Research Paper No. 9302

Net Returns to Early Social Security Cohorts

(Contemporary Policy Issues, October 1993, pp. 1-14)

James E. Duggan
Robert Gillingham
John S. Greenlees*

Previous research has concluded generally that early participants in the Social Security system received a very good "deal," better than later participants received, and much better than future participants are likely to get. The values of those deals, and their distribution across individuals and groups, are not well-known, however, largely because the necessary data have not been available. By contrast, our study uses the Social Security Administration's 1988 Continuous Work History Sample (CWHS) to calculate, by selected sex, race, household type, income and birth cohort, the real internal rates of return to contributions received by early participants. We also employ new Census Bureau mortality projections to more accurately forecast how life expectancies and benefit streams vary by race, as well as by sex and birth cohort.

The calculations presented here are important to an understanding of how the Social Security system redistributes income. All the groups we study received high real rates of return, although the returns varied widely by household type, income level, birth cohort, and other factors. We estimate that persons born from 1895 to 1922 received a total transfer of $3.6 trillion, of which $1.3 trillion remained to be paid as of 1988.

I. Introduction

The combined benefit and contribution structure of the U.S. Social Security program generates substantial income transfers within and across generations. A highly progressive benefit formula transfers income from high-wage to low-wage earners, and benefits are paid by transferring resources from current workers to current beneficiaries. The transfers implicit in this system do not always flow from high-income to low-income earners, however, and their magnitude may be higher or lower than intended. This causes concern over intra- and intergenerational equity and raises the question of whether the program is doing an acceptable job of redistribution. A number of studies have attempted to evaluate the relative generosity of Social Security (the relationship between benefits and contributions) toward program participants, but these studies have been hampered by the lack of appropriate data. As a consequence, the value of Social Security participation, and its distribution across individuals and groups, are not well-known.

In this paper, we report on an empirical assessment of Social Security income transfers for early participants in the system. Our objective is to quantify the magnitudes of and variations in transfers that take place within and across cohorts. For selected sex, race, household type, income, and age categories, we derive the present values of contributions and benefits (and net benefits) and the internal rates of return to contributions. We discuss the sensitivity of our results to the choice of a discount rate series, and we decompose our benefit values into those benefits already received and those remaining to be paid to our sample workers after 1988.

An important aspect of our work, and one that sets it apart from previous studies on this topic, is the data base: the Social Security Administration's 1988 Continuous Work History Sample (CWHS). The CWHS is an earnings history file for a 1 percent sample of Social Security records. Because it has not been publicly available since the 1970s, no previous analysis of these data has been possible. The file has over 2.5 million records with actual earnings histories spanning the period 1951 to 1988.

The CWHS permits a more complete analysis of the Social Security contribution and benefit base than has been possible in previous studies. No other available file contains longitudinal earnings data for such an extended period and such a large number of individuals. As detailed later, the file also contains benefit information that we use to compute benefit histories for current and former Social Security beneficiaries. The individual account records allow us to examine both the mean and the dispersion of contributions and benefits for actual (and appropriately weighted) beneficiary classes. In contrast to other research, our analysis is able to estimate the returns *actually received* by early cohorts. In particular, we find that the early participants under study here experienced real rates of return greater than 9% and received an aggregate income transfer of $3.6 trillion.

II. Previous Research

A number of studies have addressed the topic of this paper. Though the studies differ in important ways, they generally conclude that early participants in the Social Security program fared very well financially from the program. The preferential treatment of early cohorts is endemic to any maturing retirement system. Several studies also demonstrate that, within birth cohorts, the returns from the Social Security program depend upon marital status and family income. Previous studies base their conclusions on calculations of rates of return and / or net present values either for actual case histories of workers or for "representative" workers.

Freiden, Leimer, and Hoffman (1976) used an early version of the CWHS to examine a sample of case histories of workers retiring between the years 1967 and 1970. They concluded that, for this particular group, the Old-Age Insurance (OAI) program was strongly progressive (i. e., redistributed in favor of low-income persons). Burkhauser and Warlick (1981) used the 1973 Current Population Survey - Internal Revenue Service - Social Security Administration Exact Match file to investigate case histories of a sample of retirees and survivors, concluding that intergenerational transfers in the OASI program were large for early cohorts but diminished over time, and that all income classes received benefits exceeding an actuarially fair annuity. Meyer and Wolff (1986) also examined case histories from the Exact Match file to study the redistributive effects of the OAI, deriving conclusions similar to Burkhauser and Warlick. Finally, Hurd and Shoven (1985) calculated rates of return on OASI contributions for a sample of persons in the Social Security Administration's Retirement History Survey. They found that Social Security transfers and rates of return were very high for their sample.

Examples of the "representative worker" approach include Boskin *et al* (1987), Leimer (1978), Pellechio and Goodfellow (1983), and Myers and Schobel (1983). In this approach, earnings profiles are either derived from parameters estimated with Census or Current Population Survey data, or simply postulated to follow age-experience profiles and general economy-wide growth. Boskin *et al* (1987), for example, calculate that an average-income individual born in 1915 could expect a net *gain* (benefits less contributions) from the OASDI program of $63,000. By contrast, an individual born in 1975 and with the same earnings can expect a *loss* of $39,000. The study by Pellechio and Goodfellow (1983) also found large intragenerational transfers in the OASI program and illustrated the losses sustained by all generations from the 1983 Amendments. Myers and Schobel (1983) analyzed the returns to OASI program participants for various stylized cases, also showing that early cohorts fared very well.

The studies that analyzed actual case histories were quite restrictive in the cases or programs addressed and none were sufficiently current to assess adequately the effects of the major changes that occurred in the 1977 and 1983 Amendments. The representative worker approach precludes an accurate assessment of actual program experience. In contrast, our study examines actual case histories for a wider range of situations than prior studies and covers the period through 1988, which includes several years past the last major reform to the Social Security program. In addition, we pay particular attention to modeling future survival probabilities, notably incorporating new, recently published Census Bureau projections of mortality rates broken down by age, sex, and race.

III. Data Description

A. The Continuous Work History Sample

As pointed out in section I, the CWHS has important advantages for the analysis presented in this paper.[1] The CWHS also has a number of disadvantages. For our purposes, the most serious shortcoming is the absence of historical benefit data. Benefit amounts are included on the file for the current year only (1988 in our file). As a consequence, a crucial part of our work involved computing benefit histories using the information in the CWHS. The information for precise benefit computation is incomplete, however. The complexity and changing nature of benefit formulas, as well as conditions that affect individual cases, are not captured in the CWHS data base. In many cases, we could not expect to duplicate exactly either the benefit history or the current benefit.[2]

The CWHS contains demographic data only on age, sex, and race. Information on marital status and other family relationships is severely limited, further complicating the benefit computation process and precluding illustrations of rates of return for certain population classes of interest. Further, income data on the file relate only to wage-and-salary and self-employment earnings, which, for years preceding 1978, are capped at the Social Security taxable maximum.[3]

B. Sample Selection Criteria

In selecting a sample from the CWHS file, we employed two primary criteria:

(1) birth years between 1895 and 1922,

(2) initial benefit entitlement after 1956, and

(3) no covered employment in 1988.

