Southern Economic Journal 2003, 69(4), 842–864

Social Security Outcomes by Racial and Education Groups

Liqun Liu* and Andrew J. Rettenmaier†

This article evaluates the Social Security outcomes for different racial and education groups. Outcomes differ across groups due to the interactions between group-specific mortality risks and lifetime earnings, the benefit formula, and the benefit package, which includes life insurance, spousal benefits, and retirement pensions. Based on either the rate of return or present value, individuals with less education fare better than those with higher educations. This holds even before accounting for preretirement survivors' benefits, which, when accounted for, reinforce this finding. Single whites do considerably better than single blacks when outcomes are compared by internal rates of return. Accounting for survivors' benefits reduces regressivity, but blacks continue to fare worse than whites. In contrast, based on present values, whites generally do worse than their respective counterparts.

1. Introduction

Social Security is primarily an intergenerational transfer system providing payments to retired workers and their families financed by payroll taxes on current workers. The Old-Age and Survivors Insurance (OASI) program also provides life insurance through survivors benefits. Because longer lives are positively related to income, the retirement pension favors workers with higher lifetime incomes, other things equal. Conversely, survivors' insurance is more likely to be awarded within groups with higher mortality rates at younger ages, which happens to be those with lower incomes. Further, the benefit formula replaces a higher percentage of the income of workers with lower lifetime earnings, while spousal retirement benefits favor couples in which only one spouse works. As a result, any particular group's outcome depends on their lifetime earnings, their group-specific longevity, the tax rates they face, and the Social Security benefit formula.

There have been quite a few studies devoted to calculating the internal rate of return and net present value of Social Security.[1] Some consensus has been reached by those studies: early generations do better than later generations, women do better than men, and married couples with a single earner do better than singles or working couples. These results are not surprising given that a pay-as-you-go system usually generates a higher return in its start-up phase than in the mature phase, that women live longer than men, and that nonworking spouses receive benefits without making tax payments.

However, to date, a consensus has not been reached on some of the more interesting but less obvious issues such as how different income classes or different races fare in the system. This article

* Private Enterprise Research Center, Texas A&M University, College Station, TX 77843-4231, USA; E-mail lliu@tamu.edu.

† Private Enterprise Research Center, Texas A&M University, College Station, TX 77843-4231, USA; E-mail a-rettenmaier@tamu.edu; corresponding author.

The authors thank Thomas R. Saving, Dong Li, and two anonymous referees for very helpful suggestions. They also thank The Lynde and Harry Bradley Foundation and the National Center for Policy Analysis (NCPA) for financial support. Portions of this paper have appeared in NCPA policy reports No. 236 and No. 240 and are used with permission.

Received December 2000; accepted July 2002.

[1] See Schieber and Shoven (1999) for an excellent overview of the broader background of the issues discussed in this article.

evaluates how each benefit component affects progressivity by focusing on *ex ante* well-defined demographic groups classified by education and race and by projecting the returns for current working generations assuming that payroll taxes rise to cover any financing shortfall. The distinguishing features of this article are its accounting of the incidence of survivors' insurance and its use of education- and race-specific mortality tables and earnings profiles for each birth cohort. Ultimately, we calculate the expected net present value and the expected internal rate of return of the OASI package for groups defined by family type, birth cohort, race, and education level.[2]

We find that, even without accounting for the preretirement survivors' payments that benefit low education groups more, these groups enjoy a higher rate of return. This suggests that the redistributive nature of the benefit formula outweighs the effects of lower life expectancies. In contrast with the outcomes based on education, our estimates indicate that the longevity disadvantage of blacks offsets the redistributional effect of the benefit formula, resulting in a lower rate of return for blacks than for whites. This holds even though blacks, as a group, receive more preretirement survivors' benefits due to a higher probability of early deaths. However, we show that the money's worth ratio is sensitive to the discount rate used. As the discount rate increases within the plausible range, Social Security becomes less regressive and even progressive with respect to the redistribution among racial groups when survivors' benefits are taken into account.

Adding to previous discussions of Social Security rates of return that focused on earlier generations, this study projects the returns from Social Security for current working generations, taking into account the forecasted financing shortfall. This exercise produces two notable findings. The first is that the dispersion in rates of return by education category grows over time as a consequence of forecasted increasing education premiums. The second finding is that, while the return from Social Security declined over time for earlier generations due to a retirement age that remains constant combined with increasing life spans, rates of return flatten out for current working generations and even increase for less educated members of younger generations despite the increased payroll taxes required to keep the system solvent.

Earlier studies (Leimer 1978; Hurd and Shoven 1985; Boskin et al. 1987; Duggan, Gillingham, and Greenlees 1993; and Steuerle and Bakija 1994) concluded that the low lifetime earners do better than those with high lifetime earnings.[3] Duggan, Gillingham, and Greenlees (1993) also found that blacks receive a higher rate of return than do whites. These outcomes are consistent with the intent of the benefit formula that replaces a higher percentage of lower income workers' preretirement income.

Due to the lack of information on income- or race-adjusted mortality risks, the longevity disadvantage of the poor and blacks were not always taken into account in those early studies. By using the mortality rates experienced by people of different incomes or ethnic backgrounds, several more recent studies concluded that the progressivity previous studies found in Social Security may have disappeared or even reversed. For example, Garrett (1995) found that, after adjusting mortality rates according to income, Social Security's rate of return is higher for the middle and lower-middle quintile than that for the lowest quintile.[4] An even more surprising result is found in Beach and Davis

---

[2] We use education level as an approximation of income level because, from a prospective point of view, education is a better defined group characteristic than lifetime income.

[3] The Report of the 1994–1996 Advisory Council on Social Security (1997) also found that, across all years, lower income workers have higher returns than do higher income workers.

[4] Garrett only studies the 1925 birth cohort. Among single-earner couples, the rates of return for the middle quintile and the lower-middle quintile are, respectively, 2.92 and 3.10%, while it is 2.90% for the lowest quintile.

(1998), in which race-adjusted mortality makes the rate of return for blacks considerably lower than that of the general population.[5]

Studies finding that Social Security's progressivity is offset by the lower life expectancy of blacks and individuals with lower lifetime earnings have drawn criticism.[6] Most important, some of these studies fail to account for all the components of Social Security benefits, especially preretirement survivors' benefits and disability benefits. Because groups with shorter life expectancies are likely to benefit more from survivor's insurance and the disability benefits than groups with longer life expectancies, ignoring these components when calculating rates of return may make the system seem less progressive than it really is.

Our findings also complement a few more recent studies that have focused on the progressivity in the current Social Security and its implications for the transition to a retirement system based on individual accounts. For example, Gustman and Steinmeier (2000) found that, although Social Security significantly redistributes from individuals with high lifetime earnings to those with low lifetime earnings, much of the redistribution is from men to women. They also show that the redistribution is from families in which both spouses spend much of their potential work lives in the labor market to families where a spouse, often with high earnings potential, chooses to spend much of his or her work life outside of the labor force. As a consequence, there is very little redistribution from families with high to low earnings potential when families are arrayed by their earnings capacities. Liebman (2002) found that much of the intragenerational redistribution in the existing Social Security system is not related to income and that factors like differential life expectancies tend to offset the progressivity of the basic benefit formula.

Coronado, Fullerton, and Glass (2000a) estimated potential changes to the progressivity of the current system from four Social Security reform proposals by focusing on the retirement portion of the program and the redistribution between rich and poor of a given generation. They found that each of the proposed reforms is a slightly regressive change to the current system. Brown (2000) investigated redistribution in an individual accounts retirement program under various annuity and bequest arrangements with an emphasis on differential mortalities across gender, race, and level of education. He found that, while a basic single-life real annuity significantly redistributes from economically disadvantaged groups toward groups that are better off, these transfers can be substantially reduced through the use of joint life annuities, survivor provisions, and bequest options. Although these studies use different data sets, estimate mortality and lifetime income in somewhat different ways, and even have slightly different definitions of progressivity, they reveal the degree and sources of progressivity in the current and reformed systems from different perspectives.

While a detailed description of the methodology used in obtaining our results follows in the next section, two general comments are in order. First, like most previous studies on this topic, this study ignores disability insurance under Social Security. This is possible and appropriate because the disability component is separable on both the tax side and the benefit side and can be analyzed independently. Because we find that blacks' internal rate of return from the OASI program is less than whites', our analysis is open to the criticism that, by omitting disability insurance (DI) (both the DI taxes and benefits), we ignore the possibility that it might restore the redistributive nature of the extended program. With this line of reasoning, including Medicare as part of the total retirement

---

[5] In Beach and Davis's study, this is true for all comparable cohorts, family types, and income levels. For example, for birth cohort 1970 and single-earner family with two children, the rate of return for blacks is 1.90% while the rate of return for the general population is 2.71%.

[6] For more details, see Goss (1998) and Schieber and Shoven (1999).

package could also be justified, with its inclusion benefiting groups with higher life expectancy. Of course, all above criticisms are legitimate, and it would be interesting to see how including DI and hospital insurance (HI) components of the elderly entitlement package would affect the system's progressivity, but here we limit our discussion to the OASI program.

Second, as in other studies, this article identifies the Social Security investment of hypothetical individuals rather than the investment realized by actual individuals as done by Duggan, Gillingham, and Greenlees (1993) and some of the more recent studies. While using work history data would provide exact earnings history and more accurate information on the historical relationship between death rates and the characteristics of different demographic groups, it would also generate several additional difficulties. For the purpose of this study, the most serious shortcoming of the work history data is the lack of complete lifetime earnings for all but the very early cohorts.

