BURCH CENTER WORKING PAPER SERIES

University of California, Berkeley
Department of Economics - #3880
Berkeley, CA 94720-3880

Projecting Social Security's Finances and Its Treatment of Postwar Americans

by

Steven Caldwell
Cornell University

Alla Gantman
Boston University

Jagadeesh Gokhale
The Federal Reserve Bank of Cleveland

Thomas Johnson
Cornell University

Laurence J. Kotlikoff
Boston University

December 1998
Burch Working Paper No. **B98-02**

Though not listed as a co-author, Melissa Favreault made indispensable contributions to the development of CORSIM, especially OASDI-related parts of CORSIM, as part of her doctoral dissertation work at Cornell. We also benefited from her advice during the preparation of the CORSIM runs reported in this paper, and from her feedback on an earlier draft of the paper. We thank Bill Richie and Felicitie Bell of the Social Security Administration Office of the Actuary for providing essential data and critical advice. Deborah Bailey, Lee Cohen and Howard Iams of Social Security's Office of Research, Evaluation and Statistics permitted us to report initial results from their on-going evaluation of CORSIM. We also thank Steven McKay and Tim Zayatz of Social Security's Office of the Actuary for critically important and extensive assistance in clarifying OASI benefit determination rules. Alan Auerbach, Nada Eissa, Ken Wachter, and Ronald Lee provided valuable feedback on an earlier draft. Laurence Kotlikoff and Steven Caldwell are grateful to Merrill Lynch & Co. for research support on a previous project that set the groundwork for this study. Finally, we thank Economic Security Planning, Inc. for permitting their use for this study of SSBC **--** a detailed OASI benefit calculator. All opinions expressed here are strictly those of the authors and are not necessarily those of the Federal Reserve Bank of Cleveland, Boston University, Cornell University, Merrill Lynch & Co., or Economic Security Planning, Inc.

Abstract

Social Security's finances are deeply troubled. In order to pay all of Social Security's benefits on an ongoing basis, the average American worker needs to immediately start paying a nickel more of every dollar earned in payroll taxes. This assessment comes from Social Security's own actuaries and is based on their "intermediate" assumptions. Under more pessimistic, but arguably more realistic assumptions, average workers need to pay an additional 7 cents per dollar earned. Since Social Security is currently taxing average workers 12 cents per dollar earned, the immediate and permanent tax hike needed to avoid defaulting on benefit promises ranges between 40 and 60 percent!

The magnitude of Social Security's fiscal problem invites careful attention to the actuaries' forecasting method. It also invites attention to the System's likely ultimate treatment of America's workers. This paper looks at both issues. It first lays out Social Security's projection methodology. It then compares this methodology with a dynamic microsimulation approach to forecasting future benefits and taxes. Next, it presents a specific dynamic microsimulation model that combines two tools: CORSIM -- a socioeconomic microsimulation model -- and SSBC -- a detailed Social Security benefit calculator. The paper uses this model to examine Social Security's benefit projections based on its low, intermediate, and high cost assumptions. Finally, the paper uses the model to compute internal rate of return and lifetime net tax rates for postwar Americans under a) the actuaries' low, intermediate, and high cost assumptions, b) the assumption of an immediate and permanent tax hike sufficient, under intermediate assumptions, to meet benefit commitments, and c) the assumption of an immediate and permanent benefit cut sufficient, under intermediate assumptions, to eliminate the System's long-term fiscal imbalance.

Our findings suggest three things: first, there may be a somewhat smaller imbalance between long-run benefits and payroll tax revenues than is being forecast by the actuaries. Although our projections of aggregate taxes are quite close to those of the Social Security actuaries for years when comparisons are meaningful, our projected benefit payments are roughly 15 percent smaller, for years when we can form comparisons given the nature of our data. Second, assuming no change in current law, postwar Americans will earn less than a 2 percent real rate of return on their contributions to Social Security. If one assumes that postwar Americans could otherwise invest their contributions at a 5 percent real rate, this below-market rate of return translates into lifetime net Social Security tax rates of more than 5 cents per dollar earned. Third, implementing the tax hikes or benefit cuts that the actuaries suggest would resolve fully Social Security's long-term fiscal imbalance will leave today's newborns receiving a real return on their contributions of only 1 percent or thereabouts.

I. Introduction

The Social Security System's long-term finances are in crisis. Under intermediate assumptions the System's payroll tax must be raised by 38 percent if we want to pay promised benefits on an ongoing basis. This represents 5 cents per dollar earned by the typical American worker. Moreover, this tax hike must be implemented immediately and be permanent. Under high-cost assumptions, the situation is worse -- payroll taxes need to be raised by 58 percent, meaning that typical workers will have to surrender 7 more cents per dollar earned to the Old Age Survivors and Disability Insurance System (OASDI).

The true size of Social Security's fiscal problem is more than twice as large as the System's Trustees are publicly acknowledging in their Trustee's Report.[1] The reason is that the Trustees have instructed the actuaries to consider benefits and taxes over only the next 75 years. Although 75 years seems like a long time, there are huge deficits looming in years 76 and beyond. In systematically ignoring those longer-term shortfalls, the Trustees are dramatically understating the true dimensions of the long-run revenue shortfall.[2]

In addition to appreciating the Social Security actuaries' assessment of the System's true long-run solvency, it's important to know how they are arriving at their projections. This paper describes, in general terms, the actuaries' methodology and contrasts it with an alternative one based on a microsimulation approach to forecasting benefit and tax payments. Our understanding of the actuaries' approach is based on extensive discussions with Bill Richie, one of Social Security's top actuaries.

---

[1] Steve Goss, Social Security's distinguished Deputy Chief Actuary, provided estimates of Social Security's untruncated long-term liabilities under intermediate assumptions; we are most grateful for his help.

[2] The problem with myopic forecasting is not new. Roughly one third of blame that can be levied on the 1983 Greenspan Commission for not fixing Social Security's long-term finances once and for all can, apparently, be traced to the Commission's use of a truncated projection horizon.

Nonetheless, our understanding is constrained by the fact that the actuaries do not have a detailed written description of their procedures.

Beyond describing, to the extent we can, the actuaries' forecasting method and contrasting it with our own, the paper attempts to assess the accuracy of the actuaries' forecasts by comparing their low cost, intermediate cost, and high cost projections with those derived from our own microsimulation model. Our model, described in Caldwell, et. al. (1999b), combines *CORSIM* – a socioeconomic microsimulator – with *SSBC* – a detailed OASI Social Security benefit calculator.[3]

The term "attempts" needs to be clarified. The actuaries project only aggregate benefits; i.e., they do not project benefits for different demographic and socioeconomic subgroups, including large ones, like male and female birth cohorts.[4] In contrast, our model projects benefits and taxes by extremely detailed demographic and socioeconomic subgroups, but only for birth cohorts we define as "postwar Americans." These cohorts include native-born Americans as well as U.S. immigrants who were born or are projected to be born between 1945 and 2000.

Since we do not consider all Social Security benefit recipients or taxpayers, just those born between 1945 and 2000, we are unable to project total benefits and total taxes in any future year. However, we are able to estimate, for any given year, total benefits received by and taxes paid by postwar Americans.

---

[3] CORSIM contains its own calculator of Social Security taxes and benefits, but for this paper we chose to use the SSBC calculator because it was more detailed and had been more thoroughly tested. We should add, however, that using CORSIM with its own calculator has certain advantages. First, the CORSIM calculator includes DI, so that the full OASDI program is simulated, not only OASI. Second, CORSIM calculates taxes and benefits for the full population, rather than for selected cohorts. For extensive OASDI simulations using CORSIM's own tax and benefit calculators, see Favreault (1998) and Favreault and Caldwell (1997, 1998).

[4] The actuaries do appear to have the capacity to form separate benefit projections for cohorts differentiated by sex.

For the year 2050, our postwar population ranges in age from 50 to 105. Since most OASI benefits are paid to those age 60 and above, it seems worthwhile to compare the Trustee's aggregate benefit projections for 2050 and neighboring years with our own. For the year 2010, our postwar population ranges in age from 10 to 65. For the year 2020, it ranges in age from 20 to 75. Since virtually all OASI taxes are paid by workers between the ages of 15 to 75, it seems worthwhile to compare the Trustee's aggregate tax projections for the period 2010-2020.

The paper's final objectives are fourfold: first, to calculate the internal rate of return that different types of postwar Americans can expect, on average, to earn on their OASI contributions in the form of OASI benefits; second, to calculate OASI lifetime net tax rates for different types of postwar Americans; third, to determine the sensitivity of these calculations to the three sets of demographic and economic assumptions considered by the actuaries; and fourth, to indicate how the internal rates of return will change in response to tax hikes or benefit cuts.

Our findings suggest three things: first, there may be a somewhat smaller imbalance between long-run benefits and payroll tax revenues than is being forecast by the actuaries. Although our projections of aggregate taxes are quite close to those of the Social Security actuaries for years when comparisons are meaningful, our projected benefit payments are roughly 15 percent smaller, again, for years when we can form comparisons given the nature of our data. Second, assuming no change in current law, postwar Americans will earn less than a 2 percent real rate of return on their contributions to Social Security. If one assumes that postwar Americans could otherwise invest their contributions at a 5 percent real rate, this below-market rate of return translates into lifetime net Social

Security tax rates of more than 5 cents per dollar earned. Third, implementing the tax hikes or benefit cuts that the actuaries suggest would resolve fully Social Security's long-term fiscal imbalance will leave today's newborns receiving a real return on their contributions of only 1 percent or thereabouts.

The next section describes the Social Security's actuaries' long-term forecasting methodology. Section III describes in general terms our microsimulation model, regulating details to the Appendix. Section IV compares projections based on the two methodologies. Section V presents internal rate-of-return and lifetime net-tax-rate calculations based on current policy under intermediate, high, and low cost assumptions. It also shows how these internal rates of return change if the payroll tax is immediately and permanently increased by close to 40 percent or benefits are immediately and permanently cut by 25 percent. These are the alternative immediate and permanent tax hike and benefit cuts needed to achieve present value budget balance for the Social Security System under intermediate assumptions. The final section, VI, summarizes and concludes the paper.

II. Social Security's Long-Term Forecasting Methodology

Chart I, provided by Bill Richie of the Social Security Administration's Office of the Actuary, describes, via a flow diagram, how Social Security arrives at its short- and long-term forecasts. As mentioned, the actuaries do not have a written description of what they are doing within each of the boxes in their diagram, so our understanding of their methodology is limited to what we can infer from the diagram and from discussions with the actuaries.

The first page of the chart provides an overview. It indicates that demographic projections are used to form economic projections. The economic projections (including the projection of payroll-taxable labor income) are, in turn, used to project taxable income to the System. The economic projections are also used, in conjunction with the demographic projections to project benefit outgo. By comparing projected tax income and benefit outgo, the actuaries arrive at the system's actuarial status.

The second page of the chart shows how the demographic projections are formed. The actuaries start with the mortality, immigration, and fertility assumptions chosen by the Trustees. They use these in concert with NCHS, INS, and Census data to produce annual birth rates, death rates, marriage rates, divorce rates, and immigration rates. All these rates are generated on an age- and sex-specific basis. These rates are then used to forecast total population by age, sex, and marital status. As the first page of the flow chart shows, these totals are ultimately used to form economic projections concerning labor supply and other variables as well as benefit (outgo) projections.

