape than the NPVs, but it is difficult to make any such statement without having a very good understanding about what actually drove economic growth.

Finally, we cannot ignore the fact that for generations born after 2052, the NPVs turn increasingly negative, with no end in sight to the trend which has dropped the NPV below -4% by the end of our projection. These negative NPVs might easily be overwhelmed by positive externalities to education, but we have no evidence on this point.

It is well known 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<sup>xiv</sup>, our analysis suggests that all current generations would gain from policies that preserve benefit levels by raising taxes, as against the reverse, and that is also true for their children and most grandchildren. The big gainers from benefit cuts are generations farther in the future, but in the absence of such reform their losses may be enormous.

## Acknowledgments

Research was funded by grants from NIA, R37-AG11761 and R37-AG25247. David Cutler generously provided us with the data used for his generational accounts of Medicare. Wenlan Qian and Pablo Comelatto assisted with estimation. We have received helpful comments from Kent Smetters, Michael Hurd, Alan Auerbach, an anonymous referee, and participants in both the Berkeley Public Finance Seminar and the 2004 NBER Summer Institute on Economics of Aging.

## Appendix A: Methods and Data Sources for Estimates of Generational Accounts

The necessary ingredients for the calculation of the NPVs are an interest rate,  $r$  (or a series of interest rates,  $r(t)$ , for the life time 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, the NPV for the generation born in year  $s$ , with constant discount rate  $r$ , is given by:

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

## Methods for estimating NPV for public education, Social Security, and Medicare

The population, education expenditure and taxes data mainly come 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

In the census data we get from IPUMS, educational expenditures are not given. 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 the 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 was in public schools (that is, we adjusted to remove private school enrollment). When day care and nursery school enrollments were reported, we

<sup>xiv</sup>In this context, deadweight loss is the inefficiency caused by higher taxes.

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% per year (in real terms, consistent with Board of Trustees, 2004). Incomes by age are likewise assumed to grow at this rate.

### Calculating the taxes paid for education, by age

Property taxes have always been an important source of funding for public education. 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 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% of property taxes on rental properties are passed on to renters in higher rents. The age profile of the value of landlord-owned homes is 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 NPV 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.<sup>xv</sup> We have projected the TER in three ways. First, at the average of the historical trends for the US 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 NPVs 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 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 be able to perform sensitivity analyses by altering the assumptions about the demographic and economic future.

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<sup>xv</sup>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.

## 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, AGK 1) assume that the generations that are already born will contribute and benefit according to the transfer systems under current law or with specified changes; 2) assume that the implicit debt created by such transfer systems will be uniformly spread over the future generations; then 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 does not tell us the lifetime contribution of any given cohort. In particular, AGK does 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 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 an NPV 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 find \$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%, a growth rate of GDP per capita of 1.7%, and do not include Medicare receipts from general revenue in calculating the NPV for Medicare. We assume a discount rate of 3% and a productivity growth rate of 1.6% (with covered earnings growing at 1.4%). In calculating the NPV for Medicare, we include future income from general revenues. Given these differences, the agreement is quite good.

## Appendix C. Robustness to Inclusion of Veteran 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 NPV accounts, we carried out a detailed analysis of the Veterans Pensions, as described below. Benefits peaked around 1950 at about 2% of GDP and have been steadily declining since.

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 U.S. 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% 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 War. 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 which correspond to the mass military conscriptions during the First World War (cohorts born in the mid 1890s) and the Second World War (cohorts born around 1920). For the vast majority of cohorts, net transfers to veterans represent less than half a percent of lifetime earnings.

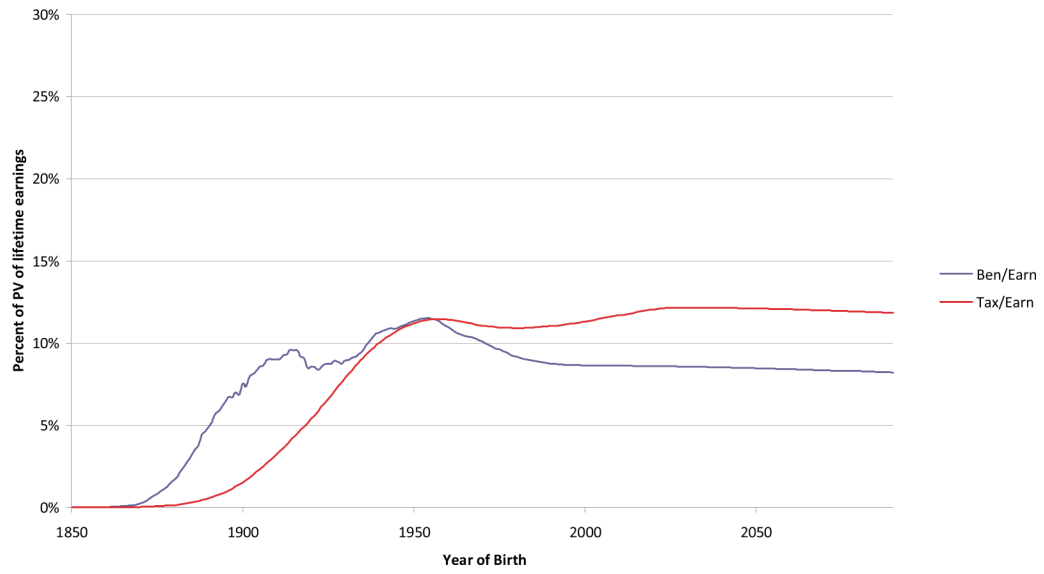
As seen in Figure A1, the inclusion of these benefits does not significantly alter our findings. NPV as a percent of lifetime earnings are 0.6% lower when veterans benefits are included in the calculation for cohorts born 1850 to 1885. NPVs are 2.1% higher for cohorts born 1891 to 1896 reflecting the large veterans population of these cohorts. After 1926, the inclusion of veterans benefits makes very little difference: on average, NPVs are about 0.3% lower.