Our fundamental objective in choosing a sample from the CWHS was to select a group of insured individuals on the basis of when they were born. Selection by birth cohort avoids the bias that would result from selection on the basis of outcomes (such as being alive in 1988, or receipt of Social Security benefits).

The sample used in this paper is drawn from the set of all Social Security participants with birth years between 1895 and 1922. The choice of these particular bounding years was driven primarily by the limitations of the CWHS data base, and by our desire at this stage of our research to measure benefit returns without forecasting future work patterns. The CWHS file provides annual benefit status information only for 1956-88. Consequently, we were not able to identify the initial benefit year of insured workers retiring in 1956 or earlier. Individuals born before 1895 reached age 62 prior to 1957, implying that we would often fail to observe their initial benefit status and year. We therefore excluded those individuals, and included in our sample only records with benefit eligibility beginning after 1956.

In 1988, the year corresponding to the CWHS sample, persons born after 1922 had either not reached or were just at the normal retirement age of 65. Consequently, many of these individuals would still be employed workers. Moreover, a large proportion of the workers would have spouses who had not reached the age at which they would be eligible to apply for benefits and who therefore would not be observed. In excluding these later cohorts, we also deleted all other individuals who were in covered employment in 1988. The potential effects of this truncation on the basis of work status is discussed later in section V.

For this paper, we have chosen to focus on the OASI program. We do not include disability benefits in program returns, and we exclude the DI portion of the Social Security (Federal Insurance Contributions Act, or FICA) contribution rate. However, we did not delete disabled individuals from our sample. Upon reaching age 65, disability beneficiaries are automatically recategorized as old-age beneficiaries, and their subsequent benefits are paid from the OASI trust fund. We include these OASI benefits as returns to their prior contributions.

Under the OASI program, those potentially eligible for benefits include retired old-age workers and certain of their dependents (spouses and/or children), and survivors of insured workers (widows and widowers, eligible children, dependent parents) who may or may not have been beneficiaries. In this paper, we analyze benefits paid to three principal beneficiary types: insured workers (old-age benefits), their spouses (spousal benefits), and surviving spouses (widow(er) benefits). Because the CWHS provides birthdates only for insured workers and spouse beneficiaries, it would be highly problematic for us to forecast either the durations or levels of future benefit flows for other dependents. Therefore, we excluded those dependent benefits from our analyses, implicitly setting them to zero in all cases.

Ignoring nonspouse dependent benefits will impart a clear downward bias to our rate of return calculations. However, the degree of bias is difficult to judge. Currently, approximately four percent of OASI benefits are paid to, or on behalf of, survivors other than spouses and to children of current beneficiaries.[4] Furthermore, many of the insured workers in this group, on whose account such benefits would be paid, died at relatively young ages, and so were below average in both contributions and benefits.

Insureds who were deceased in 1988 and who were no longer paying survivor benefits present especially difficult measurement problems. For these individuals, we do not observe any past or current benefit levels, nor can we identify the mix of beneficiaries, if any. We could not exclude them from our sample, however, without introducing serious biases. Deceased individuals, including those who died prior to entitlement, were therefore included in our computations if they satisfied our other editing criteria. Our approach to estimating historical benefits for these cases is discussed in section IV and in the appendix.

C. Classifications of Workers

Household Type. The records in our CWHS sample fall into a number of different demographic situations as observed in 1988: current unmarried beneficiaries, deceased former beneficiaries, beneficiaries and spouses both currently receiving benefits, surviving spouse beneficiaries of deceased workers who died before retirement, and so on. For analytical comparisons, we classified these records into two household categories:

(1) Individuals. This category includes all records, of both current beneficiaries and deceased former workers that indicate absence of a spouse.

(2) Dependent couples. This is our term for married couples in which only one partner was a covered worker. They are identified in our file by a spouse presence and no dual entitlement. This category is observed in the widest variety of contexts, depending on whether the insured or spouse, or both, were deceased in 1988.

The most significant complexity in this categorization involves the treatment of dually entitled spouses. As discussed in the appendix, these former workers are receiving either spousal or survivor benefits that exceed the benefits to which they would be entitled based on their own history of contributions. This category includes only current beneficiaries, since no dual entitlement information is not given on records of deceased insureds.[5]

Unfortunately, we are unable to classify households in the more traditional fashion available to those working with hypothetical situations or with a household sample such as the CPS. That is, we cannot divide households into singles, two-earner couples, and single-earner couples. The latter category corresponds to group (2) above, but our group (1) includes not only single persons but also dual beneficiaries and their spouses; we have no way of pairing these two-earner couples. In interpreting our tables, it must be kept in mind that the benefits paid to some members of group (1) are explicitly based on the contributions of other insured workers.[6]

Birth Cohort. In order to observe how the rate of return to Social Security varied as the program matured and changed over time, we subdivided our sample into four, approximately equal-sized cohorts by birth year: 1895-1903, 1904-1910, 1911-1916, and 1917-1922. The last cohort includes the bulk of those workers in our sample whose benefits were determined under "new law," that is, under the 1977 Social Security Amendments.

Income Class. Analysis of the progressivity of Social Security C the relationships among income, contributions, and benefits C required that our sample of insured workers from different cohorts and lifetime work patterns be ranked on a consistent income scale. For this purpose, we computed each worker's mean annual taxable (i.e., FICA) earnings from age 42 through age 62 or year of death, whichever came sooner, with each year's earnings indexed to 1988 using the national-average earnings per worker in covered employment. The sample was then ranked and divided into three equal quantiles on this average-earnings basis.

Under this procedure, which is roughly similar to that used in Social Security's process of computing average indexed monthly earnings (discussed below) workers are more likely to fall into the lower income classes if they have years without covered employment between age 42 and 62. Because years after death are not included in our calculation, workers who died before retirement age will not be classified as low-income for that reason. However, our low-income group will include some occasional workers whose wage rates or wealth levels may be high. We also recognize that the fluctuating ratio of taxable to total earnings, caused by occasional changes in the FICA contributions ceiling, introduces some ambiguity into our income categorization.