The article is organized as follows. In the next section, we illustrate the data and methodology used in our calculations. In the third section, we present our findings. In the concluding section, we discuss the implications of our findings in light of the broader interest in Social Security reform.

2. Data and Methodology

Because Social Security benefits are determined by workers' past earnings, the first element needed in evaluating the investment is an appropriate earnings profile for each group considered. Actual and projected life-cycle earnings for the 1935–1980 birth cohorts are based on data from the March supplements to the 1964–1998 Current Population Survey. The data pertain to the years 1963–1997 because the survey questions refer to the previous year. In the years covered by the survey, actual average historical taxable earnings for each group are used. The actual earnings of individuals born in 1935 are known from the time they turned 18 until they reached 62 years of age. A brief description of how we estimate life-cycle earnings for each group considered for the years before 1964 and after 1997 is found in the Appendix.

Our projections of life-cycle earnings capture the effects of recent trends in the labor market, such as the growth in women's earnings relative to men's, the growth in the earnings of blacks relative to whites, and the increased dispersion in earnings based on skill. For example, the projected average lifetime earnings of women born in 1935 are 33% of men's earnings, but women born in 1980 are projected to earn 82% of the lifetime earnings of men.[7] We estimate that black men born in 1935 will earn, over their lifetimes, an amount equal to 71% of the earnings of white men born in the same year. Our estimates suggest a narrowing in the wage gap, with black men born in 1980 earning an amount equal to 78% of the lifetime earnings of white men.

The life-cycle predictions by education evidence the growth in earnings dispersion. The ratio of the earnings of male college graduates to high school graduates will grow from 1.12 to 1.65 for the 1935 and 1980 birth years, respectively, based on our estimates. Among women, we project the ratio to grow from 1.36 to 1.94 over the same span of birth years. Also, the primary reason for grouping individuals by their education level is to define static income groups over the life cycle, given that education is indicative of a lifetime stock of human capital.[8]

---

[7] The present values for these examples are calculated using a 4% real discount rate and assume that the average worker survives with certainty to the age of 75.

[8] Because the average group member is the unit of observation, average earnings reflect those of all members of a group, including workers and nonworkers. Mortality rates are likewise based on the same reference point. Thus, the results we obtain are representative of the outcomes for the average individual in a birth year by racial or education group.

The next component in making our estimates is each group's unique mortality risks. The year of death may define the last year of tax payments, the starting year of certain benefits such as survivors benefits, and the final year of certain benefits like one's own retirement benefits or one's spouse's benefits.[9] However, generally available cohort-based life tables are for all the men or women in a birth cohort as a whole. Bell, Wade, and Goss (1992) have estimated cohort-specific life tables for men and women born between 1900 and 1990. However, for consistency across all groups, U.S. Census Bureau estimates are used. The Census Bureau provides separate race-specific life tables from which we obtain cohort-based life tables. Our main rationale for using the Census Bureau's data is the gradual convergence over time in the longevity of whites and blacks exhibited in its projections.[10]

Transforming the census birth-year life tables for men and women into education category-specific life tables is accomplished by using the relative mortality estimates of Sorlie, Backlund, and Keller (1995). They estimated mortality ratios for various classifications of the population according to race, employment status, income, education, marital status, and household size. We use their estimates of the education-specific relative mortality rates. Their findings suggest that less (more) educated men and women are more (less) likely to die than those with high school educations (their reference group). At higher ages, the education differentials decline, indicating a convergence in mortality among those who survive. Their results are summarized in Appendix Table A1.

Two things must be done to obtain applicable mortality ratios. First, the ratios in each age-sex group are stated relative to high school graduates. However, this reference group does not correspond to the average person in that age-sex category; the mortality rates in general sex-specific life tables do. Thus, we must first restate the relative mortality rates with reference to the average person in a particular age-sex group. Second, the mortality ratios are estimated for discrete age groups rather than for single years of age. In essence, the ratios represent an average relative mortality rate in an education-sex-age category, but for the same reason the relative mortality differs between the 25–44 age group and the 45–64 age group. The relative mortality rate should also differ between age 25 and age 44. The Appendix describes in further detail how these education-specific relative risk ratios are used to generate education-specific life tables.

The next components needed in estimating Social Security outcomes are the historical and projected tax rate schedules and benefit formulas. These schedules have changed over time and both are subject to future changes due to the fact that pay-as-you-go financing will necessitate tax or benefit changes, or both. On the benefit side, we assume that the components of the benefit formula all grow at the rate used in making the intermediate assumption in the 1999 Trustees Report.[11] On the tax side, we assume that the projected long-run financing imbalance will be restored by tax increases alone. Historical tax rates are used up to the present, and projected tax rates, based on the cost rates published in the Social Security Trustee's Report, are used in future years.[12] Over their years in the labor force, our oldest cohort has faced tax rates between 3 and 11.2%. To pay scheduled benefits,

---

[9] All benefits, except for preretirement survivors benefits, are assumed to begin at the scheduled normal retirement ages.

[10] As an example of the difference between the Census Bureau's and the Social Security Administration's forecasts, 77.6 and 76.4%, respectively, of men born in 1960, conditional on surviving to the age of 18, are expected to survive to the age of 67. Using the Census Bureau's life tables produces higher rates of return and net present values than would the use of the Social Security Administration's life tables.

[11] For our older birth cohorts, the survivors' benefits arising from deaths prior to the retirement age are calculated by retrospectively imposing the indexed bend points in the primary insurance amount formula and family maximum formula prior to 1979.

[12] Using a widely accepted convention, we assume the entire burden of the payroll tax (both the employer and employee portion) is borne by workers.

young workers will face higher tax rates. We assume that future tax rates are equal to benefit payments as a percent of taxable payroll in all years after this ratio exceeds the current tax rate. Using this tax rate schedule implicitly assumes workers bear the full burden of financing future benefit payments. As such, it ignores the redemption of Trust Fund bonds, which would spread the burden across generations.

Redeeming Trust Fund bonds necessitates additional tax revenues, increased debt, or a reduction in other government expenditures. Each option produces different generational burdens. Retirees bear part of the burden if additional general income taxes or reduced government expenditures are used to pay benefits. Such actions effectively reduce retirees' benefits and lower their returns. Financing the redemption of the Trust Fund bonds by issuing explicit debt results in more difficult to isolate generational burdens. In the simplest case, borrowing shifts the burden to future generations. However, altruistic taxpayers will recognize that the additional debt will burden their children and as a result, will leave them a larger inheritance. To do so, they must reduce their own consumption and save. The latter situation results in a tax burden equivalent to the case of a general tax increase.

Pay-as-you go financing can also be maintained by reducing benefits rather than raising taxes. If this avenue is taken, midway through the next decade, benefits cuts will be necessary. Whose benefits are cut and by how much is contingent on the reform path taken. For example, all retirees' benefits could be reduced proportionally such that expenditures equal revenues, the benefit cut could apply only to new retirees, or benefit cuts could gradually transform Social Security to a means-tested program. Each reform would have a different distributional effect.[13] For these reasons, we restrict our analysis to the distributional consequences of scheduled benefits and payroll tax financing of those benefits.

A final consideration is family structure. Spousal retirement benefits are irrelevant for singles, but are important in identifying the returns for a couple. For couples with children, the preretirement survivors' insurance component also comes into play if the worker dies when the children are young. For couples with or without children, the after-retirement survivors' insurance becomes relevant if the worker dies before the spouse. Also, the return for a one-earner couple is enhanced by the spousal benefit, which is equal to 50% of the wage earner's own pension benefits. A double earner family can be represented by some mix of singles and the one-earner couple. Thus, we focus on single women, single men, and one-earner couples with children.

In the case of the one-earner couple, we assume that men's life spans are random, but the nonearning wives live with certainty to their life expectancy conditional on reaching the age of 25. Taking into account uncertainty in the time of death for both husbands and wives makes the calculation unnecessarily complicated. Our calculations for the one-earner family are further simplified by assuming that couples marry at the age of 22 (hence, we assume husbands and wives belong to the same birth cohort), that no divorce or cross-group marriage occurs, and that couples have twins at age 25.

Having defined lifetime earnings, mortality rates, tax and benefit schedules, and family types, the cash flows that an average individual in a group realizes through Social Security can be readily calculated. The Appendix provides the formulas for the expected net present value and the expected internal rate of return. Basically, for a representative individual in a group (defined by birth year, family type, race, and education level), OASI is a stochastic combination of tax payments and benefit receipts

[13] The 2001 Commission to Strengthen Social Security produced three proposals incorporating individual retirement accounts. The second and third proposal took into account how individual accounts would affect benefit levels for different income classes. Under the second proposal, future initial total benefits for low-income workers are actually higher than under current law.

being determined by the age of death. Given a discount rate, a net present value can be calculated for each realized stream of cash flows. The weighted (by the probability of death for each age) sum of all the possible net present values gives us the expected net present value. On the other hand, the discount rate that makes the expected net present value zero is the expected internal rate of return.

The internal rate of return has an advantage in that it does not depend on the market interest rate, which is often uncertain or non-unique. In the context of evaluating Social Security investments, determining which discount rate to use is critical in calculating the net present value and the money's worth ratios. Most studies on this subject use a 2–3% real rate of return.[14] Others have suggested a higher discount rate. The generational accounting literature has used a real rate of 5%, arguing that, though the rate exceeds the government borrowing rate, it is justified given the riskiness of the future flows.[15] Coronado, Fullerton, and Glass (2000b) have evaluated the progressivity of Social Security, ultimately using a 4% real discount rate. We use a 4% real discount rate to calculate the expected net present values and money's worth ratios. However, given variation in mortality risks across groups, the relative size of the net present values and money's worth ratios may be sensitive to the rate chosen. Therefore, in addition to the 4% discount rate, we also use rates from 2 to 6%.