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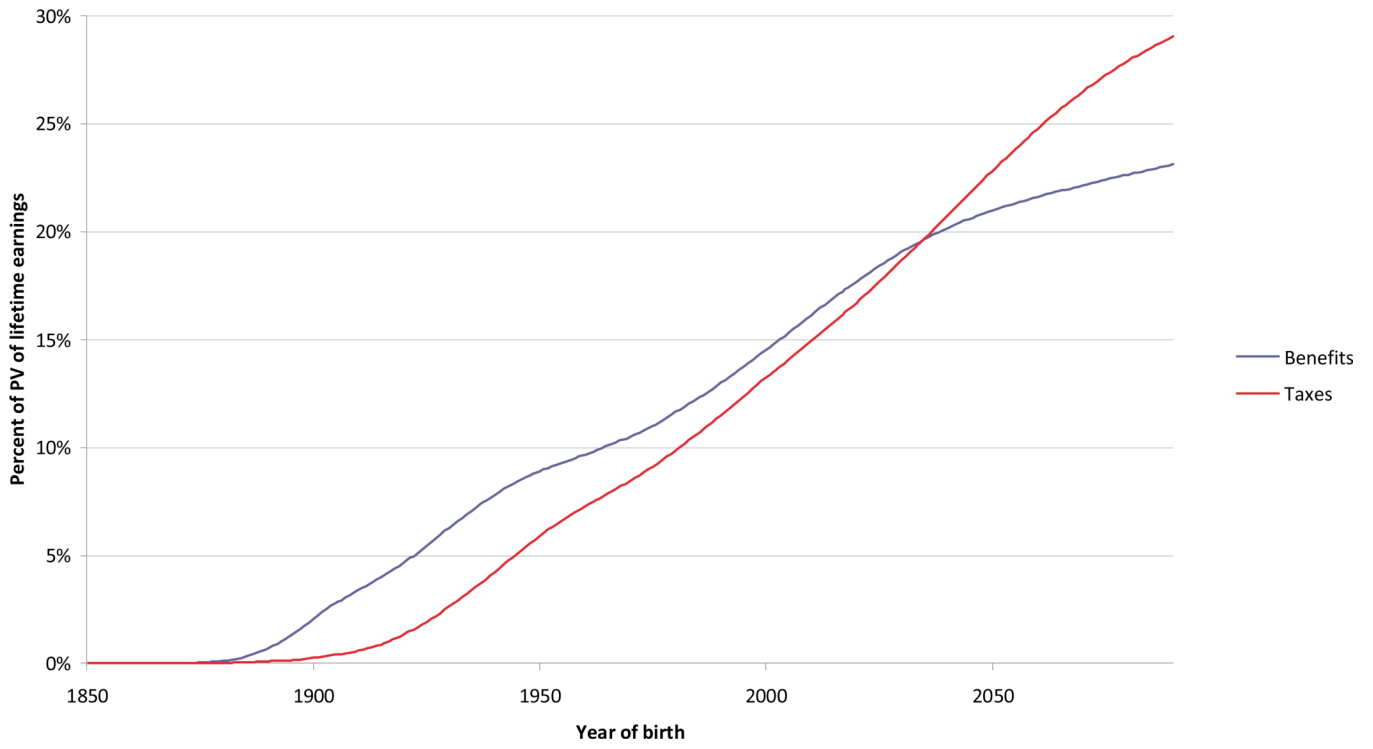
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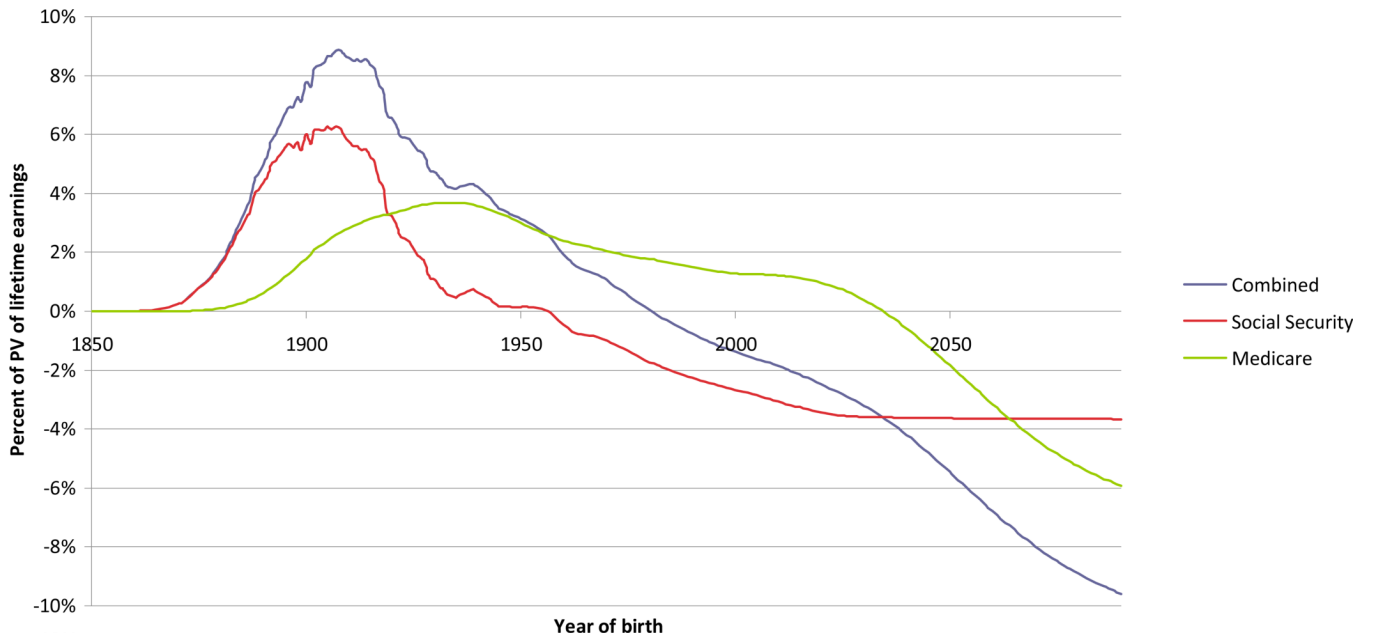
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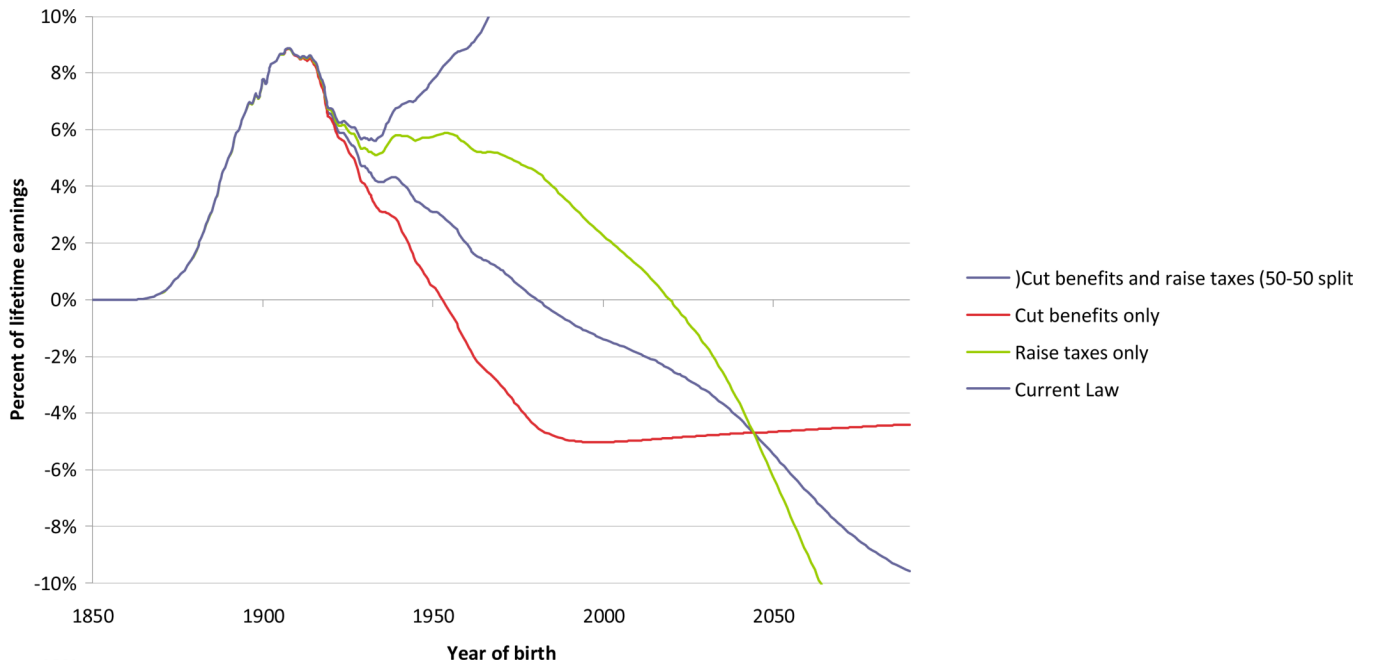
**Figure 1.**  
Present value at birth of Social Security benefits and taxes