Page 3 of the chart considers short-range economic projections. The first steps in forming these projections involve using a) BLS survey data in conjunction with the demographic outputs described on the previous page to generate totals of workers, wage workers, and self-employed workers and b) SSA employment and earnings and BLS employment to get total covered wages and self employment income. Knowing total labor income, covered labor income, and the totals of those paying Social Security taxes suffices to generate average covered earnings and ratios of taxable to total earnings. At this point, the actuaries use a) SSA data on the historical distribution of covered wages as between sectors and between non self-employed and self-employed and b) quarterly wage data from SSA administrative records to produce short-run forecasts of payroll tax revenues.

The process of producing long-range revenue projections is detailed on page 4 of the chart. The basic idea appears to be to use labor force data on participation and unemployment rates by age and sex as well as demographic projections to forecast future levels of employment. This forecast is then combined with a labor-productivity growth rate assumption to forecast total GDP. Armed with their estimate of the time-path of future GDP, the actuaries appear to use GDP income shares to estimate total future labor income. These figures are then adjusted by extrapolations of historic ratios of covered earnings to total earnings and of taxable earnings to covered earnings, to estimate the OASDI tax base and, given projected future tax rates, future total Social Security payroll taxes.

The final two pages of the chart consider the formation of aggregate benefit projections and their taxation under the federal income tax. The actuaries start with estimates of the fully insured population based on historical data. As each year passes, they update the fully insured population. Next, they use ratios of certain beneficiary types (e.g., retirees and widows) to the fully insured population to figure out how many beneficiaries of each type there will be in each year in the future. In the process, they also determine how many new beneficiaries of each type (*newly entitled beneficiaries*) will appear each year. For those receiving benefits as of the start year of their projection, their procedure is to simply grow their benefits through time at the inflation rate. For newly entitled beneficiaries their procedure entails assigning an average benefit based on a sample of 20,000 newly entitled workers whose earnings histories are updated and adjusted for projected productivity and other changes through time. The adding together of the benefits paid to existing beneficiaries to those paid to new ones leads to a projection of total benefit payments.

III. The CORSIM-SSBC Model[5]

As indicated, our microsimulation model combines two submodels: CORSIM and SSBC. CORSIM is a dynamic microsimulation model of the U.S. population developed by Steven Caldwell of Cornell University and his associates.[6] The model is similar in form and purpose to other policy-oriented dynamic microsimulation models developed around the world.[7] CORSIM starts with a representative sample of Americans alive in 1960. It then "grows' this sample of persons and households through time demographically and economically. For example, persons are born, age, attend school, leave the family, marry and start new families, work and earn money, become disabled, retire, and die. Households form, gain and lose members, migrate among states, pay taxes, make expenditures and accumulate assets. In effect, the model simulates a longitudinal annual survey of American persons and households; population representation is maintained by

[5] This section draws on Favreault (1998) and Caldwell, et. al. (1999).

[6] Large-scale dynamic microsimulation modeling traces back to the seminal contributions of Guy Orcutt (1957). The first operational model is described in Orcutt, et. al. (1961). In the 1970's Orcutt directed a team at the Urban Institute that constructed the DYNASIM model (Orcutt, Caldwell, and Wertheimer, 1976). CORSIM, under development since 1987, is descended from DYNASIM.

[7] Other prominent large-scale, policy-oriented dynamic microsimulation models developed for the U.S. include DYNASIM2 (see Zedlewski, 1989) and PRISM (see Kennell and Sheils, 1990). Anderson (1998), Ross (1991) and Citro and Hanushek (1991) review microsimulation models and alternative modeling strategies. Outside the U.S. dynamic microsimulation models have been developed and used extensively for public pension analysis. Examples include the following: DYNACAN in Canada (Morrison, 1998); MOSART in Norway; NEDYMAS in the Netherlands; LIFEMOD in Britain; HARDING in Australia; the RFV/ATP model in Sweden; and the Frankfurt model in Germany. All but DYNACAN are discussed in Harding (1996). Smaller, demographically-oriented microsimulation models in the U.S. include SOCSIM (see Hammel, Hutchinson, Wachter, Lundy, and Deuel, 1976), and CAMSIM (see Smith, 1987), and are reviewed in Bongaarts, Burch, and Wachter (1987) and DeVos and Palloni (1989).

subtracting decedents and adding births and immigrants each year. For this paper, the population is aged from 1960 to the year 2090.

SSBC uses a subset of CORSIM's completed lifetime demographic and economic experiences to determine OASI retirement, spousal, widow(er), mother, father, children, and divorcee benefits as well as OASI taxes. It does so taking into account Social Security's earnings test, family benefit maxima, actuarial reductions and increases, benefit recomputation, eligibility rules, the ceiling on taxable earnings, and legislated changes in normal retirement ages.[8]

Microsimulation

Microsimulation begins with a population sample and then "grows/ages" this population in discrete intervals, such as a month or year. Through the aging process, the model simulates life histories for each sample member. Life histories refer to sample members' demographic, economic, health, and social experiences through time. The simulation is generated by a set of mathematical algorithms that combine deterministic and stochastic elements.

The processes for continuous variables, like earnings, are typically represented by regression equations with a deterministic component that is based on the sample member's socioeconomic characteristics, and an error component that is drawn from a pre-specified distribution with strongly auto-regressive properties. Discrete-state changes (e.g., the transition from unmarried to married, from living to dead, from not working to working)

[8] Although SSBC considers the OASI system in great detail, it leaves out the DI portion of Social Security. It also ignores the taxation of Social Security benefits under federal and state income taxes. Both of these omissions lead to an understatement of Social Security's redistribution from the lifetime rich to the lifetime poor.

are typically represented as logistic functions. These logistic functions determine the probabilities of various state changes for each sample member as functions of the member's socio-economic characteristics.[9] Because stochastic components are pervasive in dynamic microsimulation models, solutions for these models depend on the particular stochastic outcomes for each model run. A particular individual's outcome in a single run might differ from that of another person who is observationally identical. Furthermore, the very same individual might display different outcomes across model runs. One can reduce this Monte Carlo variability by averaging outcomes across multiple model runs, though this exacts a high price in computational resources. Fortunately there exist more practical variance reduction techniques.[10]

Alignment

CORSIM incorporates an array of alignment, or benchmarking, processes. Alignment is treated as an integral part of module development with the particular aim of

---

[9] They are typically evaluated by taking a random draw from a uniform distribution whose values range from 0 to 1. If the value of the draw, say .7, is higher than the probability predicted by the logistic function, say .6, sample member experiences the change in question. If not, the sample member remains in the initial state. In either case, it is necessary to update the member's record since this information may be relevant for future transitions.

[10] Neufeld (1996b) provides an overview of these techniques. One approach, called the "sidewalk" method, entails keeping a running sum of probabilities, called the sidewalk variable and initialized at 0.5, to decide when events occur. When a unit's contribution to this sum causes the sum to reach or exceed an integer value, then the unit experiences the event (as opposed to the unit experiencing the event when its probability exceeds a random draw). The sidewalk method preserves the principle that probabilities of greater magnitudes result in greater likelihood of experiencing the event. One of the key advantages of the sidewalk method is that the actual number of events experienced by a group never exceeds the expected number of events by more than one. Further, the method prevents the elimination of entire high-event-probability subgroups. It has the potential disadvantages of first imposing negative dependence of events for related individuals when the initial data base is structured so that individuals within families are processed sequentially and also of non-repeatability across passes in the same run. To combat this limitation, Neufeld developed a "hybrid random number method" in which the advantages of sidewalk are combined with a more traditional tabular method. In this strategy, probabilities are subject to minor adjustment in order to ensure that the expected number of events will be nearly realized.

enabling modules to employ and reconcile data drawn from diverse sources and analytic levels. Initial micro-level outcomes in CORSIM are aligned, or benchmarked, to credible historical estimates (or future projections) at subgroup, group and aggregate levels. For example, initial values of CORSIM-simulated earnings for persons with particular characteristics are averaged to calculate a CORSIM-simulated group mean. A credible historical estimate of mean earnings for that group—based upon Current Population Survey (CPS) data—is compared to the CORSIM mean for the same group. Any difference between the CORSIM mean and the CPS mean is used as the starting point of an alignment process. The alignment process depends upon the underlying function. If the underlying function is linear, the alignment is a simple linear scaling. If the underlying function is nonlinear, as is the case for discrete outcomes, the alignment is non-linear; see Johnson (1996) and Neufeld (1996a).

Once the alignment processes and parameters are determined, the population is passed again through CORSIM, at which time a modified, aligned earnings is simulated for each woman in the group. These modified earnings cause the mean group earnings to closely track the historical benchmark. For some modules, multiple alignments are carried out to make simulated outcomes track multiple historical benchmarks. For example, aggregate earned income in CORSIM is aligned to historical National Income and Product Account estimates (or projections). Given alignment, CORSIM outcomes at the micro level track multiple historical (or projected) benchmarks, while retaining distributive richness at the micro-level. This enables CORSIM to draw upon, reconcile and integrate diverse sources and levels of historical data.[11]

---

[11]Alignment also plays the critical function of assuring that inputs to successive processes are accurate. For example, if one misspecifies the fertility function and does not subsequently align its predictions,

Of particular importance for this study is our benchmarking of CORSIM's aggregate labor income in the future to projections of aggregate labor income (including proprietorship income) provided by the Social Security actuaries. Specifically, the actuaries provided three separate projections, corresponding to their high, intermediate, and low cost forecasts. We used each of these projections in producing three CORSIM data sets – one based on high cost demographic and economic assumptions, one based on intermediate demographic and economic assumptions, and one based on low cost demographic and economic assumptions.

Simulating with CORSIM

CORSIM begins in 1960 with an initial population consisting of the 1960 U.S. Census Public Use Microdata Sample (PUMS). The PUMS is a one-in-one-thousand sample, so when CORSIM runs with the full PUMS all simulated counts are scaled by a multiple of 1000 to represent national totals. To make the size of the file more manageable, a subsample of approximately 50,000 persons was drawn from the full 1960 PUMS and used for the runs reported in this paper. The Census survey does not provide all the information needed as baseline data; the remaining information is imputed to the 1960 sample from a variety of sources. CORSIM "grows" the 1960 sample demographically and economically in one-year intervals through the year 2100. As detailed in Caldwell, et al. (1996) and in the Appendix to this paper, CORSIM updating processes are implemented by modules that consist of stochastic equations, alignment procedures and/or deterministic algorithms. As Table 1 makes clear, the stochastic equations are tested and estimated

even perfectly specified functions for work and earnings would generate inaccurate outputs, since both are dependent upon fertility outcomes.

using—whenever possible--large, nationally representative, longitudinal micro data files. Data used for the rule-based algorithms and for alignment are drawn from a variety of other program descriptions and data files.