As this exercise illustrates, calculating rates of return and present values on a prospective basis requires making numerous assumptions regarding each group's lifetime income and longevity, the program's future funding arrangements, the persistence of the current benefit formula and structure, and the discount rate chosen, to name a few. While we are explicit about our assumptions and the likely effects of varying them, the reported results only identify how the groups fare should the program evolve as assumed. Without making the assumptions, only retrospective analyses are possible. Given the rising uncertainty of forecasts with longer horizons, the outcomes for the early birth cohorts should be given more weight than the later birth cohorts.

3. Results

Net Present Values

Figures summarize the expected net present values and expected internal rates of return for every fifth birth cohort between 1935 and 1980. Figure 1 presents the net present values for whites, blacks, and all racial groups combined.[16] All present values are in 1999 dollars and are computed when the members of the birth cohort are 25 years of age. Single men are depicted in the upper left-hand panel. The experience of single men and women represents the simplest Social Security investment where tax payments produce only retirement benefits.[17]

As the graph shows, all single men earn a negative present value by participating in Social Security if a 4% discount rate is used. Thus, Social Security is a net lifetime tax for single men, with whites paying a higher lifetime absolute tax than blacks. In the next panel of Figure 1, we see that

[14] For example, Hurd and Shoven (1985), Boskin et al. (1987), and Garrett (1995) use 3%, while the Report of the 1994–1996 Advisory Council (1997) used the rate on the special public debt obligations issued by the United States Treasury to the Trust Fund. In future years, the rate was set to 2.3%. Murphy and Welch (1998) use 2.3 and 3.5%, Steuerle and Bakija (1994) use a rate of 2%, and Duggan, Gillingham, and Greenlees (1993) use a similar rate of 2.2%.

[15] See Auerbach, Kotlikoff, and Leibfritz (1999) for a discussion of the appropriate discount rate in the context of generational account. They point out that the correct discount rate remains an open question and, as a consequence, present their results under several alternative rates (p. 37).

[16] The all-inclusive category includes whites, blacks, native Americans, and Asian Americans.

[17] We ignore the small death benefit.

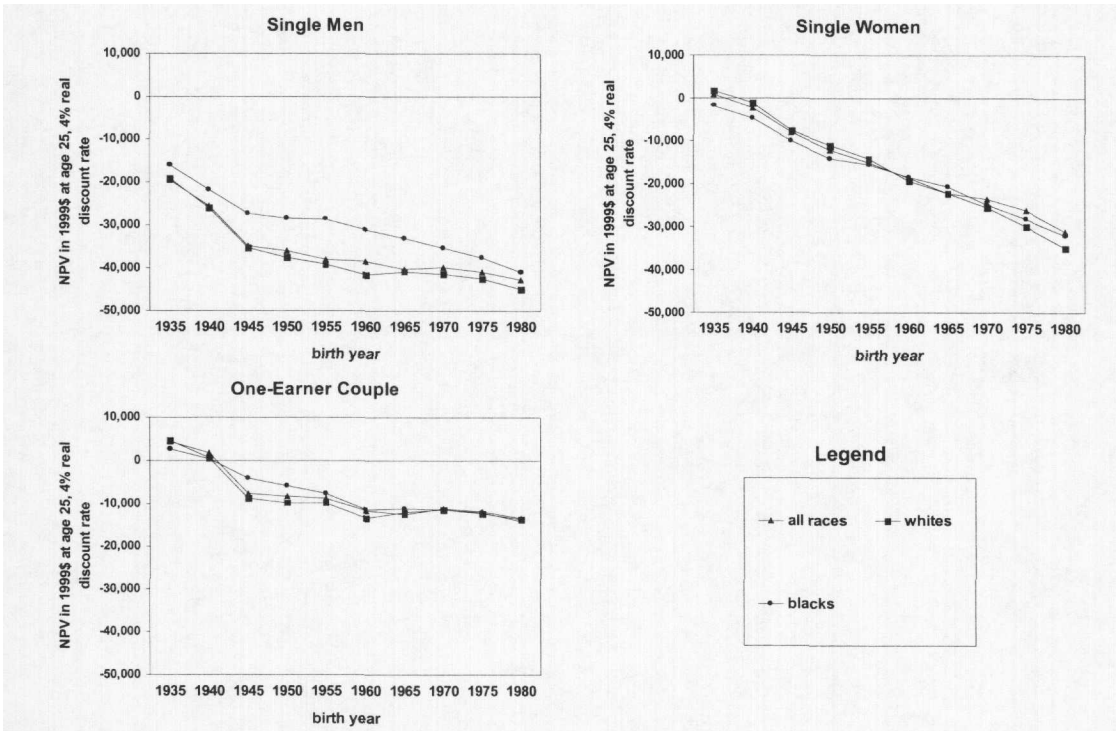

Figure 1. Net Present Value by Racial Groups

single women do better than single men and that the net present values decline for each successive birth year. Besides the general decline due to institutional factors, the diminishing net present values for working women in general is attributable to increased labor force attachment and higher relative wages. This results in higher lifetime earnings and lower replacement rates from the concave benefit formula. The graph also shows that the difference between races is small, with whites faring better for the first 20 years and blacks faring slightly better in the remaining years.

These results are qualified as follows. We have assumed that single and married members of the same cohort and sex have identical earnings and mortality. Assuming identical earnings overstates the earnings for single men and underestimates the earnings of single women. For single men, this implies lower lifetime taxes and benefits. However, because of the redistributive benefit formula, the benefits relative to tax payments will rise, all else equal. Because mortality also differs by marital status, with married men and women outliving their single counterparts, the effect of controlling for earnings and mortality would work in opposite directions for men and would likely lower the net benefits for single women relative to those reported here.

The final panel shows the outcome for married men with nonworking spouses. For the 1945 to the 1960 birth cohorts, whites pay more in net lifetime taxes, but for the other birth years 1935, 1940, and the 1965 and younger cohorts, the net lifetime tax is similar across racial categories. Recall that we assume men marry women born in the same year and have two children at the age of 25. This limits the collection of preretirement survivor's benefits to instances in which death occurs between the ages of 25 and 43. Assuming identical family composition across groups identifies how the Social Security institution differentially affects such families. Thus, these results are relevant for a particular family type, not a representative individual within the cohort. To the degree that marriage rates, the

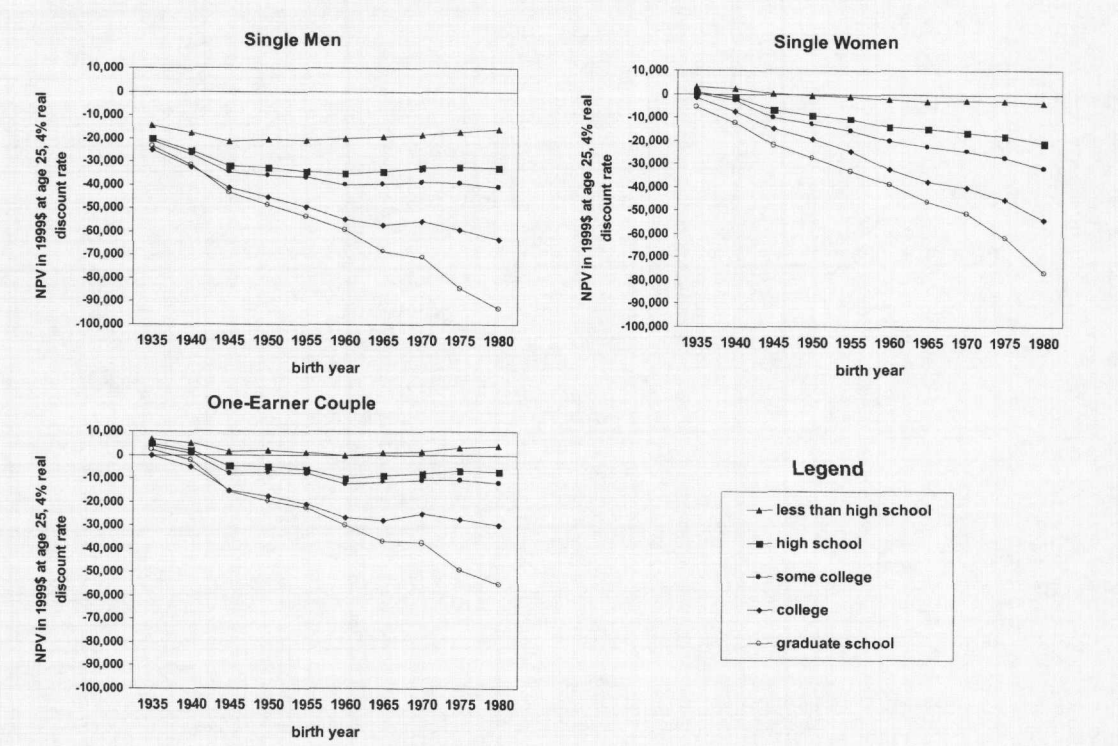

Figure 2. Net Present Value by Education Groups

age of marriage, and fertility vary by race, education, and time, our results will not reflect the outcomes for the composite individual in each group.