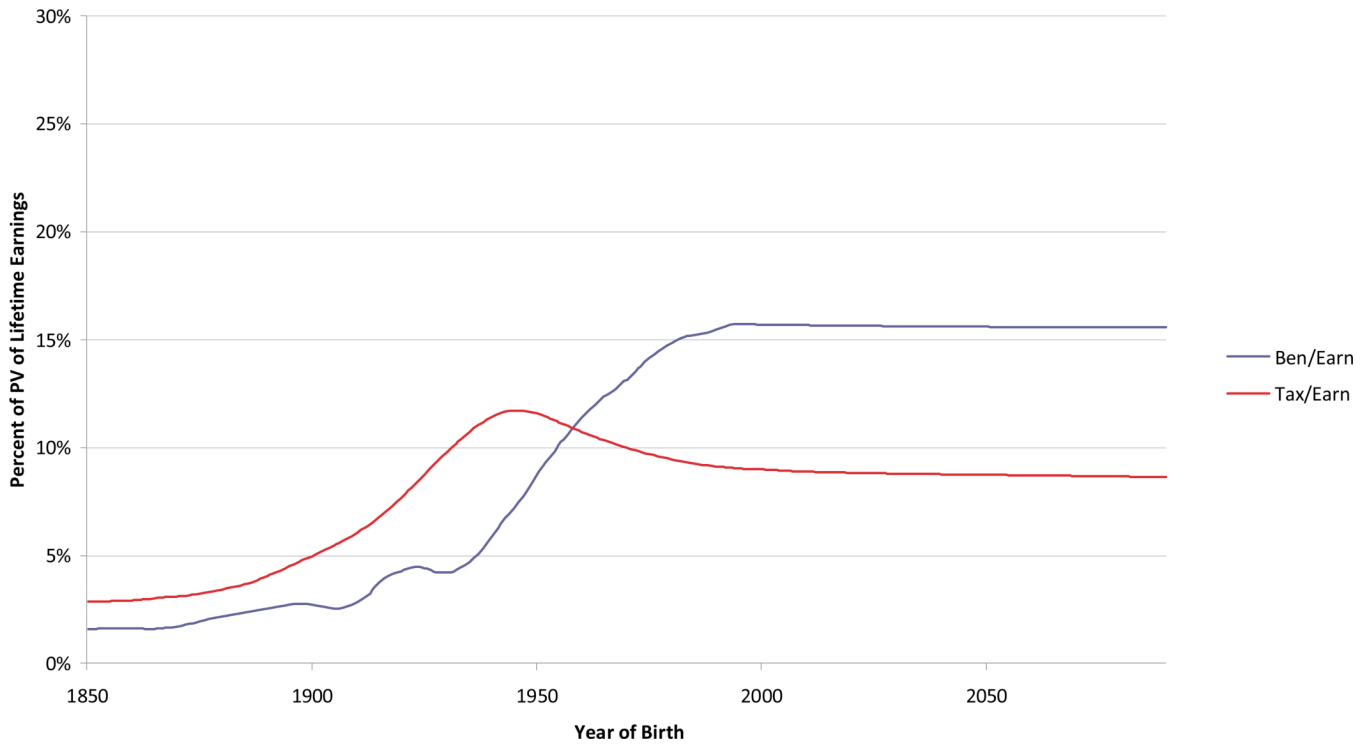
**Figure 2.**  
Present value of Medicare benefits and taxes