In an effort to capture behavioral heterogeneity across socioeconomic subgroups, CORSIM often represents a single process by means of separate equations for multiple subgroups (Caldwell, 1985). A variable highly predictive of the outcomes of one group may be irrelevant for determining the outcomes of a second group and may act in the opposite direction for a third group.[12] In addition, when benchmarking group-level or aggregate-level outcomes generated by the micro-level equations, one might wish to insure that a particular distribution of outcomes across social groups—as indicated by group-level estimates from a credible source--is maintained. For example, the benchmarking (alignment) factors attempt to account for both period and cohort effects. Yet period and cohort factors (changes in laws, political events, natural disasters) might have dissimilar effects on members of different social groups. As a result one might prefer to define these effects differently for as many socially-relevant groups as possible.[13]

Of course, extensive cross-sectional alignments do not guarantee longitudinal realism. Simulating accurate proportions of the total population working, and even accurate distributions of work status across demographic groups for each year, does not

---

[12] For example, the presence of children in the household may differentially influence the labor market behavior of men and women. Children under age five are likely to increase the probability that a man works, but decrease the probability that a woman works. In such a case, one needs to estimate equations predicting labor market outcomes for men and for women separately, and may even wish to consider estimating separate equations for those individuals who have or don't have young children.

[13] The marriage rate for a particular age group, for example, is an outcome that one would expect to vary substantially across years given changes in the number of eligible males and females in the population, shifts in the economy, and changing social norms about the acceptability of remarriage and cohabitation. The micro-equations capture several of these dimensions, but alignment ensures that appropriate totals are achieved for different age-sex groups in each year.

insure realistic work histories. We try to achieve life history realism in CORSIM by 1) extensive use of lagged endogenous variables, and 2) realistic life paths for related behaviors. However, we often find these two strategies alone are insufficient to create full life path realism (Caldwell, Favreault and Swan, 1996). A third strategy is typically required: including substantial autoregressive properties in disturbance terms. In the CORSIM simulation of weekly earnings, for example, error terms varying in size by subgroup are added to the deterministic components for subgroups based on education, prior work status, and other factors. However, if these error terms are not correlated over time, earnings can shift unrealistically from year to year. One strategy we have used is to correlate one's probability of working in a given period with the probability from all previous periods by assigning what we refer to as "permanent luck" factors to all members of the sample.[14]

Validating CORSIM

How credible is CORSIM at simulating Social Security outcomes? Given the size and complexity of the model, a full-scale treatment of its performance lies beyond the scope of this paper.[15] However, some discussion of model validation is desirable.

---

[14] One can consider these as terms that capture unobserved heterogeneity--like differences in motivation and even social grace. These factors, which are drawn from a normal distribution centered on zero, are then added to the individual's probability of working and the level of work effort (full-time versus part-time). Comparisons of year-to-year transitions observed in the PSID sample more closely resembled CORSIM patterns after this modification was made. Similarly, we impose structure on error terms in the earnings equations, dividing this error into two components: a transitory component drawn each year and then a lagged component. Weights for these respective components vary across social groups. Swan (1997) details related issues.

[15] For discussion on general strategies for validating dynamic microsimulation models, see Caldwell (1996) and Caldwell and Morrison (1999). For results from validation tests aimed specifically at assessing CORSIM's capacity to simulate Social Security outcomes, see Favreault (1998) and Favreault

Three levels of CORSIM validation can be loosely distinguished, in ascending order of challenge. The first level of validation, paralleling the traditional procedures of standard analytic research, takes place during the specification, testing and estimation of individual micro-dynamic modules. Validation at this level focuses on the fit of a particular specification to 1) theory and previous research, and 2) suitable empirical data. For example, in the CORSIM microdynamic mortality module, the probability of death for a specific individual is specified as a direct (nonlinear) function of the individual's age, race, gender, income, educational attainment, employment status, place of birth (U.S. or not), and marital status. To arrive at a final specification, multiple credible alternatives were tested and compared using sub-samples drawn from the National Longitudinal Mortality Study. Once the final specification was chosen, final parameter estimates were obtained by fitting to the full NLMS sample. Estimated parameters were highly significant according to traditional criteria, and the parameter patterns were generally consistent with patterns suggested by theory and/or found in previous research. Specification, testing and estimation exercises such as these constitute the first level of validation for stochastic modules in CORSIM.

Once the equations that survived the first level of validation testing are coded into CORSIM, the full set of equations (together with other components of CORSIM) is used to generate a 'base' simulation covering the 1960-1997 historical period. This historical simulation invites a second level of performance testing. The validation yardsticks for this

---

and Caldwell (1997, 1998). Note, however, that validation results reported in the papers cited above, as well as validation results reported in this section of the current paper, are based on simulations using the CORSIM OASDI benefit calculator, and not the SSBC OASI benefit calculator used in this paper. Since we believe the SSBC calculator to be more accurate than the CORSIM calculator, we expect that validation tests in which the SSBC calculator was used would track historical benchmarks at least as well as those using the CORSIM calculator.

second level consist of particular historical benchmarks drawn from the 1960-1997 period. Validation tests at this second level still focus on the performance of each individual module, taken one at a time. But unavoidably they also test the performance of modules supplying input variables to each individual module. An eventual outcome of the second level of validation is alignment to historical benchmarks, as discussed in the section on alignment above. But efforts to improve the underlying structure of a module take priority.

An example, again using the mortality module, would be useful. During each simulation, CORSIM-simulated *individual-level mortality probabilities* are summed and averaged to yield CORSIM-simulated *group-level mortality rates*. The CORSIM-simulated group-level mortality rates for each year over the 1960-1997 period are then compared to government estimates of group-level mortality rates over the same period. Government mortality estimates are provided for each of seventy-six groups defined by age, sex and race. CORSIM-simulated individual-level probabilities are summed and averaged to generate rates for exactly the same groups. Differences between CORSIM-simulated and government-estimated mortality rates for each of seventy-six groups over the 1960-1997 period can arise from various sources, notably including specification and estimation flaws in the CORSIM mortality module (Caldwell, 1996). The pattern of these differences across time and across groups can suggest directions for further improvement in the CORSIM mortality module.

Second-level validation tests probe well beyond the more conventional first-level validation tests. To examine how well a mortality module based upon longitudinal micro-data 'fits' group-level time series data is to impose a performance test going beyond conventional in-sample and out-of-sample tests of statistical fit. *In-sample* tests, of course, are relatively weak because the yardstick for measuring performance is typically the same data as was used for model selection and estimation. Conventional *out-of-sample* tests provide a stronger performance test because the yardstick is 'fresh' data not used in model selection and estimation. However, the extra testing strength brought about by using new data is limited by the fact that typically the new data is *the same type* as the data used for the original model selection and estimation. Second-level CORSIM validation is *out-of-type* performance testing, because the performance yardstick is data that is not only new, but also different in kind from the data used in the first place for model selection and estimation (Caldwell, 1996). To continue the mortality example, in-sample and out-of-sample tests conducted as part of the first level of validation used micro-level longitudinal data (NLMS) as performance yardsticks. But out-of-type tests conducted as part of the second level of validation used group-level time series data (Vital Statistics) as performance yardsticks. In developing CORSIM modules, we believe that out-of-type performance yardsticks provide important diagnostic information beyond that yielded by conventional in-sample and out-of-sample measures.

Nevertheless, however stringent the performance tests posed by the first and second levels of CORSIM validation, the most important validation occurs at the third level, in which the full *system* of interacting modules is tested as a unit. Even if individual modules perform well according to the first two standards, the system of interacting modules can easily wander off track. Given CORSIM's starting point in 1960, many system-level historical yardsticks for assessing CORSIM's performance are available. Potential measures include historical (or projected) data a) on univariate stocks and flows; b) on multivariate stocks and flows; c) from cross-sectional and over-time designs; and d) at micro, group, and aggregate levels. For example, how well do CORSIM-simulated multivariate population distributions match historical distributions measured by censuses (e.g., the 1990 Census)? How well do CORSIM-simulated earnings histories match those measured in national longitudinal surveys (e.g., the Panel Study of Income Dynamics)? How well do CORSIM-simulated bivariate relationships between home ownership and earnings within subgroups match those measured in cross-sectional surveys (e.g., the Survey of Consumer Finances)? The list of potential yardsticks to test the system-level realism of CORSIM is very large. The number and variety of performance-testing yardsticks should be treated as an asset for dynamic microsimulation models generally, and for CORSIM specifically.

Since the third level is the most demanding and important kind of validation, and since OASDI projections are system-level CORSIM outcomes, we illustrate this kind of validation with specific examples. One example concerns simulating the growth of female-headed families over the 1960-1997 period. Though this outcome is less immediately relevant to Social Security than examples to follow, it readily illustrates system-level validation. Recall that CORSIM modules generate flows or events, with associated stocks as consequences. For example, the stock of population in CORSIM is an outcome of birth, death and (net) immigration flows. The three flows are each aligned, but the population stocks are not aligned and hence present opportunities for independent validation. Especially useful validation opportunities are created when specific population groups are the outcomes of multiple flows. The group defined as female-headed families (with at least one child under 18 living in the household) is an example. Six distinct CORSIM events generate new additions to the stock of female-headed families, and seven distinct events generate exits.[16] A validation test using the stock of female-headed families as yardstick therefore tests the cumulative effects of thirteen distinct CORSIM processes (and indirectly tests all processes that in turn influence those thirteen flows, i.e., virtually the entire CORSIM model). Figure 1, drawn from Morris and Caldwell (1999), displays the CORSIM-simulated number of female-headed families for the U.S. over the 1960-1997 period, compared to historical estimates. The inter-temporal patterns of the two series are roughly similar, although differences are apparent in the levels. Because thirteen processes directly and cumulatively generate the number of female-headed families in CORSIM, accounting for differences between the two series might benefit from examining the matches among component flows. Unfortunately, in the case of female-headed families, not all component flows are documented with reliable historical data. In such cases examining the matches between simulated and historical flows becomes troublesome. In fact, when conventional historical data are weak or absent, one might argue that CORSIM-based estimates provide the best available historical estimates. One argument for such a claim is that CORSIM forces consistency on diverse data sources, including data on flows and stocks (Morris and Caldwell, 1999).

Given the topic of this paper, we now turn to validation tests that connect directly with Social Security issues. Numerous such tests are described in Favreault (1998), from whose dissertation we select two examples. Both examine CORSIM's capacity to simulate monthly Social Security benefits for retired female workers. Social Security benefits

[16] New entries to female-headed family status in CORSIM can arise when a child is born (to a single woman), a divorce occurs, a husband dies, an unmarried mother moves out from her family of origin, a single woman adopts, or a female-headed family immigrates. Exits can arise when a single mother

depend on each individual's earnings history, age, marital status and spouse's earnings. Simulating benefits for retired female workers is particularly challenging, since female worker benefits are more likely than male worker benefits to depend on the joint distribution of husband and wife earnings histories. Moreover, female earnings histories tend to be more variable, and more difficult to predict, than male earnings histories. Therefore, simulating realistic retired female worker benefits poses a challenge. Figure 2 displays *average* benefits for retired female workers over the 1961-1997 period. One series was simulated by CORSIM, the other series was drawn from Social Security administrative data.[17] The two series are similar. Even in 1997 at the end of the comparison period—by which CORSIM has simulated thirty-seven years in the life of each retired worker--the difference between the two series is only 1.1 percent.

