CHAPTER 9

SSASIM

SOCIAL SECURITY POLICY SIMULATION MODEL

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SOCIAL SECURITY POLICY SIMULATION MODEL

I. OVERVIEW

SSASIM is policy simulation model of the Old Age and Survivors Insurance (OASI) and the Disability Insurance (DI) Social Security programs. The model can also simulate a variety of incremental reforms in these two existing defined-benefit programs, as well as a range of structural reforms that introduce a defined-contribution tier into Social Security.

The specified policies assumed for a model run define that run's *policy regime*. The implications of a reform relative to current-law policy are determined by comparing the output results from a *model run* that assumes the reform policy regime with results from a run that assumes the current-law policy regime.

The model simulates a policy regime for any specified number of years into the future. It represents the population with age-gender cells – as in the model used by the Social Security Administration's Office of the Actuary to produce the annual OASDI Trustees' Report and reform analysis – rather than with a representative sample of individuals (as in a microsimulation model).

The model can be run in several different *simulation modes*. First, assumptions used to generate aggregate program cost and income can be either deterministic or stochastic. In the deterministic-assumption mode the time paths of the major demographic and economic assumption variables are fixed, while in the stochastic-assumption mode the time paths of the variables for each *simulation scenario* are drawn from an assumed probability distribution using Monte Carlo methods. Risk is measured by how much the implications of a policy regime vary across scenarios.

Second, the model can be run in either an exogenous-growth mode or in an endogenous-growth mode. When growth is endogenous the implications of the specified policy regime feed back through national savings and investment to influence the rate of economic growth.

Third, the model can produce birth cohort life histories of up to nine men and up to nine women who may be paired into married couples and can calculate various policy performance measures (replacement rate, rate of return, etc.) for each individual and couple. These life histories can be generated in one of two modes. In the certain-lives mode, each cohort individual's age of

disability and age of death is fixed. In the uncertain-lives mode, disability and death occur at ages that are determined by age- and gender-specific disability incidence and mortality rates, as explained below. The model can be run, therefore, in one of eight combinations of simulation modes.

II. DESCRIPTION

Model Architecture

The SSASIM model was designed with a modular architecture, dividing the model into a number of separate computer programs, each one of which specializes in providing one kind of service. The objective is to increase productivity from the specialization allowed by the division of labor among component programs. Data-handling tasks can be assigned to a relatively inexpensive, mass-marketed database management program that has superior data retrieval and ease-of-use features. Repetitive Monte Carlo calculations can be performed by a compiled program that has been custom designed to do the necessary simulation computations. Statistical analysis and visualization of the simulated output can be done with relatively inexpensive, mass-marketed spreadsheets or statistical packages.

The basic structure of the SSASIM model is shown in Figure 1. The model consists of two sets of data files on disk and three separate kinds of computer programs. The two sets of data files are: the input database, and several output results files for each model run, which consists of the simulation of one policy regime under one set of assumptions and one combination of simulation modes. The three computer programs are: a database interface, a stochastic simulator, and one or more output analyzers.

Database Interface

The model's database interface program is a relational database management system that reads from and writes to the model's input database. The database interface program is a customized version of Microsoft Fox-Pro, which is a relatively inexpensive, full-featured database management system.

Input Database

The model's input database is organized as a relational database. Relational databases facilitate the organization of complex data on the attributes of and relationships between several different kinds of objects in a way that is intuitive, efficient, and flexible.

Figure 1

Structure of SSASIM

FIGURE I

Structure of SSASIM

Source: Martin R. Holmer, *Introductory Guide to SSASIM – 2/15/99 Version,* February 15, 1999

Stochastic Simulator

The model's stochastic simulator program reads model input parameters and historical demographic and economic data from the input database, performs the requested run, and writes detailed simulation output and summary results to text files. The simulator processes one or more scheduled model runs automatically in a non-interactive manner.

The stochastic simulator program is written in the CORSIM++ language and is organized in a modular fashion using CORSIM++ classes that correspond to real world entities related to Social Security.

Output Results

The model's output results are text files that have been formatted to look like relational database tables. There is a set of output results files produced by the simulator during the course of each model run. The model user can save the output results from many different runs and compare results across runs long after the model runs were processed by the simulator.