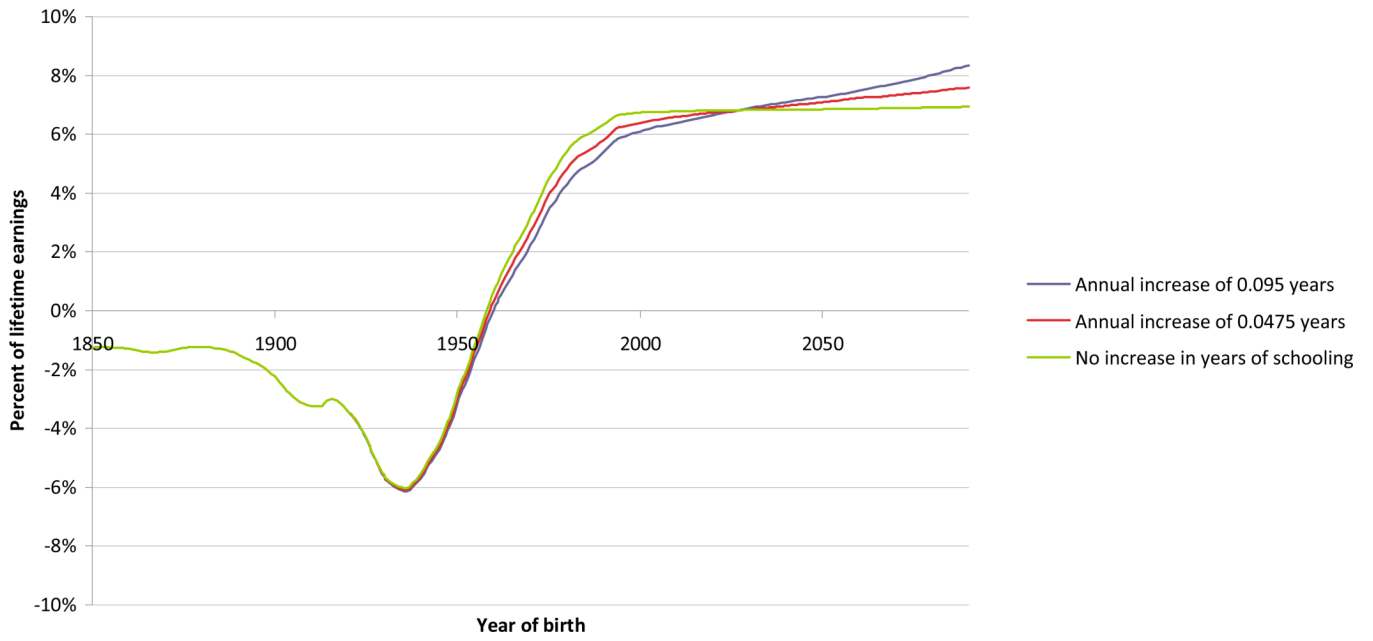
**Figure 3.** NPV at birth of expected lifetime Social Security and Medicare benefits as percent of lifetime earnings