Sex and Race. Interpretation of the relationship between sex and Social Security benefits is complicated by the structure of our CWHS sample. The overwhelming majority of our dependent couple records in household class (2) associate the contributions of a male insured worker with the benefits paid to the worker and his wife. Similarly, dual beneficiaries, whose benefits are by definition greater than those justified by their own contributions, are almost always women.

Until 1980, SSA collected race information only for white, black, and other (or unknown) classifications. In 1980, SSA began to phase in (for new participants only) a seven-way classification of race: white, black, Hispanic, Asian or Pacific Islander, North American Indian or Eskimo, other, and unknown. The more detailed classication would apply only to a small number of persons in our sample, however. Consequently, we consolidated the race classes in our sample into three C white, black, and other or unknown. The three-way race classification corresponds to the structure of our mortality rate data (discussed below).

IV. Empirical Issues and Methods

Our focus is on the present values of Social Security benefits and the contributions and internal rates of return to these contributions for the beneficiary classes described above. In this section, we summarize the procedures we followed in deriving these values. Further computational details are given in the appendix.

A. Benefit and Contribution Streams

Benefit levels for 1988 are observed only for current beneficiaries (insured workers and spouses), who comprise about 52 percent of our sample. Pre-1988 benefits are unobserved, however, and no benefits are observed for deceased former beneficiaries. In order to complete the benefit streams for all current and past beneficiaries, we applied Social Security benefit rules to the information available in the CWHS.

In our sample, the years of initial entitlement span the period 1957 to 1988. During this time, the rules for benefit determination were changed frequently, with the most dramatic changes stemming from the 1977 Social Security Amendments. With the 1977 Amendments, persons who were born after 1916 or who died or became disabled after 1978 have their benefits computed on a completely different basis than the rest of the beneficiary population. We refer to the post-1977 rules as "new law" and the pre-1977 rules as "old law."

We programmed the Social Security benefit computation rules for the entire period spanned by our sample records. Benefit computation at initial entitlement involves three fundamental steps: (1) calculation of average monthly earnings (AME, under old law) or average indexed monthly earnings (AIME, under new law) in covered employment; (2) calculation of the basic Social Security benefit, the primary insurance amount (PIA), from either the AME or AIME by means of a progressive rate formula; and (3) calculation of the individual's benefit by applying appropriate beneficiary percentages to the PIA (e. g., 100 percent for old-age benefits at normal retirement, 50 percent for spousal benefits). The resulting benefit is reduced for subsequent earnings that exceed specified threshold amounts (the "earnings test"). The result is then adjusted downward for early retirement (normal retirement age was 65 in 1988) or upward for delayed retirement.[7]

Estimating Social Security (FICA) contributions presented many fewer obstacles than was the case for benefits. The CWHS provides considerable, although not complete, detail on income from wages and salaries and from self-employment. Once complete earnings streams were constructed, aggregate lifetime contributions could then be estimated simply by multiplying wage-and-salary and self-employment incomes in each year by the corresponding (employer plus employee) OASI contributions rates, which were taken from Department of Health and Human Services (1991, p. 33). This implicitly assumes that the burden of the employer's share is passed on to labor.[8]

B. Mortality Rates

An important research issue, addressed recently by Menchik (1992), is the extent to which differences in mortality rates affect the relative rates of return on Social Security contributions achieved by various demographic and socioeconomic groups. Thus, for example, rising life expectancies increase the benefits received by more recent birth cohorts. For this paper, we use recently published Census Bureau mortality rate projections broken down by race as well as by age and sex. The results presented in Section V below reflect the generally higher projected death rates for blacks relative to whites, and the lower death rates in the "other" (mostly Asian) category.

For years beyond 1988, our simulations imprecisely measure the relationship between Social Security returns and other variables if future mortality rates are affected by characteristics other than cohort, age, sex, and race. For years prior to 1989, however, our benefit calculations reflect *actual* mortality experience for each recipient, and are thus unaffected by errors in death rate projections.[9] These historical returns make up approximately 70 percent of total estimated discounted benefits in our sample.

C. Deflation and Indexation

The estimated rates of return presented in the next section require that Social Security contributions and benefits be put in constant-dollar terms. For this purpose, we deflated nominal values by the Consumer Price Index (CPI), published by the U.S. Bureau of Labor Statistics (BLS). Specifically, we employed the BLS's alternative CPI-U-X1 series, which, beginning in 1967, incorporates the improved treatment of homeownership costs used in the official CPI only since 1983. Future inflation rates are the official SSA projections, as reported in U.S. Congress (1992a); these reach a steady-state value of 4.0 percent beginning in 1996.

We computed present values of contributions and benefits based on the interest rates paid on special public debt obligations, the bonds purchased by the Social Security trust funds. This rate averaged 1.2% in real terms between 1937 and 1990. As with inflation rates, we used official SSA projections of nominal interest rates,[10] which are 6.3 percent for each year beginning in 2003. In combination with the 4.0 percent inflation forecast, this implies an ultimate real interest rate of just over 2.2 percent.

Our calculations of net benefits, and the determination of whether workers were treated generously, are naturally sensitive to this choice of discount rate. From the point of view of the insured worker, the appropriate rate is determined by the alternative return that could be earned from long-term investment in other assets, and on the individual's relative preference for the risk characteristics associated with Social Security wealth. However, previous research on Social Security reveals little agreement on the degree of risk inherent in the program or the appropriate discount rate given the price-indexation of benefits, the provision of benefits to spouses and survivors, and other program features. Blinder, Gordon, and Wise (1980), Hurd and Shoven (1985), and Boskin *et al* (1987) used a 3% real discount rate, Browning (1985) a 6% real rate, and Feldstein and Samwick (1992) a 2% rate. Recently, Leimer and Richardson (1992) have estimated that a negative real discount rate might be appropriate. We make no attempt to contribute to this debate here. Our present-value estimates can perhaps best be interpreted from the point of view of the program; that is, we value the streams of contributions and benefits relative to the trust fund's rate of return on assets. For purposes of comparison, in Section V we present some alternative present value calculations using, alternatively, a constant three percent real discount rate and a zero percent rate. The three percent rate has been used in previous studies, as noted above, and the two alternatives effectively bound the trust fund rate used in our main analyses.

V. Results

1 displays the present values of contributions, benefits, and net benefits (that is, benefits less contributions), along with real internal rates of return, for our entire sample of 39,884 workers and for several of the subgroups described above. The present values are group means. The rates of return, defined as the rates of discount that equate the present values of contributions and benefits, are computed from the aggregate annual net benefits for each group.

The first line of the table summarizes the extraordinarily favorable results achieved by the 1895-1922 birth cohort as a whole. Their mean contributions were only $26,020 in 1988 dollars, and their past and projected benefit payments total $115,932. This translates to a net benefit of almost $90,000, and an aggregate real return of 9.2 percent annually.