Output Analyzer

The model's output analyzer program can be any software program that is appropriate for the desired post-simulation analysis of the output results. The output results are formatted in a manner that allows them to be easily imported into a wide variety of commercial data analysis or spreadsheet programs to permit statistical analysis of the simulation output, output visualization, and preparation of presentation graphics.

Simulation Modes

This section describes how Monte Carlo methods are used to implement the stochastic-assumption simulation mode and how the endogenous-growth and uncertain-lives simulation modes are implemented.

Monte Carlo Methods for Stochastic Assumptions

The model utilizes Monte Carlo simulation methods to derive the policy implications of uncertainty about the future values of major demographic and economic assumption variables. The use of Monte Carlo methods requires the description of future variable values with probability distributions rather than point estimates. These probability distributions specify expectations about the future value of the assumption variables.

Each model run draws from these probability distributions to generate the time path of assumption variables for each scenario. These randomly drawn assumptions are used to calculate for that scenario the implications of the run's assumed policy regime. The model permits the specification of correlations among assumption variables (such that draws from the distributions are statistically related) and of feedback links (so that future values of variables are affected by prior values of other variables) so that complex interactions between Social Security operations, demographic variables, and economic variables can be represented.

In accordance with Monte Carlo simulation methods, the model performs these scenario calculations repetitively, generating as many scenarios as specified for the run in the input database. Often one thousand scenarios are specified for a model run to ensure that the statistical precision of the output results is sufficient for the analytical purpose of the run. After each scenario's calculations are completed, detailed output and summary results are collected. After all a run's scenarios have been calculated and the scenario results collected, the model writes all the scenario values for each specified collection of output variables to a set of output result files. These files are then available for statistical summarization or visualization using an output analyzer program.

Embedded Economic Growth Model for Endogenous Growth

An economic growth model is integrated into the broader Social Security model. There are input links through which the broader model's variables affect the growth model's input variables. For example, the broader model's employment and productivity growth rate variables directly determine the growth model's corresponding input variables. Social Security program finances (including individual account finances if specified in the policy regime) affect the growth model's national saving and investment rate. There are output links through which the growth model's output variables feed back to influence variables in the broader model. For example, faster growth leading to higher output causes Social Security taxable earnings to be higher. Changes in the growth model's marginal productivity of capital causes changes in the broader model's asset returns.

Embedded Microsimulation Model for Uncertain Lives

The embedded microsimulation model generates life histories for up to nine men and up to nine women who are members of the same birth cohort and who may be paired in as many as nine married couples. The model can simulate life histories for cohort individuals born in 1930 and following years.

Depending on the specified input parameters, the generated life histories may be as stylized as those used in conventional Social Security analysis, or they may be more realistic exhibiting career earnings growth, periods of non-employment, disability risk, and an uncertain age of death. Given a simulated life history, the embedded microsimulation model also calculates lifetime Social Security taxes (and account contributions) as well as lifetime benefits (and account withdrawals including annuity payments) under the policy regime assumed for the model run and birth cohort. The model

uses these lifetime benefits and taxes to calculate present values, program rates of return, payback ratios, as well as more traditional measures such as replacement rates and benefit levels. The ability to simulate couples allows calculation of survivors' benefits in addition to spouses' retirement and disability benefits. Although the embedded microsimulation model does not process a large, representative sample of individuals in a birth cohort, it can generate a limited number of life histories and policy performance measures for the specified individual and couples. When the SSASIM model is run in stochastic mode, the variation across scenarios in life histories and policy performance measures is induced by variation in the cohort's demographic and economic environment and by individual disability and mortality risks. The distribution of policy performance measures across these stochastic scenarios can be used to assess the degree of risk inherent in the simulated policy regime and can be compared with distributions produced by other policy regimes.

Simulator Logic

The model's stochastic simulator is quite complex since it must represent both the internal dynamics of, and the interactions between, the population, the economy, and Social Security programs. The model relies on probability distributions that represent expectations concerning the major assumption variables, correlations between these assumption variables, feedback links between variables, and the internal procedural logic of the model, to represent population dynamics, economic development, and the workings of Social Security programs.