Figure 2 summarizes the net present values based on their education level and birth year. As the graph indicates, the present values generally decline for the more recent birth years. For all birth years, those with the least education have higher net present values even though they have shorter life spans. Another notable feature of this figure is the increased dispersion in the relative net present values for the different groups. The increased dispersion is a consequence of the growing dispersion in wages over the last 25 years, which is carried on in our earnings projections. Since the mid-1970s, the earnings of more educated males have risen relative to the average, while the earnings of the less educated and less skilled have fallen. Further, real earnings for the average male have not grown significantly. Our predictions of future earnings assume continued spreading of the earnings distribution.[18] As Figure 2 indicates, we expect the net present value to rise modestly for workers with less than college educations born after 1960. This results from their earnings falling relative to the average and the benefit formula replacing a higher percentage of their preretirement earnings.

Some of the rise for the lower education groups can also be attributed to the fact that the retirement age is not increased above 67 for the more recent birth years even though longevity rises.

[18] If the trend toward greater inequality reverses or stabilizes, the distribution of net present values and internal rates of return would contract relative to the distribution reported here, though the ordering of outcomes would likely remain unchanged. As a point of reference, using an alternate method of projecting future wages, the *Report of the 1994–1996 Advisory Council on Social Security* estimates present law money's worth ratios and internal rates of return for individuals and families with low, average, high, and maximum lifetime earnings. Similar to our results, the *Report* indicates that money's worth ratios and internal rates of return decline as income rises, and this finding holds across birth cohorts.

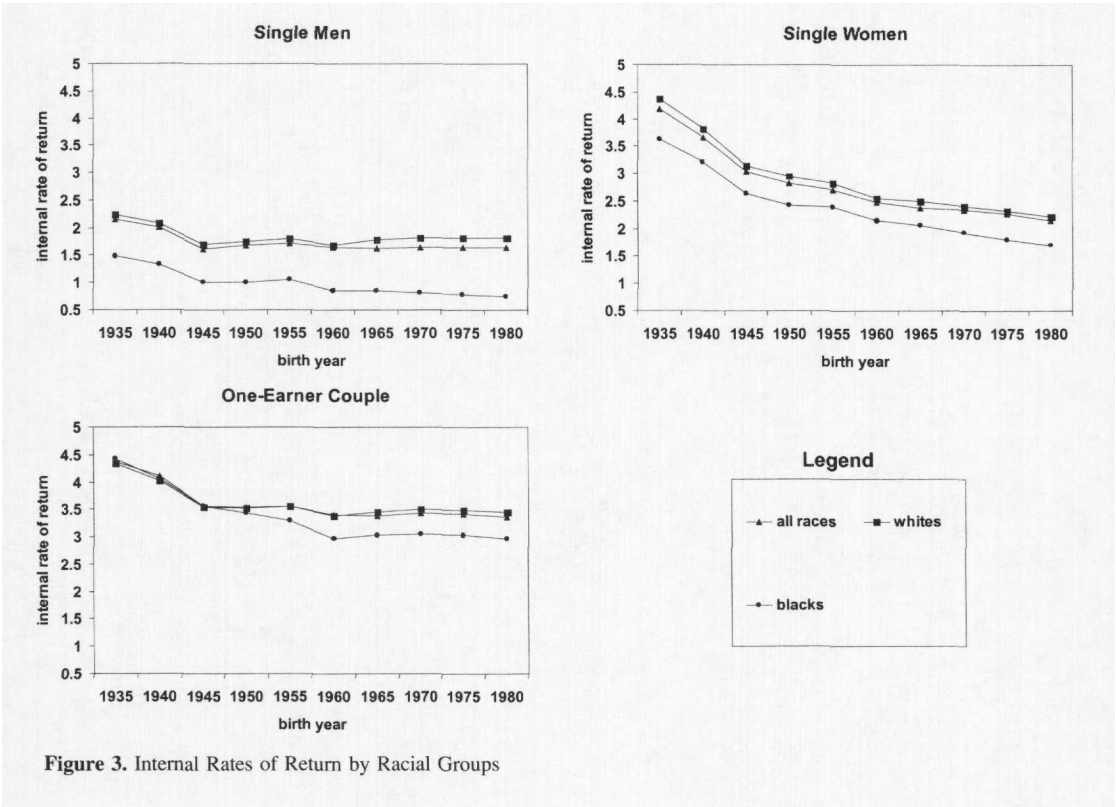

Figure 3. Internal Rates of Return by Racial Groups

Between now and 2027, the Social Security retirement age is scheduled to rise to 67. Those born in 1960 are the first to retire at 67. With a constant retirement age and increasing life spans, workers born in more recent years will enjoy a longer expected retirement period, thus possibly raising their net present values. While workers with lower educations enjoy modest increases in their net present values, higher income workers' net present values drop precipitously for more recent birth years. The second panel in the figure reveals similar results for single women. The net present values are higher, in general, than those for single men with the same education due to longer expected lives and lower relative earnings.

The bottom panel in the figure shows the net present values for married men in one-earner families. As the figure indicates, the outcomes for the later birth years are ordered identically to those in the previous figures, with the low education workers having the highest net present values. Only for those with the lowest education are the expected net present values for the younger workers positive. Relative to single men, the net present values improve significantly as a result of the survivors' benefits and spousal benefits. For college graduates born in 1980, the net present value for married men is $33,576 more than the value for single men. For the average member of the 1980 birth year, the net present value is $29,368 higher for married men.

Internal Rates of Return

The internal rates of return for black and white single men appear in Figure 3. In general, the returns decline across time and blacks have persistently lower rates than whites. How is this reconciled with the results based on net present values? The size of the underlying investment can

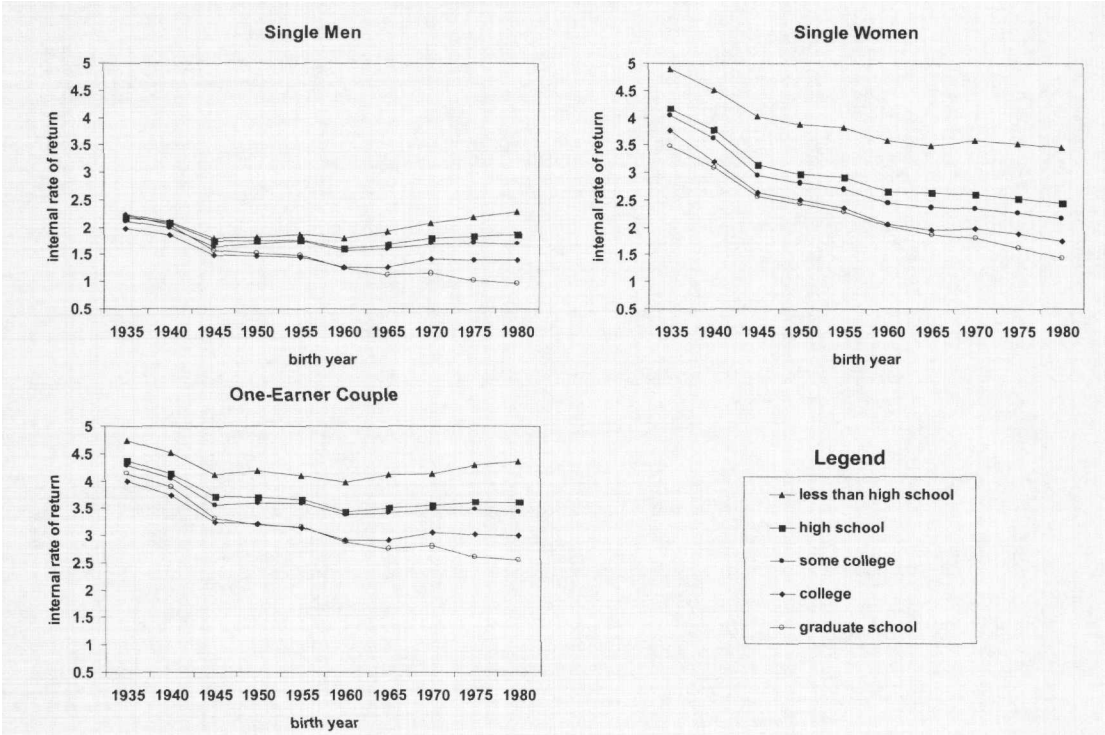

Figure 4. Internal Rates of Return by Education Groups

affect the rankings. In comparing single blacks to single whites born in 1980, it is useful to note that benefits were equal to only 33% of costs for blacks but were equal to 47% of costs for whites. As a result, the internal rate of return for whites is actually higher. For individuals born in 1980, the rate of return for blacks is only 0.7% and the rate for whites is 1.1 percentage points higher at 1.8%. Single black women also have a lower rate of return than do single white women.

The expected returns for married men are quite similar for the first three birth years considered, but from birth year 1950 on, the rates for blacks fall below the rates for whites. By birth year 1980, the internal rate of return for married white men is 3.5% and the rate for married black men is 3.0%. Including survivors' and spousal benefits narrows the gap between the rates of return to only 0.5 percentage points, as opposed to the 1.8 percentage point difference experienced among singles. Given that blacks are more likely to die at younger ages, the inclusion of the survivors' benefits awarded in the event of preretirement deaths tends to close the gap in rates of return, though not completely.

A final notable feature is that the internal rates of return within racial groups for the 1960 and later birth cohorts are quite similar. The decline in rates of return between the 1935 and 1960 birth cohorts results from higher relative tax payments for the younger birth years and an increase in the retirement age from 65 to 67. The higher retirement age is fully phased in by the time the individuals born in 1960 retire, and at this time, no further increases in the retirement age are scheduled. Though the individuals born in 1965 and beyond will face higher tax rates over their lifetime, their increased longevity coupled with a fixed retirement age produce relatively stable rates of return.