As expected, dependent couples are shown to have experienced higher returns than individual workers. Insureds with nonworking spouses contributed approximately $8,500 more in present value than did individuals, but received over $84,000 more in retirement, spousal, and survivor benefits. The last column of the table indicates that dependent couples received a real rate of return 1.3 percentage points higher than individuals, on their generally greater level of contributions.

1 also shows that women and blacks contributed less than others on average, and received less in benefits. The measured relationship between sex and return is, of course, affected by the sample treatment of dual beneficiaries (see appendix), as well as the greater life expectancies of women. On a rate-of-return basis, both blacks and women experienced relatively favorable results, equal to 9.5 percent and 10.7 percent, respectively, compared to 9.2 percent for the sample as a whole. Our result for blacks contrasts with results reported by Hurd and Shoven (1985) but is consistent with those of Freiden, *et al* (1976).

Perhaps the most striking contrast in the table is that between new- and old-law beneficiaries. Contributions under new law averaged almost twice as much in 1988 dollars, and estimated average gross benefits are about $16,000 lower. This result is consistent with the intent of the 1977 law, which was to correct a technical flaw in the 1972 Social Security Amendments that caused continuously rising replacement rates (initial benefit as a proportion of previous earnings for new retirees) and threatened the financial viability of the system. The new law phased in level replacement rates while lowering the general benefit level. The mean value of the transfer from other households thus averaged only $59,870 for new-law workers, compared to $95,952 for old-law workers. Even under new law, however, early cohorts received a real rate of return of 6.0 percent, well above the rates that current workers can reasonably expect.

2 and 1 highlight the impact of birth year and income level. Each birth cohort in our sample was required to make greater Social Security contributions than the previous cohort, and received a lower real rate of return to those contributions. In terms of present value, each succeeding cohort received lower net benefits, although the 1904-1910 group averaged slightly higher *gross* benefits than their predecessors. Again, the sharpest dropoff in net benefit was experienced by new-law beneficiaries, reflecting implementation of the 1977 Social Security Amendments. The dramatically lower net benefit for the fourth, mostly new-law, cohort would seem to support the contention by its members ("notch babies") that they were treated unfairly by the new law. The issue is quite complicated, however. All persons born after 1916 have their benefits computed under new-law rules and, as per Congressional intent, have lower returns than what would result under old-law rules. Consequently, there is no inequity as compared to subsequent cohorts. In addition, persons born between 1917 and 1921

alternatively have benefits computed under a transitional guarantee formula which assures a benefit no lower than what would result under old-law rules in effect December 1978. The upshot is that a "notch" results primarily for persons that work past age 62; under old law, such people will continue to benefit from the overly generous 1972 benefit formula, while under new law the transitional guarantee erodes for these people and new law becomes operative.[11]

The relationship between income and return in 2 is less clear-cut. Higher-income workers had larger contributions, benefits, and net benefits. However, their real rate of return was lower. The implication is that Social Security is a progressive system as measured by the rate of return; low-income workers received a higher ratio of benefits to contributions, due to the nature of the benefit formula. However, high-income workers have in the past received the greatest present value of benefits, by being able to participate to a greater extent in a system that provided returns that far exceeded the riskless returns earned by the Social Security trust funds. 1 displays the aggregate real rate of return by cohort and income class, to highlight the separate importance of these two factors. The rate of return declines sharply and consistently for both later cohorts and higher income classes.[12]

Using the CWHS sample, we can analyze the degree to which Social Security returns vary within, as well as between, subgroups. The worst outcome, of course, is zero benefits, which occurs when the insured worker dies before retirement and leaves no survivors.[13] Retirees can also experience unfavorable outcomes if they receive nonzero benefits but negative real rates of return; that is, with real benefits less than contributions. Other workers experienced positive rates of return that did not exceed the Social Security interest rate used as our discount factor, so that their present value of net benefits was negative. In our sample, the two extreme results were by far the most likely. Out of 39,884 insured workers, 32,060 received positive net benefits in present value, while another 5,956 received zero benefits. Less than 2,000 received nonzero benefits but a rate of return below the Social Security interest rate.

3 presents our net benefit estimates, by cohort, along with two alternative sets of estimates derived under the assumption of either a constant 3 percent real interest rate or a zero percent rate (no discounting). Since the 3 percent rate is higher than most historical and projected values of the Social Security bond rate, the two alternative rates effectively bound the Social Security trust fund rate. In general, the 3 percent rate yields the highest estimates of the present value of past contributions, and the lowest present values of future benefits. The resulting net benefit estimates are uniformly lower than those obtained based on the trust fund discount rate, while retaining the same declining trend across cohorts.

Relative to the other two discount rate assumptions, the zero-percent rule increases the present values of benefits relative to contributions for each covered worker. It also lowers the relative present values of earlier cohorts. By this measure, the highest average net benefits are received by the 1911-1916 group.

The alternative discounting assumptions do not change the result that, in general, the workers in our 1895-1922 birth sample achieved large returns from the Social Security program. Moreover, the high real rates of return in Tables 1 and 2 imply that estimated net benefits would be positive even using higher, less standard discount rates such as the 6% rate suggested by Browning (1985).[14]

In 4 we present estimates of the net benefits that remained to be paid to these workers as of the end of 1988, using the trust fund rate series for discounting. We also aggregate benefits across the samples to obtain estimates of the total transfers paid, and remaining to be paid, to these cohorts. Subtracting the second column from the first yields the result that, by 1988, each cohort in our sample except the last had already received benefits in present value totalling far more than the value of their contributions. The second column shows that significant additional benefits lay in the future. The estimated post-1988 obligation to surviving retirees and their spouses was $32,646 per worker, in 1988 dollars. The estimated total transfer to the 1895-1922 generation is $3.6 trillion dollars, of which more than $1.3 trillion remained to be paid as of 1988. The often-discussed "notch" cohort alone could expect a total net gain from Social Security of approximately $475 billion.