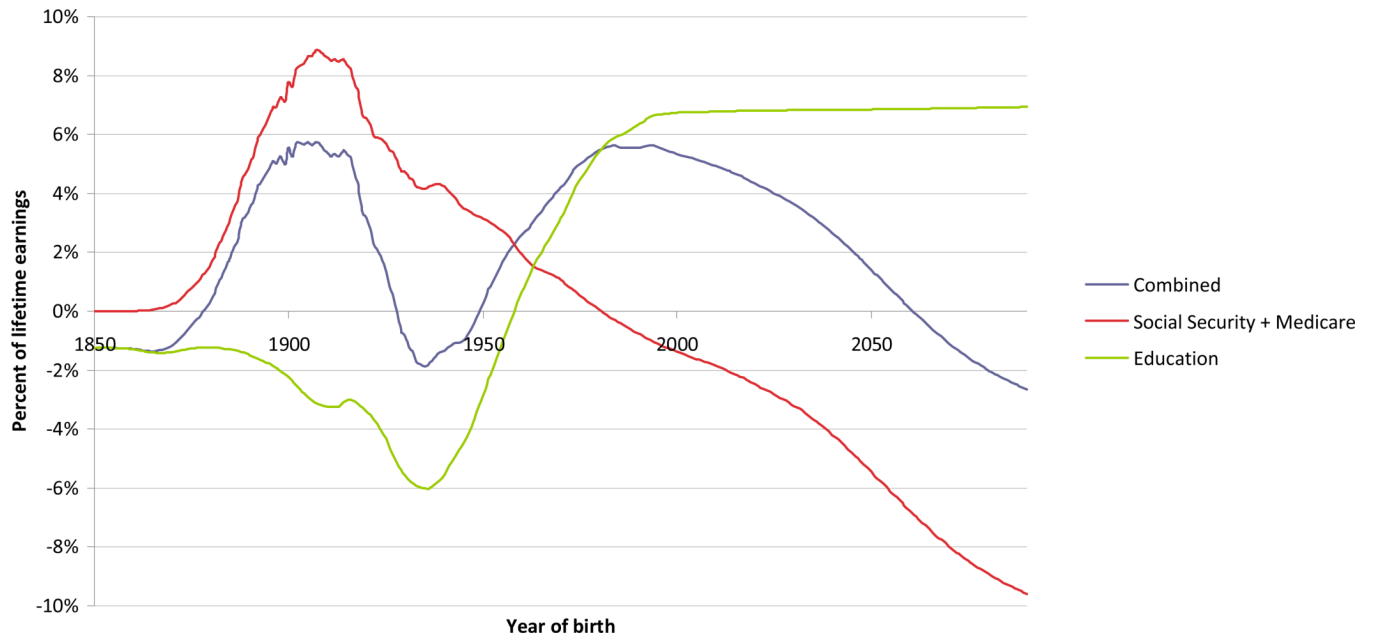
**Fig 4.** NPV at birth of expected lifetime Social Security and Medicare as percent of lifetime earnings