The internal rates of return by education categories are presented in Figure 4. Consistent with the results based on net present values, the relative rankings of the Social Security investment using the internal rate of return indicates workers with less education generally have a higher rate of return than

do those with more education. For the earlier birth years, those with higher educations had slightly higher rates of return than the average, but for most birth years, the lower education workers fare better than those with higher education. Single men born in 1935 who earned a high school diploma can expect a 2.18% rate of return, while similarly educated men born in 1980 can expect a 1.86% return. High education workers experience a much more pronounced decline, from 2.19 to 0.96%. The increased dispersion in returns for more recent birth years is consistent with the pattern observed based on the net present values.

The pattern exhibited for women, depicted in the right-hand panel of Figure 4, is slightly different. Their rates of return start at a higher level for the earlier birth years and drop across the board. Their decline is accentuated by increasing earnings within each education classification. As noted earlier, once the benefit formula is applied to the increased earnings, the replacement rate and the rate of return fall.

Married men born in 1980 receive a rate of return that more than doubles the return of single men born in the same year. The now familiar pattern of declining and more differentiated rates of return as we move from older to younger birth years is again evident in the last panel. From birth year 1935 to birth year 1980, the rate of return declined almost 1 percentage point from 3.97 to 3.00% for the college educated. It declined from 4.11 to 2.55% for those with the highest educations.

We have a final comment on the rate of return measure as compared with the present value measure. Noticeably, the ranking of the Social Security investments by net present values and the ranking by internal rates of return are different for the comparison across racial groups. For example, whites born in 1965, regardless of family type, have a higher rate of return but also a larger loss in terms of present value on their Social Security investment than their black counterparts. This pattern of differential rankings of Social Security outcomes by the two criteria was also observed in previous studies by Duggan, Gillingham, and Greenlees (1993) and Boskin et al. (1987). We offer the following explanation for the differential rankings. Mandatory participation in Social Security amounts to a tax for all the demographic groups of later generations revealed as a negative present value or a lower than market rate of return. While the ranking by rate of return indicates the progressivity or regressivity of the tax system, the ranking by present value reveals the direction of the intragenerational redistribution implicit in the system. Whites collect benefits longer due to their longevity advantage, which more than offsets the progressive nature of the benefit formula. This results in a higher internal rate of return for the whites. However, because the rates of return for whites are still below the market interest rate, whites with higher lifetime earnings are required to play an unfavorable game for higher stakes, resulting in a lower net present value.

Decomposition of Social Security Benefits

Tables 1 and 2 present the components of the net present value calculations by racial categories for individuals born in 1935 and 1980. All dollar values are in 1999 dollars, and the net present values are computed when the individuals are 25 years of age using a real discount rate of 4%. In total, whites pay almost $17,000 more in average lifetime taxes than blacks, paying $47,128 relative to blacks, who pay $30,234.

Four benefit categories are identified under the benefits heading. The first are benefits arising from preretirement deaths. These benefits are based on our standing assumption that families have two children born when the worker is 25 and that each child and the surviving spouse collect benefits. Survivors of black decedents collect $9440, and survivors of white decedents collect $4603. The next category identifies one's own retirement benefits. On average, whites collect $27,933, while black retirees collect $14,150. The difference between these benefits and the total taxes produce the net

Table 1. Social Security Expected Net Taxes and Benefits at the Age of 25 for Men Born in 1935 Reported in 1999$ Using a 4% Real Discount Rate

	All	Blacks	Whites
Total taxes	(45,864)	(30,234)	(47,128)
Benefits			
Survivors' benefits resulting from deaths prior to retirement	6506	9440	4603
Own retirement benefits	26,379	14,150	27,933
Spousal retirement benefits	13,190	7075	13,966
Survivors' benefits resulting from deaths at or above the retirement age	4321	2319	5267
Total benefits	50,396	32,985	51,769
Expected Net Present Value for Single Men	(19,485)	(16,084)	(19,195)
Expected Net Present Value for One-Earner Couple	4532	2751	4641
Internal Rate of Return for Single Men	2.15	1.50	2.24
Internal Rate of Return for One-Earner Couple	4.37	4.43	4.35
Money's Worth Ratio for Single Men	57.52	46.80	59.27
Money's Worth Ratio for One-Earner Couple	109.88	109.10	109.85

present values for single men, as were previously presented in Figure 1. Single white men pay a lifetime net tax of over $19,000, while black singles pay a lifetime net tax of $16,084.

The final two benefit components are spousal retirement benefits and survivors' benefits that accrue after the retirement age is attained for the worker. The spousal benefits are equal to half of the pensioner's benefit while he is alive. This, of course, assumes that the wife does not collect benefits based on her own earnings history. The survivors' benefits are equal to the pensioner's benefits from the time he dies until the spouse dies. Accounting for all benefits, married white and black men born in 1935 receive a net transfer of $4641 and $2751, respectively. By looking at these component parts of the Social Security package, we see that the survivors' insurance, arising from preretirement deaths, tends to favor blacks, but the benefits awarded after reaching retirement favor whites.

Table 1 also reports the internal rates of return and the money's worth ratios. The internal rates of return are as depicted in Figure 1. For this birth year, the rates of return for single blacks and whites are 1.5 and 2.24%, respectively. The rates are almost the same for married men, with blacks receiving a return of 4.43% compared with 4.35% for whites. The money's worth ratios indicate the share of each dollar in taxes returned in the form of benefits. Single black men receive $0.47 for every dollar in taxes, and single white men receive $0.59. Married men in both racial groups received about $1.10 for each dollar in taxes paid.

Table 2 presents the results for the last birth year analyzed. As in the previous table, differential mortality rates drive the relative distribution of tax payments and benefits awarded. Among blacks, benefits awarded to survivors of individuals who die before reaching the retirement age account for 27% of all benefits, but for whites, these benefits make up just 9% of the total. As the graphs indicate, the net present values and internal rates of return have declined across the board. Again, single black men fare worse than single white men when compared on the basis of the internal rates of return and the money's worth ratios. Married black men are expected to receive $0.77 for each dollar in taxes, while married whites are expected to receive $0.84.

It is instructive to consider the relative outcomes when spousal retirement benefits are omitted. With each new group of retirees, the importance of spousal benefits in determining the rate of return

Table 2. Social Security Expected Net Taxes and Benefits at the Age of 25 for Men Born in 1980 Reported in 1999$ Using a 4% Real Discount Rate

	All	Blacks	Whites
Total taxes	(77,481)	(61,645)	(84,891)
Benefits			
Survivors' benefits resulting from deaths prior to retirement	8326	12,874	6290
Own retirement benefits	34,719	20,666	40,060
Spousal retirement benefits	17,359	10,333	20,030
Survivors' benefits resulting from deaths at or above the retirement age	3683	3771	4969
Total benefits	64,087	47,643	71,350
Expected Net Present Value for Single Men	(42,762)	(40,979)	(44,831)
Expected Net Present Value for One-Earner Couple	(13,394)	(14,001)	(13,542)
Internal Rate of Return for Single Men	1.64	0.73	1.82
Internal Rate of Return for One-Earner Couple	3.36	2.97	3.46
Money's Worth Ratio for Single Men	44.81	33.52	47.19
Money's Worth Ratio for One-Earner Couple	82.71	77.29	84.05

on a man's tax payments will decline as more women's benefits are based on their own work histories. Omitting the spousal benefits produces net present values that fall to −$24,335 and −$33,571 for blacks and whites, respectively. The money's worth ratios are almost identical at 0.60.

Tables 3 and 4 repeat the decomposition of benefits for the 1935 and 1980 birth years, but this time by education categories. As seen in Table 3, lifetime taxes rise with education for men born in 1935. For individuals with less than a high school education, the present value of expected taxes is $33,516, and for those with a graduate degree, the present value of the tax bill is $59,610. Thus, those in the highest education group pay 78% higher expected lifetime taxes than the lowest education group.

Survivors' benefits associated with premature deaths are equal to $8219 for the lowest education group and $2104 for those with graduate school educations. The almost fourfold differential reflects the greater likelihood of premature deaths among the less educated. Conversely, the remainder of the benefits, all of which are received during retirement, rise with education level. They rise for two reasons. First, as already noted, individuals with higher educations pay higher lifetime taxes, and though the benefit formula replaces a smaller share of the higher income workers earnings, benefits still rise with income. Second, because individuals with higher educations are expected to live longer, they receive more years of retirement benefits.

The net present values and rates of return for single and married men are plotted in the earlier figures for the men born in 1935. Interestingly, as a consequence of longer expected lives and only marginally higher tax payments, the highest education group actually fares better than those with college educations. Single men with college educations will pay a lifetime tax of $25,231, while those with a graduate degree pay a slightly smaller tax of $23,425. For college-educated married men, the lifetime tax is $178, but men with a graduate degree actually receive a net benefit from the system in the amount of $2333. The rates of return produce similar results for married men born in 1935—those with graduate degrees fare better under Social Security than do those who earned a college degree. Among single men, the returns for the highest education category actually exceed all others with the exception of those with less than high school educations.