The simulator is composed of discrete modules that correspond to real-world entities and perform functions related to those entities in the simulation process. Links between the modules are of two kinds. First, there are recursive links, in which current-year variable values produced by module are used in current-year calculations by another module. And second, there are lagged feedback links, in which the current-year variable values are used in the following year for calculations in another module. The use of lagged feedback links with a recursive module structure avoids the computational burden of simultaneous equation solution while allowing a reasonable characterization of general equilibrium interactions over the long time path of each simulation scenario.

Figure 2 presents a graphical representation of the structural relationships among the simulator's component modules, which are represented by boxes. Selected recursive links are represented with downward-pointing, solid-line arrows; lagged feedback links are represented by upward-pointing, broken-line arrows. The individual account module, which is not shown in this figure, is at the same level as the trust fund module, has the same recursive and lagged feedback links as the three Social Security modules.

Figure 2

Modular Structure of the Stochastic Simulator

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FIGURE 2

MODULAR STRUCTURE OF THE
STOCHASTIC SIMULATOR
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Source: Martin R. Holmer, *Introductory Guide to SSASIM – 2/15/99 Version,* February 15, 1999

Individual modules (represented as boxes), selected recursive links (marked with numbers), and lagged feedback links (marked with lowercase letters) are described in the text. The individual account module, which is not shown in this figure, is at the same level as the trust fund module, has the same recursive and lagged feedback links as the three Social Security modules. The key stochastic assumption variables include: A, interest rate, corporate bond return, equity return; B, inflation; C, productivity growth, wage-share growth, hours-worked growth; D, female and male labor force participation, unemployment; E, fertility, immigration, mortality decline, disability incidence, disability recovery.

After reading the model's input database for the run specification (starting variable values, expectations distributions, policy regime parameters, behavioral response coefficients, etc.), the stochastic simulator does the following for each multiple-year scenario in the run: First, the simulator randomly samples time paths for the assumption variables from their expectations distributions. Second, the simulator repeats a set of computations for each year in the scenario, in which the variables describing the status of the population, economy, and Social Security program at the end of the prior year are translated into values that describe the population, economy, and program status at the end of the current year. Third, the simulator saves results for that scenario for subsequent writing to the run's output results files.

Each year's calculations involve a large number of recursive links among the simulator's modules. The recursive links shown in Figure 2 on the following page are as follows:
(1) Population in each age-gender cell is used to calculate employment in each cell.
(2) Price levels are used to convert real values into nominal earnings and nominal output.
(3) Aggregate employment is used to calculate aggregate real output and aggregate real earnings. (4) The level of aggregate earnings is used to calculate covered earnings and taxable payroll.
(5) The rate of price in ation is used to calculate cost-of-living adjustments to Social Security benefits.
(6) The level of nominal earnings is used to calculate Social Security indexed earnings for age-gender cells near retirement.
(7) Employment in age-gender cells is used to calculate indexed earnings for age-gender cells near retirement.
(8) Population in age-gender cells and the disability incidence and recovery factors are used to calculate the number of beneficiaries in each age-gender cell.
(9) Social Security benefit amounts are used to calculate income tax revenue derived from taxing benefits.
(10) Returns on different asset classes are used to calculate investment income to the Social Security trust funds.
(11) Payroll and income tax revenue are used to calculate income to the trust funds.
(12) Beneficiaries and their average benefit levels are used to calculate benefit and administrative expenses paid from the trust funds.

Lagged feedback links allow for the current-year values of variables to influence the subsequent-year values of other variables. The lagged feedback links shown in Figure 2 are as follows: (a) Social Security trust fund and/or individual account asset allocation policies affect relative return spreads of equity to bonds (not yet implemented). (b) Social Security benefit policies affect retirement timing decisions (not fully tested). (c) Social Security trust fund and individual account finances affect (in the endogenous-growth simulation mode) national saving, investment, and output, which also affects the marginal productivity of capital and hence the level of asset returns in the capital markets. (d) Social Security benefit policies affect private retirement saving rates (not yet implemented).

Assumption Dynamics

The stochastic simulator randomly generates values of the assumption variables for each scenario using the expectations specified by the policy analyst. The values for each assumption variable are a time series because the simulator's annual computations require a value for each assumption variable in each future year of the scenario. The structure of the multivariate stochastic process assumed to generate these sampled time series can accommodate a number of different methods of characterizing assumption dynamics, including the method used in the Trustees' Report.