Averages, however, are notorious for concealing more than they reveal. Microsimulation is unique among modeling paradigms in its claimed capacity to generate the full distributions underlying averages. But this claim amounts to little if the distributions are not validated. Even if Figure 2 suggests that CORSIM might be able to simulate realistic *average* monthly benefit levels for retired female workers, the more difficult question concerns CORSIM's capacity to simulate realistic *distributions* of monthly benefit levels for retired female workers. Any claim that CORSIM can provide credible forecasts of the distributive impacts of Social Security reform proposals carries little weight in the absence of a demonstrated capacity to simulate historical benefit distributions. Figure 3 displays the results of one test of CORSIM's distributive realism.

---

marries, a divorced or widowed mother remarries, a mother dies, an only child dies, or an only child leaves home, or marries, or turns 18.

[17] The historical estimate is taken from Table 5.C2 in the Statistical Supplement published by the Social Security Administration (1997).

For the same group of retired female workers whose average benefit levels were examined previously, Figure 3 compares the CORSIM-simulated distribution of monthly OASDI benefit levels in 1997 to the distribution as measured by Social Security administrative records.[18] Though differences are evident—CORSIM seems to overestimate the proportion of retired female workers receiving very high and very low benefits-the overall match of the two distributions is reasonably good. This is a relatively exacting validation test because—as was previously noted--by 1997 CORSIM has simulated thirty-seven years in the life of each retired worker.

One might reasonably argue that validation tests by model developers are less persuasive than validation tests by outsiders. Equally reasonably, one could argue that outsiders with Social Security policy expertise would be especially good at testing CORSIM's capacity for credible Social Security policy analyses. Fortuitously, researchers in the Office of Research, Evaluation and Statistics (ORES), Social Security Administration, are conducting a series of validation tests aimed at assessing CORSIM's suitability for Social Security policy analysis (Bailey, Cohen and Iams, 1998). These researchers have the additional advantage of access to official Social Security earnings records, and to a recently constructed exact match of these earnings records to respondents drawn from the Survey of Income and Program Participation (SIPP). The researchers are seeking to determine CORSIM's capacity for simulating realistic distributive impacts and realistic cost analyses at the same time. Initial evaluations have focused on individual and family earnings in CORSIM. In one exercise using the matched SIPP data, ORES researchers requested the CORSIM project team to generate a set of sixteen tables from a standard simulation. These tables examined the distribution of Indexed Monthly Earnings for persons alive in 1991 classified by gender, race, birth cohort, homeowner status, and household net worth. Within groups specified by ORES, the value of Indexed Monthly Earnings was calculated for persons located at exactly the 10th, 50th and 90th percentile ranks. The ORES researchers then compared the CORSIM tables to similar ones prepared within ORES using the matched SIPP data. Figures 4 and 5 are drawn from a recent public presentation of these comparisons (Bailey, Cohen and Iams, 1998). In Figure 4, monthly indexed earnings (MIME) are compared at the 10th, 50th and 90th percentile ranks for males living in a home-owning household across three successive birth cohorts. This comparison tests CORSIM's ability to simulate specific joint distributions relevant to Social Security outcomes. Figure 5 presents comparisons of mean ratio of wife's MIME to husband's MIME for wives born in the 1931-1935 cohort, separately by race and household asset level. These ratios are important for the distribution of OASDI benefits across households. Both comparisons are reasonably successful. CORSIM seems able to simulate selected features of MIME levels and distributions for males, to capture trends by birth cohort and to represent differences according to home ownership. CORSIM also accurately represents the mean ratios of wife's MIME to husband's MIME for wives in a specific birth cohort and classified by race and household asset level, although the ratio simulated for non-white wives is not as accurate as the ratio for white wives. Given the mass of comparisons possible across sixteen complex tables, the ORES researchers avoid simple summary evaluations. However, they cautiously suggest that CORSIM may be particularly strong in its projections for economically advantaged groups and its matching of husband's and wives earnings, but possibly less so for non-white females and persons with low assets.

[18] Adapted from Figure 5.21 in Favreault (1998).

Results from a second ORES validation exercise are not yet available for citation, but the study's author has given permission for a general description of the exercise. In this evaluation individuals in both CORSIM and the matched SIPP file were classified by lifetime earnings pattern (low, middle or high), earnings trend (declining, level or rising) and earnings profile (sag, level or humped). Comparing the CORSIM and SIPP lifetime earnings patterns as they are distributed across pattern, trend and profile dimensions, the ORES study concluded that CORSIM succeeds generally in simulating a realistic variety of lifetime earnings patterns.[19]

A final validation issue involves the magnitude of the socioeconomic differentials in mortality in CORSIM, which in turn influence the socioeconomic characteristics of Social Security beneficiaries. Socioeconomic differentials in mortality have been thoroughly documented (Caldwell and Diamond, 1979). Given previous research, and given highly significant socioeconomic effects found during analyses of the National Longitudinal Mortality Survey, CORSIM's mortality module incorporates several socioeconomic variables—income, education, work status, marital status—as direct influences on individual-level mortality probabilities. However, from casual inspection of the socioeconomic parameters in the mortality module, it is difficult to estimate the magnitude of the cumulative socioeconomic differentials as the various effects "play out" over the life course.[20] To address this concern, we calculated the average CORSIM age at death distributed according to lifetime labor earnings. Displayed in Table 2, these

[19] Personal communication from Lee Cohen, November 1998.

[20] The inability of casual inspection to predict outcomes as multiple effects play out over time is of course part of the rationale for complex simulation models like CORSIM.

calculations suggest that the cumulative socioeconomic mortality differences in CORSIM, and the differences by sex, lie within a credible range.[21]

We conclude this section by stating the obvious, that the handful of validation results presented above serve at best only to illustrate. Nothing remotely close to a definitive conclusion about CORSIM's adequacy for modeling Social Security can emerge from these few examples. Models as complex as CORSIM require major continuing evaluations to assess their suitability for a variety of purposes. Without substantial investment in validation, these models will not fulfill their potential.

Sample Selection

Our sample was drawn from a master sample produced by running CORSIM from 1960 through 2100. From this master, we selected the following: a) all never married males and females (including immigrants) born between 1945 and 2000 who lived to at least age 15; b) all males (including immigrants) born between 1945 and 2000 who married women born between 1945 and 2010 and lived to at least age 15; and c) all females (including immigrants) born between 1945 and 2000 who married males born between 1945 and 2000 who lived to at least age 15.

Selecting the sample in this manner omits a) males born between 1945 and 2000 who married females born either before 1945 or after 2010 and b) females born between 1945 and 2000 who married males born either before 1945 or after 2000. Thus, at the early end of the sample we lose some males who married older women and some women who married older men. At the late end of the sample we lose some males who married very much younger women and some females who married younger men.

SSBC

SSBC is a highly detailed OASI benefit calculator developed by Economic Security Planning, Inc. for use in its financial planning software program -- ESPlanner™. SSBC calculates retirement, spousal, widow(er), mother, father, children, and divorcee benefits as well as OASI taxes. It does so taking into account Social Security's earnings test, family benefit maxima, actuarial reductions and increases, benefit recomputation, eligibility rules, the ceiling on taxable earnings, and legislated changes in normal retirement ages.

Calculation of OASI benefits, the basics of which are described in the Appendix, is extremely complex. The Social Security Handbook describing the rules governing these benefits runs over 500 pages. Even so, on many key points, the Handbook is incomplete and misleading. This assessment is shared by Social Security's senior actuaries who were consulted repeatedly in preparing SSBC. Their assistance, which proved invaluable, came in the form of both extensive discussions and the transmittal of numerous, highly detailed benefit calculations.

IV. Comparing SSA and CORSIM-SSBC Aggregate Benefit and Tax Projections

In considering the differences in our own and SSA's projected aggregates of taxes and benefits, it's worth asking what microsimulation brings to the process of projecting aggregate taxes and benefits. The answers are twofold; first, the size of aggregate social security benefits and tax payments in future years depend on the distribution of lifetime earnings. Microsimulation can be used to explore how these distributions will evolve over

[21] Communications between Ron Lee and Larry Kotlikoff, November 19-20, 1998.

time and the impact of the evolution of these distributions on aggregate taxes and benefits. Second, although it is not our focus here, microsimulation can also be used to project aggregates, such as aggregate covered labor earnings. SSA could, in principle, use these alternative aggregate forecasts in refining its own benefit and tax projection methodology.

Consider now Table 3 that reports our own and SSA's OASI aggregate benefit projections. One feature of this table that may, at first, seem counterintuitive is that our own as well as Social Security's projected aggregate benefits are lower under the high cost assumptions than under the low cost ones. The explanation here is that the high cost assumptions, although they assume greater longevity, also assume lower real wage growth. Since absolute benefit levels are a function of absolute real wages, lower real wage growth will lower absolute real benefit outlays. As Table 4 indicates, it will also lower real tax revenue.

Turning to our findings, they suggest a potentially smaller imbalance between long-run benefits and payroll tax revenues than is being forecast by the actuaries. This is true for each of three alternative sets of actuarial assumptions entertained by the actuaries and arises with respect to taxes.

Consider first the benefit projections presented in Table 3. Recall that the period over which benefit comparisons meaningful are 2050 and years close to 2050 since in 2050 our sample ranges in age from 50 to 105 in 2050. In 2050, our projected benefits under the intermediate assumptions fall short of SSA's by almost 15 percent. Our high and low cost benefit projections for 2050 are also lower than those of SSA – by about the same percentage. The roughly 15 percent under-prediction of benefits prevails for all years between 2045 and 2050 under all three sets of cost assumptions.

In thinking about the discrepancies between these two sets of benefit forecasts it's important to bear in mind that the CORSIM data used in the SSBC is benchmarked, on an annual basis, to SSA's own forecast of aggregate employee wages plus proprietorship income as well as its coverage rate. In calibrating the lifetime and annual variances of CORSIM weekly earnings module, which influence the division of earnings as between covered and non covered, we've also targeted and closely matched SSA's actual collection of OASI taxes over the period 1960 to 1998. This means that differences in the benefit projections should be arising for more microeconomic reasons involving a) the distribution of covered earnings within the workforce, b) the distribution of completed lifetimes, c) the distribution of completed workspans, d) the eligibility of particular workers and their dependents for auxiliary survivor and other benefits, and e) the extent to which benefits are earnings tested, actuarially reduced for early benefit receipt, limited by family maximums, subject to benefit re-computation, and affected by others of the highly detailed features of SSBC's benefit calculations. Since SSA's forecasting methodology does not attempt to consider these various factors, except in a highly aggregated manner, there might be some reason to favor our forecast over SSA's. But we would not advance this argument very far without substantial additional exploration.

On the other hand, since CORSIM's variances in lifetime and annual earnings have not, to date, been fully calibrated against the corresponding variances arising in the earnings records collected by SSA,[22] it could well be that the CORSIM micro earnings variance underlying the differences in projected aggregate benefits is off the mark. Another possibility is that there are some systematic differences in the calculation of benefits by the

[22] However, recall the discussion in the validation section concerning validation tests of CORSIM lifetime earnings patterns carried out by ORES researchers in SSA.