Table 3. Social Security Expected Net Taxes and Benefits at the Age of 25 for Men Born in 1935 Reported in 1999$ Using a 4% Real Discount Rate

	Less Than High School	High School	Some College	College	Graduate School
Total taxes	(33,516)	(46,713)	(49,393)	(57,933)	(59,610)
Benefits					
Survivors' benefits resulting from deaths prior to retirement	8219	6686	5570	3209	2104
Own retirement benefits	19,123	26,654	28,284	32,702	36,186
Spousal retirement benefits	9561	13,327	14,142	16,351	18,093
Survivors' benefits resulting from deaths at or above the retirement age	3191	4821	5408	5494	5560
Total benefits	40,094	51,488	53,403	57,756	61,943
Expected Net Present Value for Single Men	(14,393)	(20,059)	(21,109)	(25,231)	(23,425)
Expected Net Present Value for One-Earner Couple	6578	4775	4010	(178)	2333
Internal Rate of Return for Single Men	2.23	2.18	2.12	1.98	2.23
Internal Rate of Return for One-Earner Couple	4.75	4.37	4.30	3.99	4.14
Money's Worth Ratio for Single Men	57.06	57.06	57.26	56.45	60.70
Money's Worth Ratio for One-Earner Couple	119.63	110.22	108.12	99.69	103.91

Table 4. Social Security Expected Net Taxes and Benefits at the Age of 25 for Men Born in 1980 Reported in 1999$ Using a 4% Real Discount Rate

	Less Than High School	High School	Some College	College	Graduate School
Total taxes	(35,390)	(61,669)	(75,449)	(108,454)	(146,558)
Benefits					
Survivors' benefits resulting from deaths prior to retirement	7923	7190	7078	5183	3992
Own retirement benefits	19,126	29,002	34,351	45,091	53,388
Spousal retirement benefits	9563	14,501	17,176	22,546	26,694
Survivors' benefits resulting from deaths at or above the retirement age	2574	3837	4873	5848	7097
Total benefits	39,186	54,530	63,478	78,668	91,171
Expected Net Present Value for Single Men	(16,264)	(32,667)	(41,098)	(63,363)	(93,170)
Expected Net Present Value for One-Earner Couple	3796	(7139)	(11,971)	(29,787)	(55,387)
Internal Rate of Return for Single Men	2.29	1.86	1.71	1.40	0.96
Internal Rate of Return for One-Earner Couple	4.36	3.60	3.44	3.00	2.55
Money's Worth Ratio for Single Men	54.04	47.03	45.53	41.58	36.43
Money's Worth Ratio for One-Earner Couple	110.73	88.42	84.13	72.54	62.21

The final two rows in the table show the money's worth ratios or benefits per dollar of taxes paid. Most single men will receive approximately $0.57 cents on each dollar they paid into the system. Interestingly, those with the highest educations are expected to receive the highest benefits per dollar they pay. The expected benefits awarded to married men with less than a high school education are equal to $1.20 for each dollar in taxes they paid. At the other end of the earnings distribution, Social Security returns $1.04 for each tax dollar.

Table 4 presents the expected taxes and benefits for men born in 1980. The results consistently indicate that net taxes rise and that rates of return and money's worth ratios fall, moving from the low to high education categories. Total tax payments for the lowest education group hardly rise between the 1935 and 1980 birth year, but are almost 2.5 times higher for the highest education group, with a representative member paying expected lifetime taxes of $146,558. Whereas the ratio of the highest to lowest lifetime expected tax payments was 1.78 for the workers born in 1935, the ratio climbs to 4.14 for the workers born in 1980. As noted previously, this widening is a remnant of our earnings projection, which allows for persistence in the higher wage growth among the more educated.

The present values of expected own retirement benefits range from $19,126 to $53,388, and the present value of total expected benefits for a single-income couple range from $39,186 to $91,171 for ratios of the highest to lowest benefits of 2.79 and 2.35, respectively. The redistributive nature of the benefit formula is evident in these ratios when compared with the lifetime tax payments. So even though workers in the lower education categories have shorter expected life spans, the benefit formula produces higher rates of return and money's worth ratios as well as lower net lifetime taxes, as the remainder of the table indicates.

Sensitivity to Discount Rate Assumption

The present values in Tables 1–4 have all been based on a 4% discount rate. However, these values are sensitive to the rate at which tax payments and benefits are discounted. As we have seen, survivors' benefits are relatively more important for groups with higher mortality risks at younger ages. Therefore, higher discount rates will effectively weight the importance of benefits received at early relative to later dates, with the converse being true for lower discount rates. Tables 5 and 6 use money's worth ratios to summarize how various discount rates affect the ordering of outcomes for racial and education groups, respectively.

The top panel in Table 5 indicates the expected result that money's worth ratios are inversely related to the discount rates. Comparing the results for birth year 1935 to birth year 1980 also shows the decline in ratios over time. For single men, the money's worth ratio for whites always exceeds the ratio for blacks, but the results for one-earner couples in the bottom panel of the table show the importance of the discount rate in interpreting the relative outcomes. For the discount rates from 2 to 4%, whites have higher money's worth ratios than blacks, but when the discount rate is 5 or 6%, blacks' money's worth ratios exceed those of white one-earner couples. A reversal occurs as the relative weight of preretirement age benefits rises relative to postretirement age benefits in the money's worth ratios based on higher discount rates.

Table 6 presents the money's worth ratios by education category. Most of the interesting results were obtained among single men born in 1935. As previously noted in Table 3, single men with a graduate school education had a higher money's worth ratio than men in all the other education categories when a 4% discount rate was used. Regardless of the discount rate, men with graduate school educations have higher ratios than do men with college educations. The ranking of money's worth ratios is reversed when the higher discount rates are used, with lower education levels

Table 5. Sensitivity of Money's Worth Ratios to Differing Discount Rates

	Birth Year 1935			Birth Year 1980		
Discount Rate	All	Blacks	Whites	All	Blacks	Whites
Single men, by racial group						
2.0	104.54	86.05	107.41	88.57	65.78	94.13
3.0	77.72	63.58	79.96	63.13	47.05	66.78
4.0	57.52	46.80	59.27	44.81	33.52	47.19
5.0	42.38	34.32	43.75	31.68	23.79	33.22
6.0	31.09	25.08	32.17	22.31	16.82	23.30
One-earner couple, by racial group						
2.0	186.70	171.19	190.85	152.13	129.61	160.44
3.0	142.78	135.56	144.55	111.72	99.18	115.85
4.0	109.88	109.10	109.85	82.71	77.29	84.05
5.0	85.38	89.55	83.99	61.99	61.60	61.46
6.0	67.26	75.15	64.83	47.24	50.37	45.48

experiencing lower ratios of benefits to tax payments. Given that own retirement benefits are the sole type of Social Security benefits received by single men, the higher discount rates reduce their present value relative to the present value of tax payments. For the one-earner couples born in 1935, we again see that the highest education group has higher money's worth ratios for all discount rates than does the college-educated group. By 1980, for both single men and one-earner couples alike, the ranking of money's worth ratios are inversely related to education level across all discount rates.

The value of money's worth measures are limited when making comparisons across different proposed retirement systems. First, that the rates of return from the existing system are below market level for all demographic groups within current and future working generations does not necessarily mean prepayment, based on individual accounts, would make everyone better off, due to the accrued benefits in the system.[19] Second, it is difficult for money's worth measures to capture some costs and benefits from Social Security reform. As pointed out in Geanakoplos, Mitchell, and Zeldes (1999), individual accounts may help diminish political risks associated with future tax and benefit changes in the current system, but at the same time may expose beneficiaries to market risks. Moreover, existing money's worth measures fail to incorporate incentive effects or welfare costs and therefore have little to say about efficiency implications of a reform.[20]

4. Conclusion

We have calculated the net present value and the internal rate of return of Social Security investments for demographic groups of different family type, birth year, ethnicity, and education level by using education- and race-specific mortality tables and earnings profiles and by accounting for all the major component parts of the OASI program. Consistent with previous findings, we find that, even before accounting for preretirement survivors' benefits, which favor low education groups, Social

[19] See Mariger (1997), Geanakoplos, Mitchell, and Zeldes (1998), and Murphy and Welch (1998) for detailed analysis of this point.

[20] See Kotlikoff (1998) and Liu, Rettenmaier, and Saving (2000) for discussions of the conditions under which Social Security privatization is Pareto-improving.

Table 6. Sensitivity of Money's Worth Ratios to Differing Discount Rates

Discount Rate	Birth Year 1935					Birth Year 1980				
	Less Than High School	High School	Some College	College	Graduate School	Less Than High School	High School	Some College	College	Graduate School
Single men, by education level										
2.0	107.53	105.56	103.56	99.37	106.49	110.81	95.36	90.51	81.79	71.15
3.0	78.49	77.78	77.16	75.07	80.56	77.55	67.10	64.31	58.43	51.01
4.0	57.06	57.06	57.26	56.45	60.70	54.04	47.03	45.53	41.58	36.43
5.0	41.32	41.68	42.32	42.26	45.56	37.52	32.84	32.12	29.47	25.91
6.0	29.81	30.33	31.16	31.49	34.06	25.96	22.85	22.58	20.82	18.36
One-earner couple, by education level										
2.0	201.61	190.79	186.00	171.41	180.09	202.54	167.04	158.01	138.41	119.56
3.0	154.33	144.53	141.47	130.73	136.89	148.69	121.01	114.90	100.09	86.24
4.0	119.63	110.22	108.12	99.69	103.91	110.73	88.42	84.13	72.54	62.21
5.0	94.28	84.92	83.26	76.16	78.86	84.08	65.45	62.26	52.81	44.95
6.0	75.87	66.35	64.83	58.40	59.90	65.43	49.31	46.77	38.76	32.61

Security investments of less educated groups have higher rates of return than the investments of more highly educated groups. This suggests that the redistributive nature of the benefit formula outweighs the effects of lower life expectancies. The same conclusions are drawn if present values are used to evaluate the investment.