The Trustees' Report assumes a no-cyclical-fluctuations kind of time series for each assumption variable. Each variable is assumed to move linearly from its starting value to its ultimate value over the course of a fixed transition period. In every year following the transition period, the value of the variable is assumed to equal its ultimate value. This formulation implies that the whole time series can be describe by a single future value – the variable's assumed ultimate value.

Foster in a Social Security Actuarial Study (1994) has used univariate autoregressive processes to represent the assumption dynamics of several economic variables that are important in the short-run current-law projection presented in the Trustees' Report. This kind of stochastic process is more realistic than the kind used in the Trustees' Report because it generates time series for the assumption variables that exhibit cyclical fluctuations.

The multivariate stochastic process that generates time series for the SSASIM assumption variables is similar to that used by Foster (1994). The current version of the simulator has thirteen major assumption variables that are assumed to be stochastic: total fertility rate, net immigration flow, mortality decline rate, female labor force participation rate, male labor force participation rate, unemployment rate, inflation rate, productivity growth rate, wage share growth rate, hours worked growth rate, nominal interest rate, disability incidence rate, and disability recovery rate. Stochastic values for corporate bond and equity returns are also generated stochastically.

The simulator's assumptions module utilizes a very general kind of multivariate stochastic process that produces both cross-sectional correlation between the different variables and time-series fluctuations or cycles in the values of an individual variable. The value of an individual variable in a particular year is generated as the sum of a trend term and a deviation term.

A variable's trend term is assumed to start at its last observed historical value, move to its randomly generated ultimate value over a transition period following a linear trend (with an optional kink point), and stay at that ultimate value in all years following the transition period. The ultimate trend term values of the stochastic variables are generated for each scenario by drawing from a multivariate normal distribution, whose means, standard deviations, and correlation coefficients are specified to represent the policy analyst's expectations about the uncertainty in the ultimate trend term values for the stochastic assumption variables.

This formulation provides considerable flexibility in representing expectations about the long-run movement of the stochastic input variables. A policy analyst can specify a certain historical trend (that is, starting and ultimate values equal to the historical value and zero variance for the ultimate value) or an uncertain trend that differs substantially from that experienced in the past.

Specifying a zero variance for the error term will produce zero deviation values for all future years. This special case corresponds to a stochastic process that generates values in accordance with the Trustees' Report method.

III. Data

Data used to estimate the macroeconomic model are obtained from two sources. Yields on Treasury bonds (representing nominal interest rates) and inflation rates were taken from *Stocks, Bonds, Bills and Inflation: Market Results for 1926{1994*, Chicago: Ibbotson Associates, 1995. Unemployment data were taken from various editions of the U.S. Department of Commerce's *Statistical Abstract of the United States*, published by the U.S. Government Printing Office. Annual data for the period 1926{1994 were obtained for all three variables. The three variables in the macroeconomic model are defined as follows:
Interest rate. The yield on long term Treasury bonds with maturities of approximately twenty years. The yield is defined as the internal rate of return that equates the bond's price (the average of bid and ask, plus the accrued coupon) with the stream of cash flows (coupons and principal) promised to the bondholder.
Inflation rate. The change in the Consumer Price Index for All Urban Consumer (CPI-U), not seasonally adjusted, measured in December of each year. Prior to 1978, the CPI (instead of the CPI-U) was used.
Unemployment rate. The fraction of the civilian labor force unemployed, as defined by the U.S. Bureau of Labor Statistics (BLS). For years prior to 1947, BLS included persons 14 years and older. After 1947, BLS included only persons 16 years and older in its labor force statistics.

In order to insure that the stochastic simulator generates values within logically acceptable ranges, the macroeconomic variables are transformed as follows. Interest rates, as measured by long term Treasury bond yields, are expressed as deviations from the average value in this historical sample, where values are expressed as the natural logarithm of the decimal rates. Inflation rates are expressed as deviations from the sample average value, where values are expressed as annual decimal (not percentage) rates. Unemployment rates are expressed as deviations from the sample average value, where values are expressed as the natural logarithm of the odds of the rates.