The dollar transfer figures should be viewed as lower bounds due to the exclusion from our sample of individuals who were working in 1988. The excluded individuals were at least 65 years old in 1988 and our evidence indicates a positive relationship between net benefits and age at retirement. We investigated this issue using our 1912 birth cohort, almost all of whom had either died or retired by 1988. For this cohort, net benefits for those not working in 1978 were approximately 17 percent below average net benefits for the entire sample. The bias was only about 4 percent if all not working in 1983 were included. If the experience of this cohort is representative, our average net benefits for the 1917 and 1922 birth cohorts would be roughly 4 and 17 percent underestimates, respectively, with the downward bias increasing with each successive cohort. Our estimates of total net benefits in table 4 implicitly assign zero net benefits to excluded cases and therefore are more severe lower bounds. If instead these workers had been assigned their cohort-mean value of net benefits, the aggregate value estimates would have been $3.8 trillion for the 1895-1922 generation, and $563 billion for the notch cohort.[15]

VI. Summary and Implications

We are not the first authors to have examined the Social Security experience of the early participants. Freiden, Leimer, and Hoffman (1976), Myers and Schobel (1983), and Hurd and Shoven (1985), for example, have also estimated extraordinarily high returns to members of these cohorts. Our most important contribution is in estimating the aggregate size and distribution of these returns. We find these benefits to be quantitatively significant. Multiplying our mean net benefit by our sample size, and dividing by our sampling rate, we obtain an aggregate value of almost $3.6 trillion, in 1988 dollars. This is the amount by which the Social Security trust funds would be larger in 1988 had the system paid a rate of return to early participants equal to the system's own return on invested assets. In our sample, almost all program participants, other than those who died before eligibility for benefits, received rates of return exceeding the interest rate paid on Social Security bonds. We also demonstrate that net benefits were larger for male workers, for nonblacks, for higher income workers, and for earlier cohorts, although in some cases those groups with the highest net benefits were not those with the highest annual rates of return.

We plan to extend our research in several directions. One obvious extension would be the recognition of tax effects. For the cohorts we have examined here, the most important features to include are the deductibility of employer contributions and the use of an after-tax rate of return for computing present values. However, projecting future returns will also present the more difficult task of estimating the tax rate on benefits. For this purpose, we plan to estimate a relationship between benefits and taxable income, which can then be used to simulate the percentage of benefits subject to tax.

We have noted that some error is introduced into our inter-group comparisons by our inability to incorporate the effects on future mortality rates of factors other than cohort age, sex, and race. However, the CWHS file itself provides considerable detail on the historical relationship between death rates and the characteristics in the file. In a separate paper (Duggan, Gillingham, and Greenlees, 1993), we have begun to explore these relationships, focusing particularly on the relationship between earned income and mortality.

The next major step in our analysis will be the forecasting of earnings and benefit patterns for current workers. This will require, *inter alia*, simulation of individual labor force participation and retirement patterns in order to maintain our focus on estimating the distribution as well as the mean of Social Security returns. When this work is completed, we will be able to compute the returns from Social Security for all participants, not just the early cohorts considered here.

References

Blinder, Alan S., Ronald H. Gordon, and Donald E. Wise, "Reconsidering the Work Disincentive Effects of Social Security," *National Tax Journal*, December 1980, pp. 431-442.

Boskin, Michael J., Laurence J. Kotlikoff, Douglas J. Puffert, and John B. Shoven, "Social Security: A Financial Appraisal Across and Within Generations," *National Tax Journal*, March 1987, pp. 19-34.

Browning, Edgar K., "The Marginal Social Security Tax on Labor," *Public Finance Quarterly*, July 1985, pp. 227-51.

Burkhauser, Richard V. and Jennifer L. Warlick, "Disentangling the Annuity From the Redistributive Aspects of Social Security in the United States," *The Review of Income and Wealth*, December 1981, pp. 401-421.

Department of Health and Human Services, Social Security Administration. *Economic Projections for OASDHI Cost and Income Estimates: 1987*, Actuarial Study No. 101, May 1988.

______, *Social Security Bulletin, Annual Statistical Supplement*, December 1991.

Duggan, James E., Robert Gillingham and John S. Greenlees, "Distributional Effects of Social Security: the Notch and Pre-Notch Generations," presented at the Southern Economic Association meetings in Washington, D.C., November 1992.

______, "Progressive Returns to Social Security? An Answer from Social Security Records," presented at the Econometric Society meetings in Anaheim, California, January 1993.

Feldstein, Martin and Andrew Samwick, "Social Security Rules and Marginal Tax Rates," *National Tax Journal*, March 1992, pp. 1-22.

Freiden, Alan, Dean Leimer, and Ronald Hoffman, "Internal Rates of Return to Retired Worker-Only Beneficiaries under Social Security, 1967-70," *Studies in Income Distribution*, No. 5, U. S. Department of Health, Education, and Welfare, October 1976.

Gustman, Alan L. and Thomas L. Steinmeier, "Changing the Social Security Rules for Work after 65," *Industrial and Labor Relations Review*, July 1991, pp. 733-745.

Hurd, Michael D. and John B. Shoven, "The Distributional Impact of Social

Security," in D. Wise, ed., *Pensions, Labor, and Individual Choice,* University of Chicago Press: Chicago, 1985.

Leimer, Dean R., "Projected Rates of Return to Future Social Security Retirees Under Alternative Benefit Structures," in U. S. Department of Health, Education, and Welfare, *Policy Analysis with Social Security Research Files,* 1978, pp. 235-268.

Leimer, Dean R. and David H. Richardson, "Social Security, Uncertainty Adjustments, and the Consumption Decision," *Economica,* August 1992, pp. 311-335.

McKay, Steven F., "User's Guide for PIA Calculation Program (version 1991.1)," Office of the Actuary, Social Security Administration, 1990.

Menchik, Paul L., "Economic Status as a Determinant of Mortality Among Nonwhite and White Older Males: Or, Does Poverty Kill?" *Population Studies* (forthcoming).

Meyer, Charles W. and Nancy L. Wolff, "Intercohort and Intracohort Redistribution under Social Security," in C. Meyer, ed., *Social Security: A Critique of Radical Reform Proposals*. Lexington Books: Massachusetts, 1987.

Myers, Robert J., and Bruce D. Schobel, "A Money's-Worth Analysis of Social Security Retirement Benefits," *Transactions of the Society of Actuaries*, 1983, pp. 533-545.

Pellechio, Anthony and Gordon Goodfellow, "Individual Gains and Losses from Social Security Before and After the 1983 Amendments," *Cato Journal*, Fall 1983, pp. 417-442.

Simon, Julian L., "Great and Almost Great Magnitudes in Economics," *The Journal of Economic Perspectives*, Winter 1990, pp. 149-156.

Smith, Creston M., "The Social Security Administration's Continuous Work History Sample," *Social Security Bulletin*, October 1989, pp. 20-28.

U.S. Bureau of the Census, Current Population Reports, P25-1092, *Population Projections of the United States by Age, Sex, Race, and Hispanic Origin: 1992 to 2050*. U.S. Government Printing Office, Washington, D.C., 1992.