**Figure 5.**  
Present value at birth of education benefits and taxes

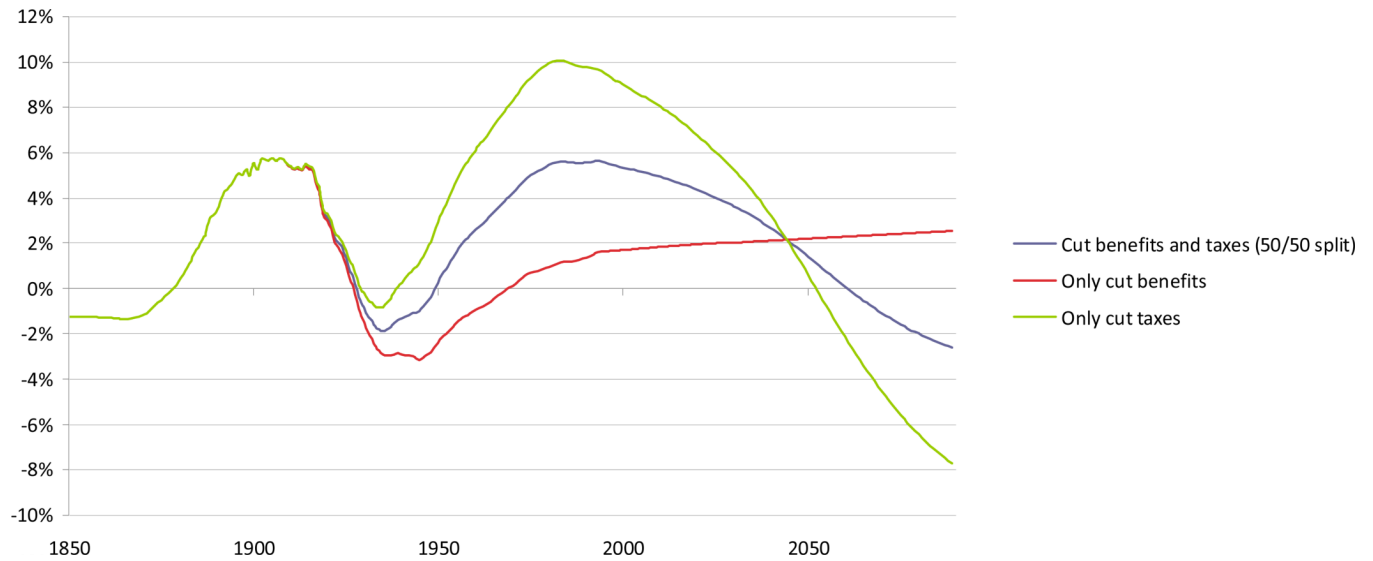


**Figure 6.**  
NPV at birth of expected lifetime education benefits as percent of lifetime earnings

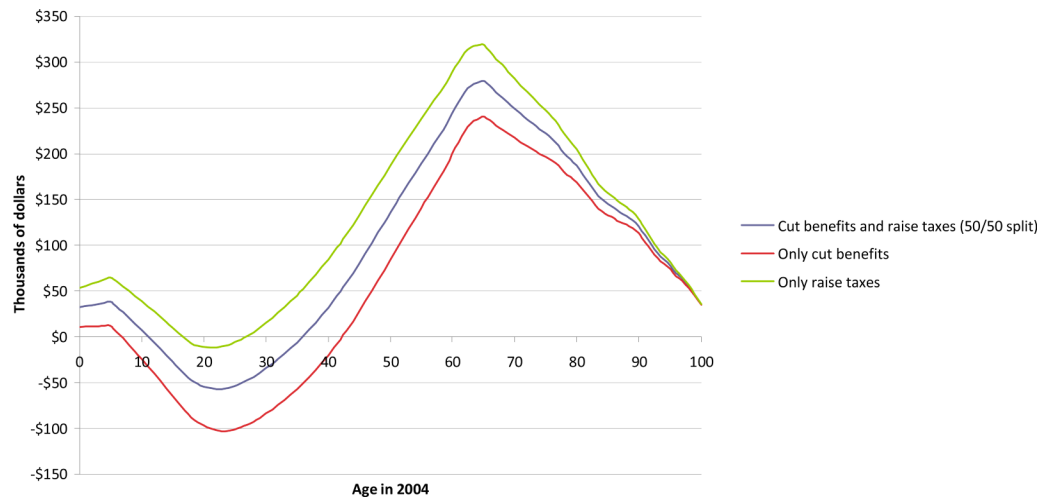


**Figure 7.**  
NPV at birth of expected lifetime education, Social Security, and Medicare benefits as percent of lifetime earnings