In contrast, the longevity disadvantage of blacks more than fully offsets the redistributional effect of the benefit formula, resulting in a lower rate of return than received by whites, even though preretirement survivors' benefits are higher for blacks due to a higher probability of early death. However, the net present value estimates for whites show that they pay more in lifetime taxes than blacks. The different ranking, based on internal rates of return and net present values, are reconciled by noting that the internal rate of return is a measure of the net tax payment's progressivity, while the present value identifies the direction of redistribution implicit in the system. Further, the higher the discount rate, the more likely it is that one-earner black families' investments produce a higher money's worth ratio than experienced by white families.

The results of this article focus on the distributional aspects of the existing Social Security system. Decomposing Social Security's benefits identifies the source of distribution in the system, which in turn may shed some new light on prospective reforms. In evaluating reform proposals featuring individual retirement accounts, changes to the benefit formula, or tax structure, it is important to look at how these proposals address spousal benefits, preretirement survivor benefits, and after-retirement survivor benefits, taking into account group-specific incidence.

Appendix

Projected Earnings

Our forecast of future taxable earnings follows a methodology described in detail in Rettenmaier and Saving (2000). In short, the real growth rates in the components of annual earnings are calculated for each group of workers, where groups are defined by age, education, sex, and race. The components of annual earnings for a group are the percentage working, their annual hours of work, and their hourly wage. Growth rates for each earnings component are estimated using inflation-adjusted data from the Current Population Surveys (CPS). Past earnings were inflated using the Personal Consumption Expenditures implicit price deflator.

The calculated real growth rates then become the basis for projecting earnings into the future. In the present study, the current Social Security taxable maximum was inflation adjusted and retrospectively imposed on earnings in earlier years before calculating growth rates. See Rettenmaier and Saving (2000) for a comparison of growth rate options and for specific assumptions used to deal with details that arise in forecasting earnings.

Longevity

Racial Groups

Mortality estimates in this study are drawn from several sources, including the U.S. Census, the Social Security Administration, and death-registration data. For the analysis by racial groups, we ultimately need estimates for each birth year from 1935 to 1980 and for both black and white men and women. The Census Bureau has published life tables in future years by race and sex. These estimates are the starting point for the birth year-specific estimates we use. Social Security Administration estimates by birth year are used to supplement the census data at higher ages.

The longevity estimates for racial groups in the birth years of interest begin with the U.S. Census Bureau's 1995, 2005, and 2050 middle series life tables. The tables are organized by single years of age, by sex, by race, and by Hispanic origin. They provide expected mortality at each age in the three cross-sections. However, we are interested in the mortality experienced by individuals born in a given year, not mortality in a given year at various ages. To create life-cycle mortality tables, we use linear interpolation to fill in the cross-section life tables for intervening years. From the entire set of cross-sectional life tables, we identify the experience of the individuals born in the years under study.

Individuals born in 1935–1980 are the focus of our study; therefore, the interpolated census data result in mortality estimates for those born in 1935 from the age of 60 to the age of 100. For the latest birth year, 1980, the census data cover mortality rates between 15 and 70 years of age. Extrapolated data are used for the years 2051–2080, which allows for tracking mortality out to the age of 100 for the latest birth year.

The void in the data for years prior to 1995 is filled using death-registration data from Anderson (1998). The death-registration data indicate the number of survivors for every fifth year of age, at 10-year intervals, between the turn of the century until 1996. The data are further partitioned by race and sex. Mortality rates between ages and the years 1940–1980 are interpolated to fill in the pre-1995 data to complete the set of cross-sectional life tables from which the birth-year life tables are constructed.

Figure A1 presents the number of survivors, conditional on reaching 18 years of age, for white, black, and all men born in 1960. By the normal retirement age of 67, 79.9% of white men are expected to be alive, 59.5% of black men are expected to be alive, and 77.6% of men of all races are expected to survive. For this birth year, the Social Security Administration expects 76.3% of the men who survive to the age of 18 to survive to the age of 67. This estimate is 1.3 percentage points lower than the estimates based on the census data. For more recent birth years, the Census Bureau data consistently produce longer life expectancies and ultimately higher rates of return than when the Social Security Administration data are used. Because the Census Bureau produces separate mortality tables for blacks and whites, which allow for gradual convergence in longevity, we opted for the census estimates throughout.

Education Groups

Calculating education level-specific life tables begins with the Census Bureau's and death registration data, which we then adjust using the relative mortality estimates of Sorlie, Backlund, and Keller (1995). We first restate the ratios in Table A1 so that they reflect ratios relative to the average person. We describe the process for men, which is repeated for women. Denote the percentage of the male population with education level i ($i = 1$ to 5 from the lowest to highest education category) in an age group j ($j = 1$ to 3 from the youngest to the oldest age category) as P_{ij}. Then for each j, $\Sigma_{i=1}^{5} P_{ij} = 1$ by definition. Each ratio in Table A1 can be denoted as r_{ij} according to its position in the table. For example, r_{43} for men is 0.90. The restated mortality ratio for people in age category j with education level i with reference to the average person in age category j, denoted as r_{ij}^{*}, is

$$r_{ij}^{*} = \frac{r_{ij}}{\sum_{i=1}^{5} P_{ij} r_{ij}}.$$

The denominator now represents all members of age category j. The major task in calculating r_{ij}^{*} is to estimate P_{ij}. Because Sorlie, Backlund, and Keller (1995) use data from nine CPSs conducted in March 1979, April 1980, August 1980, December 1980, March 1981, March 1982, March 1983, March 1984, and March 1985, the proportion of men with education level i and in age group j, P_{ij}, is obtained from the CPS data.

The relative risk ratios are further modified to apply to single years of age. Now denote R_{iam} as mortality ratio for education level i and age a, for a single year of age, and for males. Here we calculate R_{iam} from r_{ij}^{*}. Using the midpoint in the first two age categories and the age of 75 in the upper category, we let $R_{i35m} = r_{i1}^{*}$, $R_{i55m} = r_{i2}^{*}$, and $R_{i75m} = r_{i3}^{*}$ for all $I = 1, 2, 3, 4$, and 5 because r_{ij}^{*} represents the average mortality ratio for the population with education level i in age group j.

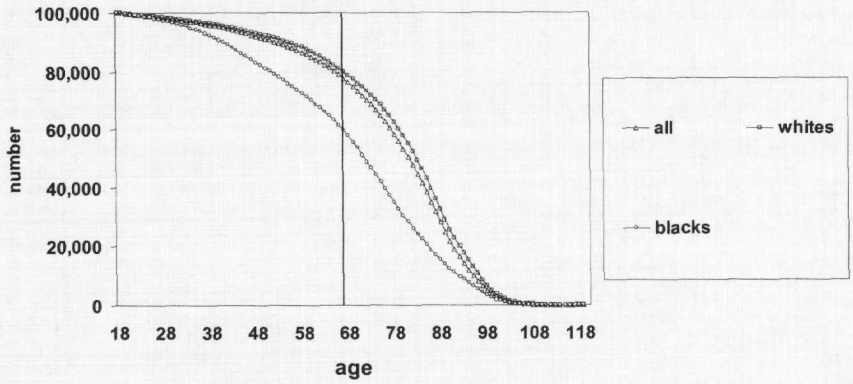

Figure A1. Survival of Men Born in 1960, by Racial Groups

Next, we obtain all R_{iam} for ages 18–119 from R_{i35m}, R_{i55m}, and R_{i75m}, using geometric interpolation. For example, for the ages between 35 and 55,

$$R_{iam} = R_{i35m}\left(\frac{R_{i55m}}{R_{i35m}}\right)^{(a-35)/20}.$$

Ratios for other ages are obtained in a similar fashion.

In those general life tables, each mortality rate number, denoted as m_{csa}, is a cohort-sex-age-specific probability of dying in a particular year (at a particular age). To make this mortality rate also group specific, a general practice is to multiply it with a group-specific ratio, which measures the relative mortality risk of a group to the population as a whole. For example, we can classify the population into five education groups, $i = 1, 2, 3, 4, 5$ corresponding to years of schooling 11 and below, 12, 13–15, 16, and 17 and above. The probability of dying at age a for a male college graduate belonging to birth cohort c would be $m_{cma} \times R_{4am}$, where R_{4am} is the relative mortality rate of a male college graduate at age a with respect to an average male of age a.

Making the adjustments, as described above, imposes constant education-based differences in mortality for each cohort. To the degree that education-based mortality differences reflect lifetime income differences, such an adjustment may underestimate future birth year-specific mortality differences given the growing disparity in life-cycle earnings. As a result, some of the disparity in Social Security outcomes reported here will be dampened if education-based mortality differences were allowed to expand for younger birth cohorts.

Figure A2 presents the survival curves for men born in 1960. The expected percentage of individuals who survive to 67, conditional on reaching 18 years of age, is 70.8% of men with less than a high school education, 75.9% of high school graduates, 77.5% of those with 13–15 years of schooling, 82.7% of college graduates, and 85.2% of those with some graduate school.