Data to estimate rates of returns on securities are from the following sources. Returns on Treasury bonds, corporate bonds and equities, as well as yields on Treasury bonds and inflation rates were taken from *Stocks, Bonds, Bills and Inflation: Market Results for 1926{1994*, Chicago: Ibbotson Associates, 1995. Annual data for the period 1926{1994 were obtained for all three variables.

The three asset returns are defined as follows:

Treasury bond return. The total annual return, assuming that bonds are held for the entire calendar year, of long term Treasury bonds with maturities averaging approximately twenty years. Total returns account for both income returns (returns from coupon payments) as well as capital gains and losses.

Corporate bond return. Same as above except that the bonds used are long-term corporate bonds, as represented by the Salomon Brothers long-term high-grade corporate bond index.

Equity return. The total annual return on U.S. large company common stocks, as represented by the Standard & Poor's 500 index. Total return includes reinvested dividends.

ANNEX 9-1

SSASIM

SUMMARY DESCRIPTION

SSASIM
Summary Description

Model Overview

Subject: U.S. Social Security System

Purpose and Objective of Model

SSASIM is a stochastic, cell-based simulation model with endogenous economic growth that is designed to conduct OASI and DI policy analysis, including OASI individual account reforms. It may be considered a generalization of the actuarial model used by the SSA Office of the Actuary.

Period of historical analysis: Annual data, 1926-1992

Forecast/simulation horizon

1992 to any specified number of years into the future. Typically, scenarios will be at least eighty years in order to calculate program summarized cost and income rates over the Trustees' Report's 75-year analysis period. Often, scenarios are much longer (e.g., about 160 years) so that lifetime policy performance measures can be calculated for cohorts born in the future.

Frequency :Annual

Base year: 1992.

Simulation technique

Monte Carlo simulation. Values are assigned randomly to each of the 13 key demographic, economic, and disability assumption variables highlighted in the Trustees' Report, based on an assumed joint distribution of these variables, and the OASDI system is simulated. Each simulation of the model then represents a draw from this joint distribution. Multiple simulations of the model then generate a distribution of model outcomes, for the given assumed joint distribution of input variables.

Solution algorithms and structure: Annual solution; recursive within each year; transition matrices.

Unit(s) of analysis

SSASIM represents the population with 252 age-gender cells (people's ages range from 0 for newborns to 125 for the very oldest) and represents productive economic establishments with an aggregate Cobb-Douglas production function that is embedded in neoclassical growth model.

Cell Structure

SSASIM has 252 cells that represent population's age and gender composition and a single "cell" (i.e., one-sector) representation of the business sector.

Databases
Base Year Database

> SSASIM uses base-year population and OASDI data that are publicly available or, in some cases, were made available from the SSA Office of the Actuary. The base-year values for the business sector were drawn from publicly available BEA sources.

Population/demographics

> SSASIM uses actual age-gender population counts for the base year. The population is simulated into the future using fertility, immigration, and mortality assumptions similar to those used in the Trustees' Report.

Individual/family/household characteristics

> SSASIM is not a microsimulation model, and therefore, has no socioeconomic detail below the population cell level.

Employer characteristics

> SSASIM does not characterize individual businesses, and therefore, has no employer characteristics.

Industry characteristics

> SSASIM represents the business sector with an aggregate production function, and therefore, has no industry characteristics.

Retirement plan coverage, participation

> The only "retirement plans" SSASIM characterizes are the federal-government sponsored OASI and DI programs. No employer-sponsored plans are represented in the current version of SSASIM.

Retirement plan vesting

> No retirement plans other than the OASI and DI programs are currently represented in SSASIM.

Retirement plan characteristics

> No retirement plans other than the OASI and DI programs are currently represented in SSASIM.

Individual Retirement Account (IRA) participation, contributions

> The current version of SSASIM represents are wide range of mandatory OASI individual accounts schemes that can be specified by the policy analyst to completely or partially replace the current defined-benefit OASI program. However, no voluntary IRA accounts are represented in the current version of the model.

Supplemental Security Income (SSI) eligibility, participation

The current version of SSASIM does not represent the SSI program.

Family assets

No individual retirement assets are represented in the current version of SSASIM, other than those in mandatory OASI individual accounts.

Home ownership

Home ownership is not represented in the SSASIM model.