U. S. Congress, House Committee on Ways and Means. *1992 Annual Report of the Trustees of the Federal Old Age and Survivors and Disability Insurance Trust Funds*. 102d Congress, Washington, D. C., April, 1992a.

______, *1992 Annual Report of the Trustees of the Federal Hospital Insurance Trust Fund*. 102d Congress, Washington, D.C., April, 1992b.

Footnotes

[*]The authors are economists in the Office of Economic Policy, U. S. Department of Treasury, Washington, DC. All views expressed are those of the authors and do not necessarily represent the policies or views of the Department of the Treasury. This paper was presented at the Western Economic Association International Annual Conference in San Francisco, California, July 11, 1992. The authors would like to thank Cres Smith of the Social Security Administration for help with interpreting the CWHS data file and Jennifer Day and Greg Spencer of the Census Bureau for providing death rate and population data. Helpful comments on an earlier draft were provided by John Hambor, John Straka, and John Turner.

1. A more detailed description of the CWHS is contained in the appendix. Also, see Smith (1989).

2. The appendix provides further discussion and some evidence of the accuracy of our benefit computations.

3. Beginning in 1978, the file contains information on total wage-and-salary compensation.

4. Computed from Table 5A in Department of Health and Human Services (1991).

5. This could impart a small downward bias in our subsequent calculations of the returns paid to workers deceased in 1988.

6. Our inability to pair working-spouses with each other, and thus to treat them as a unit, raises the issue of how one should best allocate the dual beneficiary's benefits in measuring the rate of return to each spouse's contributions. The structure of the CWHS makes this issue moot as a practical matter, since benefits paid to an insured worker are only recorded on that worker's record. A dual beneficiary is therefore observed to receive a relatively high of return, and his or her spouse is observed to receive a return comparable to single individuals. We emphasize, however, that no benefits are potentially unrecorded or counted twice in our data set as a result of the CWHS's handling of dual beneficiaries. See the appendix for further details.

7. Earnings subsequent to initial retirement also require recalculation of the AME (AIME), PIA, and benefit amount. Depending upon year of eligibility, we computed benefits under six alternative methods: old law, new law, transitional guarantee (birth cohorts 1917-21), regular minimum (eliminated 1982), special minimum (starting 1973), and old-start (using pre-1951 earnings). A history of benefit rules is contained in Department of Health and Human Services (1991).

8. We ignore the fact that employers can deduct their share of contributions in computing their income taxes. Also, in this paper we do not attempt to deal with the partial taxation of Social Security benefits. Our estimated payments include only FICA contributions, and our benefit estimates are gross of income taxes.

9. As noted in the appendix, a minor exception to this statement is that estimated mortality rates are used to impute

some past benefits for insured workers and survivors with unrecorded dates of death.

10. The special issue bonds have an interest rate equal to average market yield on all marketable interest-bearing government obligations that are part of the public debt and are not due or callable for four years (U. S. Congress, 1992a). These bonds are redeemable at anytime at par value and so bear no risk with respect to interest rate changes. Historical and projected values were obtained from Department of Health and Human Services (1988, p.26) and from Steven Goss of SSA, personal communication.

11. A detailed treatment of the notch issue is contained in Duggan, Gillingham, and Greenlees (1992).

12. Hurd and Shoven (1985) also reported larger transfers for wealthier cohorts. In contrast to our results, however, they also found higher rates of return for wealthier cohorts.

13. This yields an undefined (infinitely negative) rate of return.

14. A higher discount rate might be justified on the basis of the historical rate of return on common stocks. The compound annual rate of return for the period 1871-1985 was 6.6 percent and the rates of return during the subperiods 1871-1925 and 1926-1985 differed by only .07 percent (Simon, 1990). The rate of return can vary from this average for long periods, however, and no individual investor could be guaranteed the six percent rate on retirement contributions, nor would a pension fund be likely to limit its portfolio to common stocks.

15. Previous research (Gustman and Steinmeier, 1991) has shown that Social Security's delayed retirement credit was insufficient to compensate the loss of current benefits for those working beyond age 65. This implies that assuming retirement in 1989 would have led to an *overestimate* of the net benefits actually received by 1988 workers, many of whom would continue to work for several years.

Table 1
Estimated Present Values and Rates of Return
By Class of Covered Worker

Class of Worker		Sample	Present Value (1988 $) Contributions	Benefits	Net Benefit	Real ROR
All Workers		39,884	$26,020	$115,932	$89,912	9.2
Household Type						
	Individual	28,252	23,546	91,293	67,748	8.6
	Dependent Couple	11,632	32,030	175,773	143,743	9.9
Sex						
	Female	15,388	17,051	97,562	80,511	10.7
	Male	24,496	31,655	127,471	95,817	8.6
Race						
	White	35,437	27,031	120,017	92,986	9.1
	Black	3,767	17,462	77,663	60,200	9.5
	Other	680	20,777	115,038	94,261	10.8
Law						
	Old	33,207	22,697	118,649	95,952	9.7
	New	6,677	42,550	102,420	59,870	6.0

Table 2
Estimated Present Values and Rates of Return
By Birth Cohort and Income

Class of Worker		Sample	Present Value (1988$) Contributions	Benefits	Net Benefit	Real ROR
All Workers		39,884	$26,020	$115,932	$89,912	9.2
Birth Cohort						
	1895-1903	10,420	14,235	125,088	110,853	12.7
	1904-1910	10,440	22,896	125,792	102,896	9.4
	1911-1916	9,907	30,980	119,988	89,009	7.6
	1917-1922	9,117	37,677	89,766	52,089	5.8
Income						
	Low	13,294	5,803	67,413	61,609	12.9
	Medium	13,295	23,267	114,049	90,782	9.9
	High	13,295	48,989	166,330	117,341	7.7

Figure 1
Real Rates of Return
By Cohort and Income Class

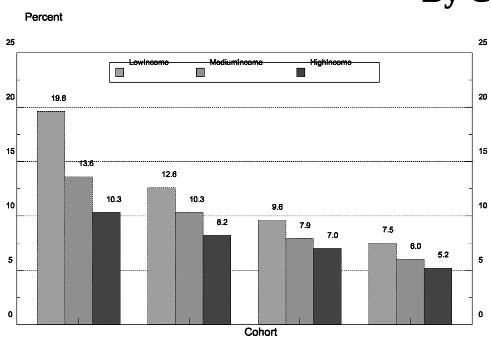

Table 3

Present Values of Net Benefits Under Alternative Discount Rates, By Birth Cohort (1988$)

	Discount Rate Assumption		
Class of Worker	Trust Fund Rate	Constant 0% Rate	Constant 3% Rate
All Workers	$89,912	$85,890	$79,435
Birth Cohort			
1895-1903	110,853	77,884	103,070
1904-1910	102,896	87,520	88,864
1911-1916	89,009	96,237	75,670
1917-1922	52,089	81,930	45,716

Table 4
Present Values of Post-1988 Net Benefits
Average Per Worker and Population Totals, By Birth Cohort
(1988$)

Class of Worker	Average Per Worker: Net Benefits	Average Per Worker: Post-1988 Net Benefits	Total (billion$)[1]: Net Benefits	Total (billion$)[1]: Post-1988 Net Benefits
All Workers	$89,912	$32,646	$3,586	$1,302
Birth Cohort				
1895-1903	110,853	8,930	1,155	93
1904-1910	102,896	23,562	1,074	246
1911-1916	89,009	44,955	882	445
1917-1922	52,089	56,779	475	518

[1]Population total=(mean net benefit)x(sample size)/sampling rate.