Methodology to Calculate Expected Internal Rates of Return and Net Present Values

Assume every individual starts working on his/her 21st birthday (January 1 for simplicity), works and pays Social Security payroll taxes all the way to the full retirement age (if still alive) specified by law for his/her cohort, then retires and receives Social Security benefits, contingent on survival, up to a common maximum biological limit. Assume in this study that one can

Table A1
Mortality Ratios for Education Groups from Sorlie, Backlund, and Keller (1995)

	Ages 25–44		Ages 45–64		Ages 65+	
	Men	Women	Men	Women	Men	Women
11 or less	1.38	1.51	1.21	1.29	1.11	1.06
12	1.00	1.00	1.00	1.00	1.00	1.00
13–15	0.92	0.85	0.91	1.01	0.97	0.96
16	0.59	0.70	0.70	0.85	0.90	0.97
17 or more	0.48	0.64	0.60	0.81	0.76	0.82

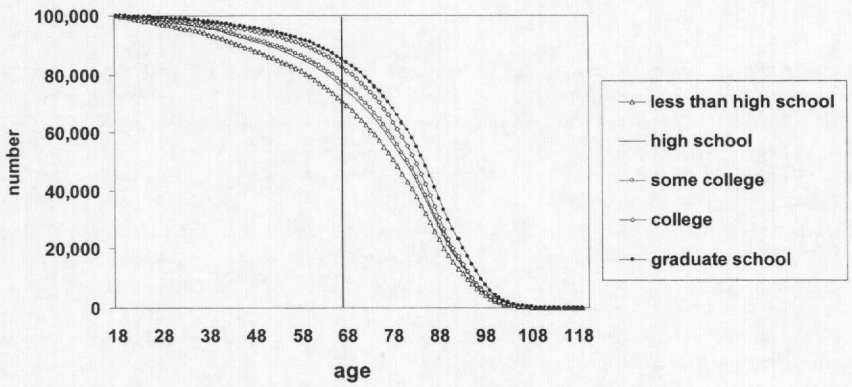

Figure A2. Survival of Men Born in 1960, by Education Groups

live up to 120 years. The whole Social Security investment is stochastic, depending on the longevity of the individual. If the age of death is t, where $t \geq 21$ (for simplicity, on the tth birthday), then the realized net cash flows from Social Security to the individual (or the individual's family) belonging to birth cohort i[21] and group j[22] can be generally expressed as $(x_{ijt1}, \ldots, x_{ijtk}, \ldots, x_{ijt(t-21)}, \ldots, x_{ijt(120-21)})$, where x_{ijtk} $(k \geq 1)$ is either a tax payment (with a negative sign in this case) or a benefit payment occurring in calendar year $i + 21 + k - 1$. For simplicity, we assume that all tax payments or benefit payments occur at the end of the year. There are two reasons for the nonzero cash flows after one's death, i.e., $x_{ijtk} \neq 0$ for $k > t - 21$. First, if the individual is married with children and the children are minors below age 16 when he or she dies at age t, then both the spouse and the children are subject to preretirement survivors' benefits. As a result, benefits will be activated upon the individual's death and continue until the children reach 16. Second, if the individual is married with a nonworking spouse who survives the individual, when the spouse reaches the full retirement age, he or she will receive 100% of the primary insurance amount until death.[23]

Given an arbitrary discount rate r, if an individual belonging to birth cohort i and group j dies at age t $(t \geq 21)$, then the net present value of the realized cash flows is

$$NPV_{ijt}(r) = \sum_{k=1}^{120-21} \frac{x_{ijtk}}{(1+r)^k}.$$

At age 21, the individual does not know exactly what his age of death will be. Denoting s_{ijq} as the probability of surviving from age q to age $q + 1$ for an individual belonging to birth cohort i and group j,[24] then the probability of this individual dying at age t $(t \geq 21)$ is

$$P_{ijt} = (1 - s_{ijt}) \prod_{q=21}^{t-1} s_{ijq}.$$

As a result, the individual's lifetime expected net present value from the Social Security deal using discount rate r is

$$ENPV_{ij}(r) = \sum_{t=21}^{120} (P_{ijt} \cdot NPV_{ijt}(r)) = \sum_{t=21}^{120} \left\{ \left[(1 - s_{ijt}) \prod_{q=21}^{t-1} s_{ijq} \right] \left[\sum_{k=1}^{120-21} \frac{x_{ijtk}}{(1+r)^k} \right] \right\}.$$

There are two discount rates that are of particular interest: the market rate of return, r_m, and the internal rate of return, r^*_{ij}. $ENPV_{ij}(r_m)$—the expected present value discounted at the market rate of return—measures the value of Social Security for the average 21-year-old individual in birth cohort i and population group j. The internal rate of return for birth cohort i and population group j, r^*_{ij}, is the solution to $ENPV_{ij}(r) = 0$.

---

[21] If $I = 1970$, then the individual was born on January 1, 1970.

[22] In short, j identifies racial group, education level, sex, and family status.

[23] A worker's surviving spouse can receive after-retirement survivors' insurance at age 60 but at a reduced rate. For simplicity, we assume in this study that all the benefits, except for the before-retirement survivors' benefits, begin at the full retirement age.

[24] From the mortality rate data, the more direct information is the probability of an age q individual belonging to birth cohort i and group j not surviving to age $q + 1$, d_{ijq}. Then $s_{ijq} = 1 - d_{ijq}$.

References

Advisory Council on Social Security. 1997. *Report of the 1994–1996 Advisory Council on Social Security. Volume I: Findings and recommendations.* Washington, DC: U.S. Government Printing Office.

Anderson, Robert N. 1998. United States Abridged Life Table, 1996. *National vital statistics reports.* Volume 47, No. 13. Hyattsville, MD: National Center for Health Statistics.

Auerbach, Alan J., Laurence J. Kotlikoff, and Willi Leibfritz, editors. 1999. *Generational accounting around the world.* Chicago: University of Chicago Press.

Beach, William W., and Gareth G. Davis. 1998. *Social Security's rate of return.* Washington, DC: Heritage Foundation.

Bell, Felicitie C., Alice H. Wade, and Stephen C. Goss. 1992. *Life tables for the United States Social Security area 1900–2080.* Actuarial Study No. 107. Washington, DC: U.S. Department of Health and Human Services, Social Security Administration, Office of the Actuary.

Boskin, Michael J., Laurence J. Kotlikoff, Douglas J. Puffert, and John B. Shoven. 1987. Social Security: A financial appraisal across and within generations. *National Tax Journal* 40:19–34.

Brown, Jeffrey. 2000. Differential mortality and the value of individual account retirement annuities. NBER Working Paper No. 7560.

Coronado, Julia Lynn, Don Fullerton, and Thomas Glass. 2000a. The progressivity of Social Security. NBER Working Paper No. 7520.

Coronado, Julia Lynn, Don Fullerton, and Thomas Glass. 2000b. Long run effects of Social Security reform proposals on lifetime progressivity. NBER Working Paper No. 7568.

Duggan, James E., Robert Gillingham, and John S. Greenlees. 1993. Returns paid to early social security cohorts. *Contemporary Policy Issues* 11:1–13.

Garrett, Daniel M. 1995. The effects of differential mortality rates on the progressivity of Social Security. *Economic Inquiry* 23:457–75.

Geanakoplos, John, Olivia. S. Mitchell, and Stephen. P. Zeldes. 1998. Would a privatized Social Security system really pay a higher rate of return? University of Pennsylvania Pension Research Council Working Paper 98-6.

Geanakoplos, John, Olivia. S. Mitchell, and Stephen. P. Zeldes. 1999. Social Security money's worth. In *Prospects for Social Security reform,* edited by Olivia S. Mitchell, Robert J. Myers, and Howard Young. Philadelphia: University of Pennsylvania Press, pp. 79–151.

Goss, Steve. 1998. Problems with 'Social Security's rate of return': A report of the Heritage Center for Data Analysis. Institute for American's Future. Available at http://www.ourfuture.org/institute/stevgoss.asp.

Gustman, Alan L., and Thomas L. Steinmeier. 2000. How effective is redistribution under the Social Security benefit formula? NBER Working Paper No. 7597.

Hurd, Michael D., and John B. Shoven. 1985. The distributional impact of Social Security. In *Pensions, Labor, and Individual Choice,* edited by David A. Wise. Chicago: University of Chicago Press, pp. 193–207.

Kotlikoff, Laurence J. 1998. Simulating the privatization of Social Security in general equilibrium. In *Privatizing Social Security,* edited by Martin Feldstein. Chicago: University of Chicago Press, pp. 265–306.

Leimer, Dean R. 1978. Projected rates of return to future Social Security retirees under alternative benefit structures. In *Policy analysis with Social Security research files.* Washington, DC: U.S. Department of Health, Education, and Welfare, pp. 235–68.

Liebman, Jeffrey B. 2002. Redistribution in the current U.S. Social Security system. In *The distributional aspects of Social Security reform,* edited by Martin Feldstein and Jeffrey Liebman. Chicago: University of Chicago Press for NBER, pp. 11–41.

Liu, Liqun, Andrew J. Rettenmaier, and Thomas R. Saving. 2000. Constraints on big bang solutions: The case of intergenerational transfers. *Journal of Institutional and Theoretical Economics* 156:270–91.

Mariger, Randall P. 1997. Social Security privatization: What it can and cannot accomplish. Finance and Economics Discussion Paper Series, Board of Governors of the Federal Reserve.

Murphy, Kevin M., and Finis Welch. 1998. Perspectives on the Social Security crisis and proposed solutions. *The American Economic Review* 88:142–50.

Rettenmaier, Andrew J., and Thomas R. Saving 2000. *The economics of Medicare reform.* Kalamazoo, MI: W.E. Upjohn Institute for Employment Research.

Schieber, Sylvester J., and John B. Shoven. 1999. *The real deal: The history and future of Social Security.* New Haven, CT: Yale University Press.

Sorlie, Paul D., Eric Backlund, and Jacob B. Keller. 1995. U.S. mortality by economic, demographic, and social characteristics: The national longitudinal mortality study. *American Journal of Public Health* 85:949–56.

Steurele, C. Eugene, and Jon M. Bakija. 1994. *Retooling Social Security for the 21st century: Right and wrong approaches to reform.* Washington, DC: Urban Institute Press.