SSBC and by SSA. This possibility seems remote, however. SSBC has been tested against ANYPIA – SSA's published retirement benefit calculator. It has also undergone very extensive testing with respect to the calculation of ancillary benefits, earnings testing, benefit re-computation, etc. A third point is that the CORSIM data we are using constitute a random sample, not a population sample. To some extent, our underestimate of aggregate benefits might reflect sampling error. A final point is that 2050 is a long way off and that small differences in underlying distribution assumptions may translate into larger ones over time.

Table 4 shows a much closer match to SSA's projections when it comes to aggregate OASI taxes. The relevant comparison years in this case are 2010 through 2020. In 2010, our sample ranges in age from 10 to 65; in 2020, it ranges in age from 20 to 75. Consider 2018, when our sample ranges in age from 18 to 73 and presumably covers virtually the entire workforce. Under the intermediate assumptions, we project taxes that are 2.8 percent higher than SSA projects. Under the high cost assumptions, our projected tax aggregate exceeds SSA's by 4.0 percent, and under the low cost assumption we match SSA's projection within 1 percent.

V. Social Security's Treatment of Postwar Americans

Internal Rates of Return

Tables 5, 6 and 7 present, respectively, intermediate, high cost, and low cost calculations of internal rates of return on OASI contributions for postwar Americans distinguished by lifetime earnings amounts, cohort, sex, race, and education. For reference, Table 8 shows the numbers of observations in these cells. Cohort 45 refers to those born from 1945 through 1949. Other cohorts are defined in the same manner except for Cohort 95, which includes those born in 2000.

Consider first the total column in the top set of numbers (the cohort comparison) in Table 5. These figures suggest that postwar American cohorts will, under current law and under intermediate assumptions, earn less than a 2 percent real rate of return on their contributions, with the highest rate of return equal to 1.98 percent and the lowest equal to 1.73 percent. Other researchers, including Steuerle and Bakija (1994) and Coronado, Fullerton, Glass (1999), have found similarly small rates of return.

Interestingly, there is no trend across the cohorts with respect to the rates of return they earn.[23] In other words, under current law, the deal Social Security is offering current middle aged Americans is not any better than it is offering younger Americans. On the one hand, earlier cohorts experienced lower OASI tax rates over the early parts of their working lives than is the case for later cohorts. On the other hand, later cohorts have greater longevity reflecting the trends incorporated in CORSIM's mortality module. In evaluating these figures, one should also bear in mind that the observed differences might reflect sampling variability.

Interestingly, there is also not much difference across the three tables with respect to different cohorts' internal rates of return. On first thought, one might expect to observe, on average, a higher rate of return in the high cost sample because its greater longevity means retirees collect their benefits for a longer period of time. On the other hand, greater longevity means that more of the sample will work for longer periods and pay more in taxes. In addition, the high cost estimate assumes a 4.5 percent rate of inflation, whereas

[23] Our results in our recent NBER working paper (Caldwell, et. al., 1998) suggesting a lower internal rate of return for younger cohorts reflect a computer error and will be corrected in Caldwell, et. al. (1999).

the low cost estimate assumes a 2.5 percent rate of inflation. Since the OASI system is not fully indexed to benefits and since, ceteris paribus, real benefits are lower the higher the rate of inflation, the fact that rates of return are not higher under the high cost assumptions may reflect this factor.

In contrast to the cross-cohort and cross-assumption comparisons, there are very marked differences in real rates of return across lifetime income levels. Across all cohorts, those in the lowest earnings group earn average a 5.19 percent return, whereas those in the highest earnings group average a 0.54 percent return. On this metric, at least, the OASI System appears to be highly progressive.

There is also a systematic and significant difference in rates of return earned by women compared to men. Across all cohorts and under the intermediate assumptions, women earn, on average, 2.79 percent on their contributions whereas men earn only 1.05 percent. This difference reflects three things. First, women live longer than men do. Second, women are lower lifetime earners than are men and, thus, benefit compared to men from Social Security's progressive OASI benefit formula. Third, we are allocating dependent, mother and father, child, and survivor benefits to the recipients of these benefits even though these benefits are based on the earnings record of one's spouse.

Under the intermediate assumptions, non whites average about a 15 basis point lower rate of return than do whites, reflecting their shorter lifespan. Non white/white differences are somewhat greater among low lifetime earners where mortality differences are greatest. The differences between non-white and white internal rates of return are largest under the low cost assumptions and smallest under the high cost assumptions. This reflects the fact that under the low cost assumption of relatively short life spans, a relatively larger fraction of non-whites pass away before receiving benefits.

Table 5 also indicates a slightly higher internal rate of return for non college-educated compared with college-educated postwar Americans. This is expected given the fact that those with less than a college education are lower lifetime earners and, thus, benefit, relatively speaking, from Social Security's progressive benefit formula.

Lifetime Net Tax Rates

Tables 9, 10 and 11 present lifetime net tax rates under the intermediate, high cost, and low cost assumptions. These lifetime net tax rates were computed using a 5 percent real discount rate. On average, Social Security represents about a 5 percent lifetime net tax; i.e., of every dollar that postwar Americans either have earned or will earn, 5 cents will be paid to Social Security in taxes above and beyond benefits received. The average lifetime net tax rate is somewhat higher under the high cost assumptions and somewhat lower under the low cost assumption.

Lifetime net tax rates show no significant trend across cohorts. But there is also a very clear pattern with respect to income level. Specifically, the middle income classes face the highest net tax rates. Consider, for example, postwar Americans with lifetime earnings of $600,000 to $720,000. On average, they face a 7.0 percent lifetime net tax rate, compared with an average negative net tax rate of 0.7 percent for those with lifetime earnings below $120,000 and a average net tax rate of 4.3 percent for those with lifetime earnings above $1.08 million. Table 9 also shows higher lifetime net tax rates for men compared to women, for the non college-educated compared to the college-educated, and for non-whites compared to whites.

The Impact of Raising Taxes or Cutting Benefits to Achieve Long-run Solvency

Our final two tables, 12 and 13, consider the tax hike or benefit cut needed under the intermediate assumptions to achieve an equality between a) the sum of the Social Security System's projected revenues (untruncated and measured in present value) and the trust fund and b) the System's projected benefit payments (untruncated and measured in present value). The immediate and permanent tax hike needed is 38 percent, while the immediate and permanent benefit cut is 25 percent.

Both tables show dramatically lower internal rates of return, particularly for younger cohorts. Those in the 1995 cohort, for example, can expect a 0.92 percent rate of return under the tax hike and a 1.01 percent rate of return under the benefit cut. The benefit cut leaves men, on average, earning a 0.4 percent real return. In the case of the tax hike, the smaller percentage reduction in the rate of return received by early cohorts reflects the fact that for these cohorts many of their tax paying years are already behind them when the tax is raised.

VI. Summary and Conclusion

This paper used CORSIM -- a dynamic microsimulation model -- and SSBC -- a detailed Social Security benefit calculator – to project aggregate OASI benefits and taxes and to evaluate Social Security's treatment of different types of postwar Americans. Our forecast entails essentially identical tax revenues, but roughly 15 percent less in long-term benefit payments. The precise reason for the differences in long-term projected benefits, although difficult to determine, is an important area for future research.

Our internal rate of return calculations indicate that postwar Americans can expect, on average, to earn a very low real return – roughly 2 percent -- on their Social Security contributions. Moreover, measured as a percent of their lifetime incomes, postwar Americans can expect, on average, to pay a fairly high net tax – 5 percent of their lifetime labor earnings -- to the system. These lifetime net tax rate calculations show that it is the middle classes who face the highest lifetime net tax rates; i.e., the system is not progressive when you discount benefits and taxes at 5 percent real.

Social Security's bad deal for postwar Americans will end up substantially worse if taxes are raised or benefits are cut by the amount needed to produce true long-term solvency. If taxes are raised or benefits are cut to eliminate the OASI system's long-term fiscal imbalance, Americans born this year will earn (after inflation) roughly 1 percent on their contributions.

References

Anderson, Joseph M., "Retirement Policy Analysis: Models, Data and Requirements for the Future," Report Prepared for the American Society of Actuaries. Capital Research Associates, Chevy Chase, MD, 1998.

Bailey, Deborah, Lee Cohen and Howard Iams, "Comparison of MIME's Between CORSIM and SIPP-DPE", Paper presented at the annual meeting of the Association for Public Policy and Management, New York City, 1998.

Bongaarts, John, T. Burch, and K.W. Wachter, eds., *Family Demography, Methods and their Applications*, Oxford, England: The Clarendon Press, 1987.

Caldwell, Steven B., "Health, Wealth, Pensions and Life Paths: The CORSIM Dynamic Microsimulation Model," in Ann Harding, Editor. *Microsimulation and Public Policy*, Amsterdam: North Holland, 1996.

________________ and Ted Diamond, "Income Differentials in Mortality: Preliminary Results Based on IRS-SSA Linked Data." *Proceedings of the American Statistical Association*, 1979.

________________, et. al., *CORSIM 3.0 Technical and User Documentation*, unpublished manuscript, Department of Sociology, Cornell University, 1996.

________________, Melissa Favreault, and Neil Swan, "Work and Earnings over the Life Course: Validation Using Dynamic Microsimulation," unpublished paper, Cornell University, 1996.

________________, Melissa Faverault, Alla Gantman, Jagadeesh Gokhale, Thomas Johnson, and Laurence J. Kotlikoff, "Social Security's Treatment of Postwar Americans," National Bureau of Economic Research Working Paper Series, 1998.

________________ and Richard J. Morrison, "Validation of Longitudinal Dynamic Microsimulation Models: Experience with CORSIM and DYNACAN," in Holly Sutherland (ed.), *Microsimulation in the New Millenium: Challenges and Innovations,* New York: Cambridge University Press, 1999.

________________, Melissa Faverault, Alla Gantman, Jagadeesh Gokhale, Thomas Johnson, and Laurence J. Kotlikoff, "Social Security's Treatment of Postwar Americans," forthcoming, *Tax Policy and the Economy*, James Poterba, ed., NBER Volume, Cambridge, MA: MIT Press, 1999.

Citro, Constance and E. Hanushek, eds., *Improving Information for Social Policy Decisions: The Uses of Microsimulation Modeling*, two volumes, Washington, D.C.: National Academy Press, 1991.

Coronado, Julia Lynn, Don Fullerton, and Thomas Glass, "Distributional Impacts of Proposed Changes to the Social Security System," forthcoming in *Tax Policy and the Economy*, 1999.

DeVos, Susan and A. Palloni, "Formal Models and Methods for the Analysis of Kinship and Household Organization," *Population Index,* vol. 55, 174-98, 1989.

Favreault, Melissa, *Whose Safety Net? Social Security, Life-Course Processes, and Inequality in the United States.* Doctoral Dissertation, Department of Sociology, Cornell University, Ithaca, New York, 1998.

Favreault, Melissa and Steven B. Caldwell, "Whose Social Safety Net? Differential Life Course Patterns and the Progressivity of the OASDI System," American Sociological Association, Toronto Canada, August 1997.

Favreault, Melissa and Steven B. Caldwell, "Assessing Distributional Impacts of Social Security by Cohort, Gender, Family Status, Lifetime Earnings and Race using Dynamic

Microsimulation," Paper presented at the annual meeting of the Association for Public Policy and Management, New York City, 1998.