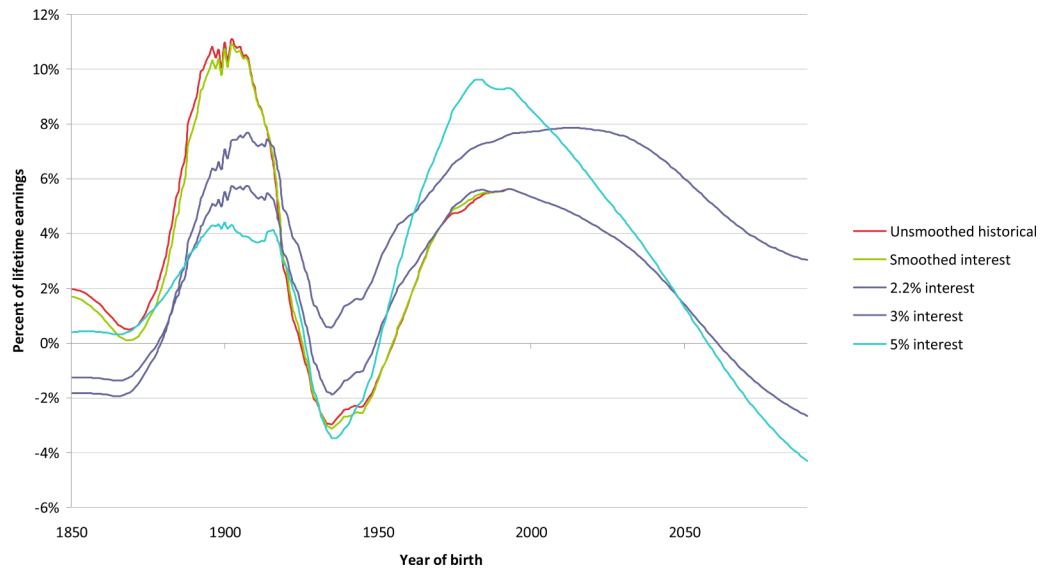




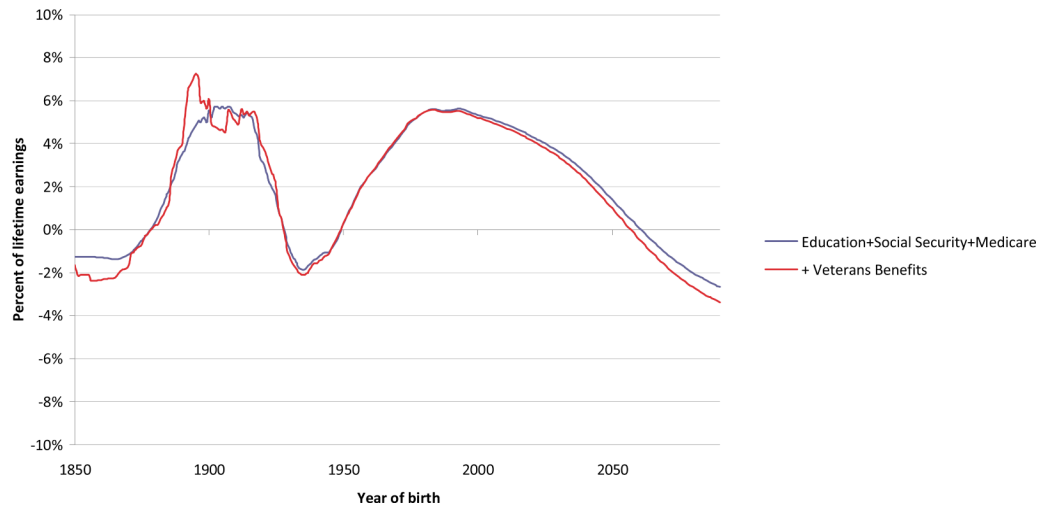
**Figure 8.** Budget balancing policy options: NPV at birth of expected lifetime education, Social Security, and Medicare benefits as percent of lifetime earnings (budget balancing options do not apply to education which is already assumed balanced)