Table A1
Means of CWHS Observed Values and Estimates of 1988 Benefits for Three Principal Beneficiary Types[1]

	Retired Worker Only	Retired Worker with Spouse	Widow(er)
		New Law	
CWHS	$526.45 (2.83)	$890.72 (9.78)	$555.16 (9.05)
Estimate	$526.56 (2.83)	$882.06 (9.69)	$547.69 (8.77)
Correlation	.99	.99	.94
Error	-$.11 (.28)	$8.66 (1.24)	$7.46 (3.18)
N	5,044	882	336
		Old Law	
CWHS	$555.41 (3.04)	$960.29 (9.72)	$504.39 (2.76)
Estimate	$553.42 (3.07)	$944.06 (9.59)	$491.91 (2.75)
Correlation	.99	.99	.97
Error	$1.99 (.25)	$16.22 (1.04)	$12.48 (.72)
N	6,159	1,542	3,557

[1]Numbers in parentheses are standard errors.

Technical Appendix

The Continuous Work History Sample. The CWHS extracts information from several sources connected to administration of the OASDI program. The process by which the CWHS is constructed is important to understanding its usefulness and limitations for purposes such as ours. Basic demographic information on date of birth, sex, and race are reported on application forms for Social Security numbers (SSN). Annual earnings data from W-2 and W-3 tax reporting forms are balanced to employer-provided totals on earnings and employment and matched by name and SSN to the demographic data (prior to 1978, taxable wages were reported quarterly on various forms depending upon the type of employment). The result is the Earnings Reference File, the file in which individual lifetime earnings and quarters of coverage are maintained for use in determining benefit entitlement and amount. This file contains employment data on years employed and type of employment (farm, nonfarm, wage or self-employment); cumulative pre-1951 Social Security earnings; annual Social Security taxable earnings, 1951 to date (1988 in our file); and total compensation, 1978 to date.

Each year, a 1 percent sample based on specified digits from the last four digits of the SSN is extracted from the Earnings Reference File. This extract forms the basis for updating the previous year's CHWS. This file was originally intended as a source to study the earnings and employment behavior that underly the Social Security tax base. The file was expanded, however, to include information from the benefit side of the OASDI program. Thus, each year selected information corresponding to the same SSNs is extracted from SSA's Master Beneficiary Record (MBR) file, which contains data collected when an individual files a claim for benefits. The MBR extract is then matched to the earnings extract as part of the annual update to the CWHS. The beneficiary data extracted for inclusion in the CWHS are dates of entitlement, benefit amounts for the current year, and types of benefit (old-age, survivor, or disability).

The benefit amount on the file generally represents a payment to the account record in the form of old-age, disability, or survivor benefits. "Dual entitlements" differ in this regard. The most common example of dual entitlement occurs when an individual is entitled to a spousal benefit as well as a benefit based on his or her own earnings history. In this case, the benefit paid is the higher of the two. For most female working spouses in the past the spousal benefit has been higher. SSA allocates this amount to the CWHS record of the dually entitled person and not to the record of the person on whose earnings history the benefit amount was based. For example, a married person eligible for an old-age benefit of $800 would entitle his or her spouse to a benefit of $400 (at normal retirement age) for a total benefit of $1,200. If the spouse had no earnings history (and consequently no CWHS record), the full $1,200 would be allocated to the primary old-age beneficiary record. If the spouse had an earnings history which entitled the spouse to less than $400, then $800 would be allocated to the primary record and $400 to the spouse record. If the spouse were entitled to more than $400 on his or her own account, that amount would appear on the spouse's record and $800 on the primary record. For these cases, direct computation of benefits from the CWHS earnings data will generally underestimate the benefit amount being paid.

No dual-beneficiary indication is given on the "primary" worker's record. Our understanding from the SSA is that the presence of a spouse date of birth on a CWHS record indicates that a spouse has applied for benefits from the insured's account and this condition applies only to dependent (i.e., non-worker) spouses. We therefore treated all cases in which there was a spouse date of birth but no current (1988) spousal or survivor benefit as cases in which there was a deceased dependent spouse.

As part of the updating process, but not part of the master records, SSA analysts add and/or modify a benefit status code, an insured status code, and a family benefit code. The latter reflects, for the current benefit year only, the type of family benefit (e. g., insured worker and spouse). The benefit status code indicates, for the years 1956 to date, whether (and what type of) benefits are being paid to the account and when the insured worker died. Insured status measures, also for 1956 to date, the potential eligibility for benefits, based on quarters of coverage.

Sample Selection. The 1988 file has just under 3.4 million records, of which over 2.5 million are "active" accounts, that is, with any history of social security earnings. For computational purposes, we selected a ten percent subsample from the 2.5 million (active) records on the full file by drawing every tenth record from the 20 CWHS tape reels. In combination with our selection by birth year and other editing procedures, this subsampling resulted in a data set with 39,884 observations. All individual social security numbers were removed from our file by SSA.

Quantitatively, the deletion of individuals with covered earnings in 1988 (age 65 or over) was our most significant edit, reducing our sample size by about 6 percent. Simulation of net benefits in these cases would have required forecasting future work patterns, an exercise that was beyond the scope of this paper. The consequence is a downward bias in our net benefit and rate of return calculations. This point is discussed further in the text.

Computed Benefit Streams. Estimation of historical benefit streams for CWHS sample workers required the programming of current and past Social Security benefit formulas. Complete benefit histories are not maintained in any official central file. We employed two independent checks on our calculations. First, for current beneficiaries, we compared our 1988 estimated values with those contained in the CWHS file. As shown in 1, we get very high correlations between CWHS and estimated benefits. We considered eliminating those cases with wide, unexplained discrepancies. However, this would have biased our results, by eliminating a subset only of those individuals who were alive or paying survivor benefits in 1988. Therefore, no cases were deleted from our sample on the criterion of imputation accuracy.