Hammel, Eugene A., D. Hutchinson, K. Wachter, R. Lundy, and R. Deuel, "The SOCSIM Demographic-Sociological Microsimulation Program Operating Manual," Institute of International Studies Research Monograph No. 27, University of California, Berkeley, California, 1976.

Harding, Ann, (Ed.), *Microsimulation and Public Policy.* Amsterdam: North Holland Press, 1996.

Johnson, Thomas, "On Methods for Alignment in CORSIM/DYNACAN," unpublished paper, Cornell University, 1996.

Kennell, D.L. and J.F. Sheils. 1990, "PRISM: dynamic simulation of pension and retirement income." Pp. 137-172 in *Microsimulation Techniques for Tax & Transfer Analysis*, edited by G. H. Lewis and R. C. Michel. Washington, D.C.: The Urban Institute Press.

Morris, Pamela A. and S.B. Caldwell, "The Dynamics of Female-Headed Families: Changes in Children's Life Course", draft, Cornell University, 1999.

Morrison, Richard J., "DYNACAN: A Canadian Microsimulation Model for Public Pension Analysis," Office of the Superintendent of Financial Institutions, Ottawa, Canada, 1998.

Neufeld, Christopher, "Aligning Sub-groups and Aggregates Simultaneously in Two Passes," unpublished paper, Office of the Superintendent of Financial Institutions Canada, 1996a.

__________________, "Final Report on a New Variance Reduction Method for CORSIM and DYNACAN," unpublished paper, Office of the Superintendent of Financial Institutions Canada, 1996b.

Nichols, Orlo R. And Richard G. Schreitmueller, "Some Comparisons of the Value of a Worker's Social Security Taxes and Benefits," Actuarial Note no. 95, Baltimore, Md.: U.S. Social Security Administration Office of the Actuary, 1978.

Orcutt, Guy, "A New Type of Socio-Economic System." *Review of Economics and Statistics*, Vol. 58, 1957, 773-797.

__________, Martin Greenberger, John Korbel, and Alice M. Rivlin, *Microanalysis of Socioeconomic Systems: A Simulation Study*. New York: Harper and Row, 1961.

__________, Steven B. Caldwell, and Richard Wertheimer, *Policy Exploration Through Microanalytic Simulation*. Washington, D.C.: The Urban Institute, 1976.

Panis, Constantijn W.A. and Lee A. Lillard, “Socioeconomic Differentials in the Returns to Social Security,” RAND Labor and Population Program Working Paper Series, Santa Monica, Ca., 1996.

Pischke, Jörn-Steffen, "Measurement Error and Earnings Dynamics: Some Estimates from the PSID Validation Study," *Journal of Business and Economic Statistics*, vol. 13, no. 3, 1995, 305-314.

Ross, C. M. 1991. "DYNASIM2 and PRISM. Examples of Dynamic Modeling." Pp. 121-140 in *Improving Information for Social Policy Decisions: The Uses of Microsimulation Modeling. Vol. II, Technical Papers*, edited by C. F. C. a. E. A. Hanushek. Washington, DC: National Academy of Sciences Press.

Smith, James E., “The Computer Simulation of Kin Sets and Kin Counts,” in *Family Demography*, ed. by J. Bongaarts, T. Buch, and K. Wachter, 1987, 249-66.

Steuerle, C. Eugene and Jon M. Bakija, *Retooling Social Security for the 21st Century,* Washington, D.C.: The Urban Institute Press, 1994.

Swan, Neil, “Problems in Dynamic Modeling of Individual Incomes,” paper delivered to Swedish Conference on Microsimulation, Stockholm Sweden, June 9-10, 1997.

U.S. Board of Trustees of the Federal Old-Age and Survivors Insurance and Disability Insurance Trust Fund, 1998 Annual Report, Washington, D.C.: U.S. Government Printing Office, 1998.

Zedlewski, S.R. 1989. "The development of the dynamic simulation of income model (DYNASIM)." Pp. 109-136 in *Microsimulation Techniques for Tax and Transfer Analysis,* edited by G. H. Lewis and R. C. Michel. Washington, DC: The Urban Institute Press.

Table 1 CORSIM Modules Used in this Study

Annual process	Groups subject to process and functional form	Process determinants	Data used in process estimation	Alignment Data
Individual Demographics				
Fertility	-30 groups (among women); age<30, have child, marital status, race, work status -logistic	age, $birth_{t-1}$, $birth_{t-2}$, duration of current marriage, earnings, family income, homeowner status, marital status, parity, schooling status, work status (F/T, P/T)	NLS:1969-87	Vital Statistics - 28 groups SSA Total Fertility Rate
Mortality	-51 groups; age, sex, race, marital status -logistic	age, birth place (US or other), education, employment status, family income, marital status, year	NLMS:1980-89	Vital Statistics - 88 groups SSA age-sex adjusted death rate
Family Demographics				
Enter Marriage Market for First Time	-20 groups; race, schooling status, sex, weeks worked -logistic	age, age^2, education, ln(earnings), number of children, weeks worked	NLS:1973-87	Census - 16 groups
Assortative Mating	-*all* non-related opposite-sex *pairs* in marriage market at t -logistic to estimate probability of match; highest joint ratings married, others return to market for possible marriage at t+1	age difference, age difference*(1 if female older, 0 otherwise), abs(male's total income-female's total income)/1000, difference in education, labor force participation interactions, male's education*(1 if older, 0 otherwise), racial interactions, state of residence, woman's number of children	Census:1980 PUMS	none
Marital Dissolution (Divorce only; Widowhood	-4 groups; earning status of wife, presence of children under 18	age difference, duration of union, husband's wages, race, wage advantage	PSID:1968-87	NCHS - 14 groups

Determined by Mortality)	-logistic			
Re-Enter Marriage Market upon Widowhood, Divorce	-7 groups; age (under 60/61+), race, sex, widowed or divorced -logistic	age, age^2, education, ln(income), divorced (v. widowed), has child, (1-nowork)*loginc, weeks worked	PSID:1968-87	NCHS - 26 groups
Individual Social and Economic Attainments				
Education: Grade Attendance, Completion	-33 groups; grade level (17 definitions, from pre-school to beyond third year graduate school), race, sex, schooling status -logistic	age, have child, living on own, marital status, parents' education, parents own home	HSB:1980-86; NLS:1979-87	CPS - 2 groups
Work Status (0/FT/PT)	-174 groups; age, have child, living with parents, marital status, race, sex, $_{weeks-1}$=0, $_{weeks-1}$>47 -probit	age, education, have child, $married_{t-1}$, marital status, number of kids, percent unemployment, youngest child's age	PSID:1972-87	Census and CPS - 35 groups SSA coverage rate - 2 groups
Number of Weeks Worked	-58 groups; age, have child, marital status, race, sex, $weeks_t \leq 47$, $weeks_t > 47$ -regression	age, education, have child, $married_{t-1}$, number of kids, percent unemployment, youngest child's age	PSID:1972-87	none
Weekly Earnings Rate	-116 groups; age, have child, marital status, race, sex, weeks $worked_t$, $weeks_{t-1}$ -regression	age, $earnings_{t-1}$, education, education*$earnings_{t-1}$, $married_{t-1}$, number of children, percent unemployment, youngest child's age	PSID:1972-87	Census and CPS - 70 groups NIPA
Age of Receipt of Social Security	-Screen for eligibility -logistic for	age, change in work $hours_{t-1,t}$, coverage, earnings, education,	PSID:1986-91	SSA Data 1961-1995 12 groups

Retirement Benefits	workers	homeowner, live alone, ln(asset income), ln(change in absolute value of income$_{t-1,t}$), marital disruption$_{t-1,t}$, marital status, race, sex, work hours		

PSID - Panel Study of Income Dynamics, SSA - Social Security Administration, PUMS- U.S. Census Public Use Microdata Sample, HSB - High School and Beyond, NCHS - National Center for Health Statistics, NLS - National Longitudinal Survey, NLS-Y - National Longitudinal Survey of Youth, NLMS - National Longitudinal Mortality Study, CPS - Current Population Survey, NIPA - National Income and Product Accounts

Appendix – Specification Details for CORSIM and SSBC

CORSIM Processes Used in this Study

Table I lists the subset of CORSIM processes used in this study, the data used in their estimation, and the aggregate statistics used in their alignment. We briefly discuss each of the processes.

Fertility -- this process is the probability that a female sample member gives birth in a given year. As indicated in the second column, separate logistic functions are used to calculate this probability -- one for each of 30 different groups of women. These groups are distinguished by their martial status, race, work status, and whether they already have children. Each logistic function was estimated from NLS data using some or all of the variables listed in column 3 as regressors. These regressors include age, past births, duration of current marriage, current marital status, and labor earnings. Alignment of the logistic probabilities is done first on an age, race, and marital-status-specific basis using Vital Statistics and then on an overall basis using the Social Security Administration's annual total fertility rate.

Mortality -- the logistics for the probability of dying in a given year are calculated separately for 51 groups distinguished by age, sex, race, and marital status. Note that the regressors for these logistics include two economic variables -- employment status and family income -- and education, which is highly correlated with income. This is important. The intragenerational progressivity of Social Security depends critically on whether poor members of particular generations live long enough to receive their benefits. Fortunately, the National Longitudinal Mortality Study used to estimate these logistics contains these key variables. As an individual is aged in CORSIM, CORSIM updates the values of these three variables and uses them in calculating the individual's current probability of dying. Vital Statistics are used to align predicted mortality rates for each of 88 distinct age-race-sex groups and then the Social Security Administration's age-sex-adjusted annual death rate is used as a final global alignment.

Enter Marriage Market for First Time -- this logistic function was estimated separately for 20 groups differing by age, race, sex, schooling, marital status, and weeks worked. The estimation was done on NLS data on individuals who changed their marital status between one year and the next from never married to married. Since Social Security spousal benefits are available to dependent spouses and Social Security survivor benefits are available to widow and widowers, having marriage depend on earnings and education, as CORSIM does, is another prerequisite for understanding Social Security's intragenerational redistribution. Census data are used to align the logistic-imputed probabilities to produce the correct national totals of first time marriages across 16 age-sex groups.

Assortative Mating -- CORSIM also must decide who marries whom. It does so through an assortative mating process. Specifically, it considers all pairings of unmarried males with unmarried females. Each pairing is assigned a marriage probability and then those pairs with the highest probability are selected as actual marriages. The probability of marriage, which was estimated based on Census data, depends on the differences and levels of the male's and female's ages, the differences in their incomes, race, state of residence, labor force participation, and other factors. Males and females who are closer in age and whose educational levels are closer have higher probabilities of marrying. Given Social Security's provision of spousal and survivor benefits, how marriages are formed will matter to the system's redistribution both across and within generations.

Marital Dissolution -- The determinants of this logistic process are the difference in spouses' ages, the duration of the marriage, the husband's wages, race, and the differences in wage rates between the husband and wife. The process is estimated with PSID data separately for four different groups of married couples. The fours groups are distinguished by the earning status of wife and the presence of children under 18. National data on divorce are used to align the probabilities, which are derived from the predicted values of the logistics, for 14 groups defined by duration of marriage.