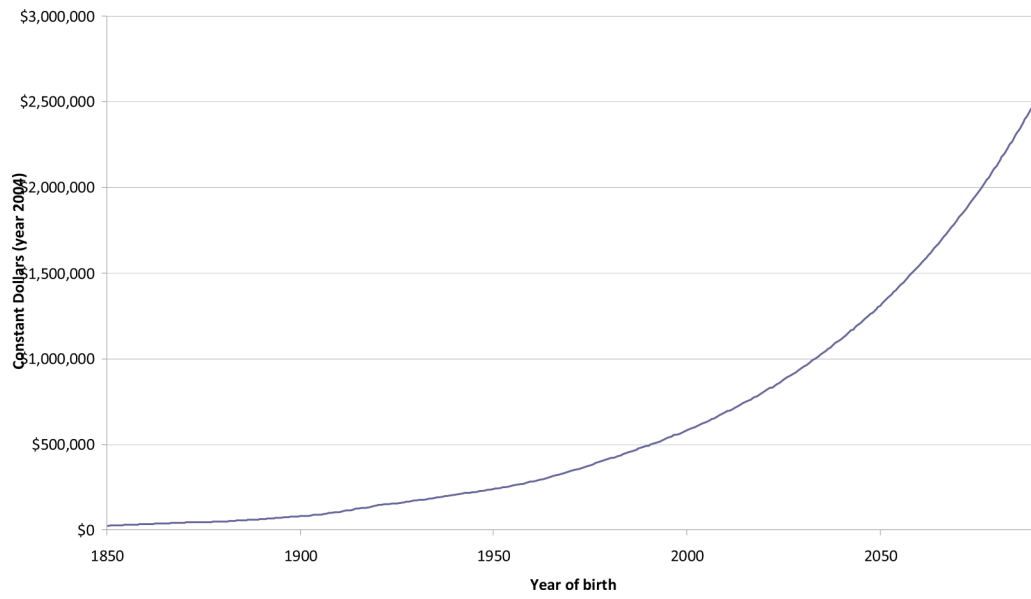
**Figure 9.** Net present value of participating in all transfer systems by age in 2004 by budget balancing options (budget balancing options do not apply to education which is already assumed balanced)



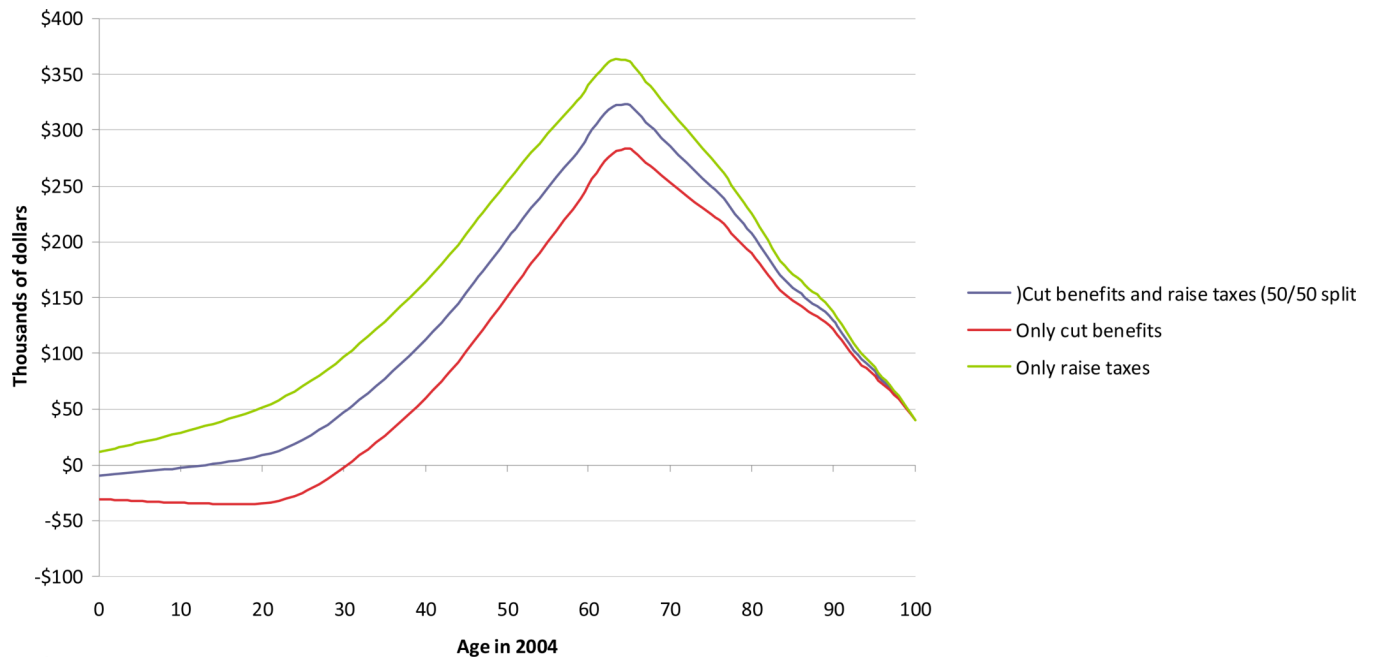
**Figure 10.**  
Sensitivity tests of NPV using various discount rates



**Figure A1.**  
NPV at birth of expected lifetime public benefits as percent of lifetime earnings



**Figure A2.**  
Present value of lifetime earnings at birth



**Figure A3.**  
Net present value of participating in Social Security and Medicare by age in 2004