Second, we made extensive use of a PIA program developed by SSA (McKay, 1990) to check results for many individual cases. The SSA PC-based program is fast, accurate, and very detailed, but is designed for a single case only. We checked numerous individual records with the McKay program, a process which led us to make a number of corrections to our PIA and benefit calculation program. Our program now gives essentially the same PIA results as McKay's program.

Some qualitative information on benefit recipiency is indicated by the annual benefit status code, as noted above. For records with current beneficiaries, the CWHS also contains a family benefit code (for the current year only), which provides information on the type of beneficiaries (e. g., primary and spouse, primary and children, widows, parents, etc.). The family benefit code does not fully distinguish among the different types of beneficiaries on the record, however, thereby limiting the potential to reconstruct prior family situations. For this reason, we ignored the presence of beneficiaries other than the insured worker and / or spouse. For records with current beneficiaries, once the AME (or AIME) and PIA are computed, we use the benefit status codes, benefit rules, and mortality probabilities (described in the text) to reconstruct primary / spouse benefits back to the year of initial entitlement. Given the historical benefits, future nominal benefits (beyond 1988) depend only on projected mortality rates and cost-of-living increases.

For records with no current beneficiaries, the insured worker and survivors, if any, have died sometime before 1988. The family benefit code is set to zero in the CWHS so is of no help in determining historical benefits. For these records, we computed annual benefits for the insured worker between the year of initial entitlement and the year of death (indicated on the file) based on the procedures described above. If the record indicated that a spouse had applied for benefits at some time, we also simulated a year of death of the spouse (not indicated on the CWHS file) following the procedures described in the text. We then computed a spousal benefit between the year in which the spouse was first eligible (using the insured worker's PIA and the benefit rules that apply to the spouse's age at eligibility) and the year of death of the insured worker or of the spouse, whichever came first. Finally, if the spouse survived the beneficiary, we computed a widow(er)'s benefit from the year of death of the insured until the simulated year of death of the spouse.

Many insured workers die before receiving benefits. Survivor benefits may nevertheless be paid on the deceased worker's account if the worker was insured at the time of his death. If the record indicated that a spouse had applied for benefits at some time, we computed a widow's benefit in a manner similar to that described in the preceding paragraph. If the record indicated that survivor benefits had been awarded but contained no indication of a spousal presence, we made no benefit computation, consistent with our abstraction from payments to beneficiaries other than spouses.

We handled dual entitlements somewhat differently. As described above, dual beneficiaries as identified in the CWHS are receiving a spousal or survivor benefit derived from another insured worker's contributions. A computed benefit based on their own earnings record would generally underestimate the benefit actually received. Consequently, for dual beneficiary spouses of living insured workers, we assigned the observed benefit, properly deflated, to each year back to the year of initial entitlement. For dual beneficiary survivors, we also used the observed benefit to compute a widow's benefit (through deflation) back to an estimated year of death of the insured worker. (For purposes of simulating years of death of the unidentified spouses, we assumed that husbands (wives) were two years older (younger) than the dual beneficiaries.) For the years between initial entitlement and the death of the insured worker, we computed the benefit as the maximum of the own-record benefit (using the standard procedures) and a spousal benefit defined as 50 percent of the delated survivor benefit.

Computed Contribution Streams. The CWHS provides total taxable earnings for each of the years 1951-1988. In addition, for each of these years the file also contains the value of earnings that were subject to the self-employment, rather than the wage and salary, contributions rate. In some cases, the reported CWHS values exceeded the maximum value of earnings subject to tax. We recoded total taxable earnings to the minimum of the reported value and the statutory cap, and limited self-employment earnings to the recoded value of total taxable earnings.

For the period 1937-1950, only wages and salaries were subject to FICA. However, the CWHS reports only total taxable earnings for the 14-year period. Following Boskin *et al* (1987), we prorated these total earnings under the assumption that from the first year of employment through 1950, earnings grew at one percent per year of age beyond the economy-wide growth in wages for male individuals and one-half percent per year for females, through age 50. Our average earnings series for the 1937-1950 period is taken from Myers and Schobel (1983). We also imposed the restriction that taxable earnings in any year could not exceed $3000, the taxable maximum throughout that period.

Mortality Rates. For the purpose of simulating future benefit flows of recipients and their spouses, we estimated separate mortality rate functions for men and women. The underlying data were newly published historical and projected death rates provided by the Census Bureau's Population Division (U.S. Bureau of the Census 1992) for the years 1990, 2000, and 2050, broken down by age, sex, race, and Hispanic origin.

For each sex, we employed 108 mortality rates, corresponding to eleven five-year age groups beginning with 45-49 plus the open-ended interval 100 or above, the three racial categories of White, Black, and Other (or Unknown), and the three calendar years given above.

Our racial categorization was governed by the limited detail in the CWHS for our sample cohorts. More detail is available for newly insured workers. Our three categories each include Hispanics, and our computed death rates for the Other category are averages of the American Indian, Eskimo, or Aleut and the Asian or Pacific Islander values, using contemporaneous Census population projections as weights.

We regressed the logarithm of the mortality rate on age, year, and dummy variables for White and Black race, with the age variable evaluated at the midpoint of the five-year age range (and using 102 for the open-ended interval). The coefficient estimates and standard errors are

$$\ln \text{DEATHRATE} = \underset{(2.37)}{14.32} + \underset{(.002)}{0.079}\ \text{AGE} - \underset{(.001)}{0.012}\ \text{YEAR} + \underset{(.076)}{0.447}\ \text{WHITE} + \underset{(.076)}{0.584}\ \text{BLACK}$$

for males, and

$$\ln \text{DEATHRATE} = \underset{(1.97)}{7.82} + \underset{(.001)}{0.083}\ \text{AGE} - \underset{(.001)}{0.009}\ \text{YEAR} + \underset{(.063)}{0.439}\ \text{WHITE} + \underset{(.063)}{0.588}\ \text{BLACK}$$

for females. The R^2 values of .954 for males and .970 for females indicate that these regressions are sufficient for our purpose, which is to use them to interpolate between the Census mortality rates in our simulations.

Deaths were simulated for current recipients by evaluating these functions at the recipient's age and with YEAR=1988. A random number was drawn from the uniform distribution bounded by zero and one, and a year of death was chosen by evaluating the regression function successively with both year and age incremented by one, until the cumulated probability of death exceeded the random draw. The same procedure was used for spouses.

In many cases, we also needed to simulate past lifetimes when, for example, we observed a deceased spouse with known date of birth but unknown date of death. The same simulation procedure was followed in such cases, iterating until a death year was obtained that preceded 1988, the year of observation.