Reentry into the Marriage Market -- CORSIM keeps track of individuals who have become divorced or widowed and gives them the opportunity to reenter the marriage market and, potentially, remarry. There are seven different logistics for reentry into this market which are distinguished by the individual's race, age, sex, and other characteristics. The actual determinants of these functions, which were estimated on PSID data, include education, income, whether one is divorced or widowed, and whether one has children. National Center for Health Statistics data were used to align predicted logistics for 26 groups defined by age, sex, and the reason for dissolution of the prior marriage (divorce versus widowhood).

Education -- The education processes (one for each of 33 separate groups) are also logistics. These logistics, which were estimated with HSB and NLS data, determine whether an individual with a certain number of years of education chooses to continue his or her education for at least one more year. A variety of factors, including age, whether you have a child, whether you're living on your own, and your parents' education influence schooling outcomes. High school graduation rates are then aligned by sex, and a global alignment of college enrollment rates is also imposed.

Work Status and Weeks Worked -- CORSIM's earnings module starts with group-specific probits determining a) whether sample members work zero or a positive number of weeks during the year and b) given that weeks worked is positive, whether weeks worked exceeds 47 weeks per year (i.e., whether the worker works full year or part year). The 174 groups for which these probits are estimated differ by age, sex, race, whether the sample member has a child, and whether he or she worked part year or full year in the past year. The explanatory variables in the probits, which were estimated on PSID data, include age, education, presence of children, youngest child's age, and marital status. Benchmarking of work status (full-year, part-year, none at all) is done separately for 35 age-race-sex subgroups based on Census and CPS data and is then aligned to coincide with Social Security's aggregate proportion of the population in covered work.

These probits are then followed by regression equations, again estimated on PSID data, which predict the actual number of weeks that an individual works. The prediction is distinct for each of 58 groups differentiated by full- or part-time work status and then age, race, sex, marital status, living with parents, and the presence of children. The regressors in this equation include education and marital status.

Weekly Earnings -- To calculate annual earnings, CORSIM multiplies weeks worked by weekly earnings. Weekly earnings is imputed based on a regression on age, lagged earnings, education, education times earnings, marital status, number of children, and the youngest child's age. Separate imputation regressions were estimated for 116 groups broken down by age, the presence of children, marital status, race, and sex. Total weekly earnings are aligned separately for 70 groups (based on age, sex, full-year vs. part-year status, and, for women, marital status and presence of children) using CPS data and then each of these groups is subjected to the same global alignment to ensure that predicted aggregate earnings coincide with the NIPA aggregates.

Age of Receipt of Social Security Retirement Benefits -- This is a key variable used by SSBC in assigning Social Security retirement, spousal, and dependent benefits to CORSIM sample members. It's key because Social Security reduces retirement benefit for early retirees and increases them for late retirees. Social Security also earnings tests benefits once individuals start receiving them. Finally, Social Security's provision of spousal benefits to current spouses and dependent benefits to children on a worker's earnings record is contingent on whether or not the worker is entitled to collect retirement benefits. For workers who are eligible to become entitled for retirement benefits, CORSIM uses logistic functions, estimated on PSID data, to determine the probability of entitlement. The logistic's regressors include age, lagged change in weeks worked, the level of earnings, education, home ownership, living arrangement, asset income, lagged income, marital status, race, and sex. Social Security Administration data on total numbers of workers applying for retirement benefits are used to align the data for 12 age-sex groups.

CORSIM Post-1996 Alignments

For each year between 1960 and 1996, CORSIM's alignments are based on actual historical aggregates or aggregates that are interpolated between actual historical data. Take, as an example, the proportions of individuals who elect to receive their Social Security retirement benefits at various ages (e.g., sixty-two and sixty-five). CORSIM calculates the historical proportions for these variables by dividing aggregate data on new awards from the Annual Statistical Supplement to the Social Security Bulletin by the total population in the age group. Likewise, historical alignment data for birth probabilities come from live birth registration data that are collected annually by each of the fifty states.

CORSIM's annual alignment totals for years beyond 1996 incorporate many of the intermediate assumptions pertaining to aggregate fertility, mortality, and migration developed by the Office of the Actuary of the Social Security Administration and reported in the 1997 Trustees' Report (Board of Trustees, 1997). Neufeld (1996a) details this procedure. CORSIM uses the Trustees' assumptions for the total fertility rate (assumed to reach its ultimate level of 1.90 in the year 2020) and the age-sex adjusted death rate[24] (assumed to decline from 832.0 per thousand in 1996 to 529.8 in 2075). It does not include the Trustees' estimates of life expectancy, although it is fairly close to their estimates.[25]

CORSIM further incorporates several of the 1997 Trustees' intermediate assumptions about anticipated economic changes, including the expected growth of wages and prices. The Trustees currently assume that the future value of increase in the Consumer Price Index (CPI) will vary between 3.2 and 3.5 percent over the projection period. Average wages in CORSIM grow as the Trustees anticipate, at a rate of CPI plus a real differential which, in the long term, equals 0.9 percent per year. Again, this is implemented as a part of CORSIM alignment, specifically, the aggregate alignment of workers' wages to the National Income and Product Account totals. The Trustees' intermediate projected changes in the size of the labor force suggest continual growth over time, ranging from an increase of zero percent to an increase of one percent. Concerning composition of the labor force, the SSA actuaries anticipate that there will be further declines in work effort among men, and eventual plateauing of increases among women in the future. CORSIM ensures that this outcome is replicated by adjusting the probability that an individual's number of weeks worked is nonzero using the Trustees' sex-specific coverage rate, defined as the proportion of the population age sixteen and over that has Social Security-covered employment in the year.[26]

CORSIM’s Shortcomings

The beauty of the dynamic microsimulation model--its great capacity for incorporating complex behavioral and administrative rules, interactions, and feedbacks--is also a potential weakness. If one is modeling dozens of interacting processes, then there are many places at which one could make errors, errors that could cumulate over the simulation process if undetected and/or left unchecked. Caldwell and Morrison (1997) list seven potential sources of error in the outcomes generated in dynamic microsimulation analyses: programming mistakes; imperfect micromodules, that it is, to the errors that one might make in representing the underlying behavioral processes one is modeling, and this includes specification and estimation issues; inaccurate inputs to a social or demographic process simulated in the model; random variation in the initial sample of a model; pure random variation, or Monte Carlo variability; differences between micro- and aggregate-level processes; and inaccurate aggregate data. In this paper, we concentrate on specification and estimation issues in CORSIM, though a more general discussion is available in Favreault (1998).

[24]This is defined as the crude rate that would occur in the enumerated total population as of April 1, 1990 if that population were to experience the death rates by age and sex observed in, or assumed for, the selected years (Board of Trustees, 1997: 64).

[25]Life expectancy can be defined at birth or at any other age; the SSA uses estimates from birth and from age 65.

[26]These data are not available in published Office of the Actuary reports, but were provided by Nettie J. Barrick and Robert Baldwin (1997; personal correspondence).

One particular area of concern for estimation is that the time frames of data used in the estimation of the social and demographic processes don't cover the entire post-1960 period (e.g., mortality logistics are estimated based on 1980-89 data). In the particular case of the mortality functions, we believe that these data are the best available, and using the most current data for projection purposes is standard practice in demographic modeling. Keeping CORSIM functions updated to the best available data is a never-ending process. Especially troublesome is the fact that the set of equations that generate earnings for individuals in the model are now ten years old. One's concerns about stale data should be attenuated by the alignment procedures, which are in fact year-specific.

One should also consider that data from the PSID and other sources are subject to measurement error which affects the size of the standard errors used in the calculation of earnings. Many of the data from which parameters for CORSIM functions are estimated are based upon self-report, and errors in self-report are known to vary in important ways. Measurement error in self-reported earnings, for example, has been shown to vary inversely with true earnings (see, for example, model explaining this in Pischke, 1995). This could lead to biased parameter estimates for these critical model functions.

One important and appealing feature of the CORSIM specification is the multiple equations and alignment groups, but there are hazards to this modeling approach. When one moves from one regression to another as one ages and moves from one alignment group to another, there can be rather dramatic variability in predicted outcomes. Patterns in fertility and mortality probabilities illustrate this well. When one examines a distribution of fertility probabilities for women in their childbearing years that are based on Vital Statistics and Census data, for example, one sees a smooth curve that is skewed to the left and peaks in the late twenties. If one plots these same probabilities for CORSIM women, one sees the same overall pattern but a few dramatic discontinuities between distinct ages.

In the CORSIM model, benchmarking is done on an annual basis rather than a lifetime basis. As already noted, this ensures annual consistency but not necessarily realistic lifepaths. Perhaps the most profound challenge that microsimulation modelers now face is to meet annual group-level targets and effectively replicate lifepaths simultaneously.[27] Through experimentation with CORSIM, we frequently find that in order to generate more realistic life paths, we need to relax some cross-sectional constraints. For example, one of the most unrelenting problems we face is the effective replication of individual earnings

[27]One major complication that modelers face is a dearth of reliable data for validating simulated lifepaths. Access to the comprehensive earnings data files held by the Social Security Administration is restricted, and these records lack links between spouses. One of the richest publicly-available sources of longitudinal data on individuals in the U.S., the Panel Study of Income Dynamics, began in 1968, which means that the maximum period for which one can currently validate trajectories using the PSID is less than thirty years. While some retrospective surveys cover longer time frames, data of this sort have numerous limitations. Even if researchers had unrestricted access to ideal validating data, conceptual issues about how to best employ these data arise. A particularly important issue is the time frame for validation. Validating outcomes in pairs of years or in sets of three years can be quite fruitful, but, again, meeting two- or three-year validation targets won't necessarily ensure realism over a longer time frame.

histories. Under CORSIM's original specification, many workers in the simulated population had extremely variable careers, with earnings jumping and falling dramatically, indeed implausibly, across just a few years. Our current representation of workers' earnings has eliminated a good deal of this variability, but at a certain cost: specifically, relaxation of the constraint that mean earnings for part-time workers in various groups hit annual national means (though earnings totals do continue to meet an overall wage pie). We believe that this tradeoff is worthwhile, but will continue to develop strategies to see that the demands of both realistic life paths and historical cross-sectional totals are satisfied. For example, more complicated lag structures in work and wage rate equations, among others, are likely to improve the realism of workers' trajectories.

SSBC's Benefit Calculations

<u>Allocation of Benefits</u>
The taxes and benefits used in forming lifetime OASI taxes and benefits are those nominally paid by the taxpayer and his employer and received by the beneficiary. Thus, a dependent benefit paid to a husband is counted as his benefit notwithstanding the fact that the benefit is based on his wife's earnings record.

<u>Retirement Benefits</u>
Eligibility -- Individuals must be *fully insured* to receive retirement benefits based on their earnings records. Becoming fully insured requires sufficient contributions at a job (including self-employment) covered by Social Security. For those born after 1929, acquiring 40 *credits* prior to retirement suffices for fully-insured status. Earnings between 1937 and 1951 are aggregated and divided by $400, and the result (rounded down to an integer number) are the pre-1952 credits which are added to the credits earned after 1950 in determining insured status. After 1951, workers earn one credit for each quarter of the year they work in Social Security-covered employment and earn above a specified minimum amount. The year of *first eligibility* for retirement benefits is the year in which the individual becomes age 62. The individual is *entitled* to retirement benefits after an application for benefits is submitted, but never before age 62.

Determination of Primary Insurance Amount (PIA) -- The PIA is the basis for all benefit payments made on a worker's earnings record. There are several steps in computing the PIA. *Base years* are computed as the years after 1950 up to the first month of entitlement to retirement benefits begins. For survivor benefits, base years include the year of the worker's death.

Elapsed years are computed as those years after 1950 (or after attainment of age 21, whichever occurs later) up to (but not including) the year of first eligibility. The maximum number of elapsed years for an earnings record is 40 (it could be shorter, for purposes of calculating survivor benefits if the person dies prior to age 62).

Computation years are calculated as the number of elapsed years less five or 2, whichever is greater. Earnings in base years (up to the maximum taxable limit in each year, and through age 60 or two years prior to death, whichever occurs earlier) are wage-indexed according to economy-wide average wages. Of these, the highest earnings in years equaling the number of computation years are added together and the sum is divided by the number of months in computation years to yield *Average Indexed Monthly Earnings* (*AIME*).

Bend Points -- The AIME is converted into a PIA using a formula with *bend points*. The bend point formula is specified as 90 percent of the first X dollars of AIME plus 32 percent of the next Y dollars of AIME plus 15 percent of the AIME in excess of Y dollars. The dollar amounts X and Y are also wage indexed and are different for different eligibility years. The dollar amounts pertaining to the year of attaining age 60 (or, for survivor benefits, the second year before death, whichever is earlier) are applied in computing the PIA.

Benefits- A person who begins to collect benefits at his or her "normal retirement age" (currently age 65) receives the PIA as the monthly retirement benefit. In subsequent years, the monthly benefit is adjusted according to the Consumer Price Index (CPI) to maintain its purchasing power.

Increases in Normal Retirement Ages -- After 2003 normal retirement ages are scheduled to increase by 2 months for every year that a person's 65th birthday occurs later than the year 2003. This progressive increase in the normal retirement age for those born later ceases between the years 2008 through 2020; those attaining age 65 in these years have a normal retirement age of 66. The postponement in retirement ages resumes after 2020 such that those born after 2025 have a normal retirement age of 67. All cohorts attaining age 65 after that year have a normal retirement age of 67.

Reductions for Age -- A person who begins to collect retirement benefits earlier than the normal retirement age receives a *reduction for age.* The reduction factor is 5/9 of 1 percent for each month of entitlement prior to the normal retirement age. The reduced benefit payment (except for the inflation adjustment) continues even after the person reaches or surpasses the normal retirement age. If the number of months of reduction exceeds 36 months (for example, in case of entitlement at age 62 when the normal retirement age is 67), then the reduction factor is 5/12 of 1 percent for every additional month of early entitlement.

Delayed Retirement Credits--Those who begin to collect benefits after their normal retirement age (up to age 70) receive *delayed retirement credits*. The amount of the delayed retirement credit for each month of delayed entitlement depends on the year in which a person attains normal retirement age. For example, those attaining age 65 in 1997 receive an additional 5 percent in monthly benefits for each year of delay in entitlement. However, those attaining age 65 in the year 2008 will receive an additional 8 percent in benefits for each year of delayed entitlement.

Earnings Test -- If a person continues to work and earn after the month of entitlement, benefits are reduced because of an *earnings test*. Beneficiaries under the normal retirement age, lose $1 for each $2 earned above an earnings limit. Those older than the normal retirement age, lose $1 for each $3 earned above a higher earnings limit. The earnings limits have already been specified through the year 2000 and are scheduled to grow with average wages in subsequent years. All benefits payable on a worker's earnings record, including the worker's own retirement benefits and spousal and child dependent benefits, are proportionally reduced by the testing of the worker's earnings.

Recomputation of Benefits -- Earnings in any year after entitlement to benefits are automatically taken into account in a recomputation of the PIA for determining the subsequent year's benefit amount. However, these earnings are not indexed before they are included in the AIME calculation. If such earnings are higher than some prior year's earnings (indexed earnings through age 60 or unindexed earnings after age 60) , they result in an increase in the PIA and benefit payable. If they are lower than all previous year's earnings, they will not lower the PIA or benefits since only the highest earnings in base years are included in the calculations.

Spousal and Child Dependent Benefits

Eligibility -- Wives and husbands of insured workers (including divorced spouses) are entitled to *spousal benefits* if the couple was married for at least 10 years at the time of application for spousal benefits, the spouse is over age 62 or has in care a child under age 16 entitled to benefits under the insured worker's record, and the insured worker is collecting retirement benefits. Children of insured workers under age 16 are entitled to *child dependent benefits* if the child is unmarried and the worker is collecting retirement benefits.

Benefits -- Spousal and child benefits equal 50 percent of the insured worker's PIA (each). Child dependent benefits may be lower only if the *family maximum* applies. Spousal benefits may be lower due to the family maximum, a reduction for age, the application of the earnings test, or the spouse's receipt of retirement benefits based or her or his own earnings record.

Family Maximum -- All benefits paid under a worker's record (except retirement benefits or divorced spousal benefits) are reduced proportionately to bring them within the family maximum benefit level. The maximum benefits payable on a worker's earnings record is determined by applying a bend point formula to the PIA similar to that applied to the AIME in calculating the PIA. For example, the family maximum equals 150 percent of the first $X of PIA plus 272 percent of the next $Y of the PIA plus 134 percent of the next $Z of the PIA plus 175 percent of the PIA greater than $X+$Y+$Z. The values X, Y, and Z are adjusted for each year of the calculation according to the growth in economy-wide average wages. In case the spousal benefit is eliminated for any reason, the benefits payable on the insured worker's record are subjected to the family maximum test again, treating the spouse as though he/she were not eligible for spousal benefits. This may result in higher benefits for children who may be eligible for dependent benefits under the worker's record.

Reduction of Spousal Benefits for Age -- Spouses eligible for the spousal benefit may elect to receive (may become entitled for) their benefits before normal retirement age. In this case the spousal benefit is reduced by 25/36 of 1 percent for each month of entitlement prior to normal retirement age. If the number of months of reduction exceeds 36 months (for example, in case of entitlement at age 62 when the normal retirement age is 67), then the reduction factor is 5/12 of 1 percent for every additional month of early entitlement.

Earnings Testing of Spousal Benefits -- If a spouse is earning above the amount allowed by the earnings test, the spousal benefits he or she is eligible to receive will be earnings tested according to the pre- and post-normal retirement schedule described above.

Redefinition of Spousal Benefits -- If a spouse is already collecting retirement benefits, the spousal benefit is redefined as the greater of the excess of the spousal benefit over the spouse's own retirement benefit or zero.

<u>Survivor Benefits (Widow(er), Father/Mother, and Children)</u>
Eligibility-- The surviving spouse of a deceased worker is eligible for *widow(er) benefits* if the widow(er) is at least age 60, is entitled (has applied for widow[er] benefits), the worker died fully insured, and the widow(er) was married to the deceased worker for at least 9 months. The widow(er) of a deceased worker is eligible for *father/mother benefits* if the widow(er) is entitled to benefits (has applied), the worker died fully insured, the widower has in care a child of the worker. A surviving child is eligible for *child survivor benefits* on the deceased worker's record if the child is under age 18 and is entitled (an application has been filed) and the worker was fully insured.

Survivor Benefits-- Monthly benefits equal 100 percent of the worker's PIA for a widow(er); they equal 75 percent of the PIA for father/mother and child survivor benefits. Widow(er) and child survivor benefits may be lower only if the family maximum applies. Widow(er)s may become entitled to (elect to receive) survivor benefits earlier than normal retirement age, but not earlier than age 60. In this case the reduction is 19/40 of 1 percent for each month of entitlement prior to normal retirement age. After the widow(er) is 62, he or she is may become entitled to (elect to receive) retirement benefits based on her own past covered earnings record. In this case the widow(er) benefits are redefined as the excess over own retirement benefit or zero, whichever is greater. Finally, widow(er) survivor and own retirement benefits are also subject to the earnings test. If the deceased worker was already collecting a reduced retirement insurance benefit, the widow(er)'s benefit cannot be greater than the reduced widow(er) benefit or the greater of 82.5 percent of the worker's PIA or the worker's own retirement benefit. If the deceased worker was already collecting a retirement insurance benefit greater than the PIA because of delayed retirement, the widow(er) or is granted the full dollar amount of the delayed retirement credit over and above the (reduced) widow(er) benefit. Father/mother benefits are not similarly augmented by delayed retirement credits that the deceased worker may have been receiving.

Father/Mother Benefits -- These benefits may be reduced if the family maximum applies or if the father or mother is entitled to the own retirement benefit. In this case the father/mother benefit is redefined as the excess over the father or mother's own retirement benefit or zero, whichever is greater. Father /mother benefits are also subject to the earnings test. On the other hand, they are not reduced for age. For those eligible to receive both widow(er) and father/mother benefits, the program calculates both and takes the larger benefit.

Calculation of a Deceased Worker's PIA -- The calculation of survivor benefits in the case of a widow(er) benefits uses the larger of two alternative calculation's of the deceased worker's PIA. These are the "wage indexing" method and the "re-indexing" method. Moreover, the year up to which the worker's wages are indexed may be different depending upon whether the deceased worker would have become age 62 before or after the widow(er) attains age 60.

The wage-indexing method -- the last year for indexing earnings is the earlier of a) the year the worker dies minus 2 years or b) the year worker would have attained age 60. Bend point formula dollar amounts are taken from the earlier of the year the worker dies or the year the worker would have attained age 62. The PIA thus calculated is inflated by the CPI up to the year the widow(er) turns age 60 (if later) to obtain the PIA value on which widower benefits would be based. Where applicable, these benefits are then adjusted for the family maximum, reduction for age, delayed retirement credits, and the earnings test.

The reindexing method -- The worker's original earnings are indexed up to the earlier of the year the widow(er) attains age 58 or b) the year the worker attains age 60. The elapsed years are computed as the number of years from 1951 (or the worker's age 22 if later) through the year the widow(er) attains age 60. The computation years equal elapsed years minus 5 years (computation years cannot be less than 2). Bend point formula dollar values are applied from the year the widow(er) attains age 60. There is no subsequent indexing of the PIA for inflation.

The Sequencing of Widow(er) Benefit Calculations -- Widow(er) benefit reductions proceed in a particular sequence: First the widow(er) plus children's benefits are subjected to the family maximum. Second, the widow(er) benefit is reduced for early entitlement (of the widow(er) prior to normal retirement age). Third, the widow(er) benefit is compared to the widow(er) own retirement benefit if entitled to the latter. Fourth, the widow(er) benefit is redefined as the excess over own benefit if own benefit is positive. Finally the earning's test is applied, first to the widow(er)'s own benefit and then to the widow(er) benefit that is in excess of own benefit. If the widow(er) benefit is eliminated as a result of these tests, the benefits payable on the insured worker's record are subjected to the family maximum test again, treating the widow(er) as though he/she were not eligible for the widow(er) benefit. This procedure can potentially increase children's benefits if the family maximum limit was binding the first time through.