Macroeconomic data

SSASIM simulates the interest rate, unemployment rate, and inflation rate , as well as labor force participation, the aggregate capital stock, and the level of labor efficiency, allowing the simulation of GDP in future years. Cyclical fluctuations in the unemployment rate and the saving rate cause cyclical fluctuations in GDP as it grows over the long term.

Labor market data

SSASIM simulates aggregate male and female labor force participation rates and unemployment rate (three of the 13 key stochastic assumption variables), which are translated into employment levels in each age-gender population cell using data provided by the SSA Office of the Actuary.

Retirement behavior

The structural benefit algorithm used in most SSASIM runs used Markov transition probability matrices to predict the number of people in each age-gender population cell moving onto or off of the OASI and DI programs. The initial receipt of program benefits is the closest event in SSASIM to retirement.

Taxes

Aggregate OASDI taxable earnings, OASI and DI payroll tax revenues, and OASI and DI trust fund revenues from the income taxation of social security benefits are all represented in SSASIM.

Health conditions, disability

Two of the 13 key stochastic assumption variables used in SSASIM represent aggregate DI incidence and DI recovery rates, the levels of which affect the number of people moving onto and off of the DI program. Fluctuations in the future values of these two variables may be interpreted as indicators of the health status of the population, or of the administrative permeability of the DI program.

Health insurance coverage

The current version of SSASIM does not represent HI (Medicare), and probably will never represent Medicaid, employer-sponsored health insurance, or any other kind of private health insurance.

Institutional population characteristics

SSASIM does not represent the institutionalized population separately from the total population.

Data Quality

Completeness

The aggregate data used in SSASIM is complete; the model's scope is less than complete because it focuses on just the OASI and DI programs.

Accuracy

The aggregate data used in SSASIM is accurate.

Representative

The aggregate data used in SSASIM is representative of the whole population and economy; it is not representative of any particular population subgroup (other than age-gender cells) or any particular business sector.

Currency

The aggregate data used in SSASIM to represent the last known historical year is for 1992.

Applicability to other contexts

Some of the aggregate data used in SSASIM could be useful for other kinds of policy analysis.

Gaps

Given the scope of SSASIM, there are no gaps in the aggregate data. However, additional information about the magnitude of various behavioral response parameters would be quite useful.

Applicability of other private/consulting firm data

Whether or not other data could be used in SSASIM to advantage depends on the nature of those other data.

Characteristics, activities, behaviors that are modeled

Demographic characteristics

Fertility, immigration, and mortality are modeled in SSASIM.

Economic activity

Labor force participation and unemployment rates, inflation rate, interest rate, and saving, investment, and capital depreciation, are all modeled in SSASIM.

Short-run/cyclical

The three macroeconomic assumption variables (inflation, unemployment, and interest rates) are modeled using an embedded vector autoregressive (VAR) model that generates short-run fluctuations around the long-run trends in these three variables.

Long-run growth, productivity

SSASIM represents long-run economic growth and productivity growth using an embedded neoclassical growth model.

Inflation

Long-run, ultimate value in each scenario is drawn from a user-specified normal distribution; short-term fluctuations around the trend value determined by the embedded macroeconomic VAR model.

Industrial sector detail

None.

Open or closed economy

Closed economy.

Labor market behavior

Trends in male and female labor force participation rates can be assumed; trend in aggregate unemployment rate can be assumed; short-term fluctuations in the unemployment rate can be generated by the embedded macroeconomic VAR model. SSASIM contains empirically based age-earnings profiles for men and women, which means that earnings levels over a birth cohort's lifetime are more realistic than assuming (as is done in the SSA Office of the Actuary model) a flat, unisex age-earnings profile.

Capital markets

National saving, domestic investment, and capital accumulation are part of the embedded neoclassical economic growth model. Stochastic asset returns for Treasury bonds and corporate bonds (which have a spread over Treasuries) are generated from the embedded macroeconomic VAR model's interest rates. Stochastic asset returns for equities (represented by the S&P500 index) are generated from a stochastic process that depends

slightly on current and lagged values of the three macroeconomic variables and mostly on the variance in the equity return error term. The mean equity return is directly influenced by the marginal productivity of capital implied by the embedded neoclassical economic growth model. This linkage means that, for example, future Social Security deficits cause, other things equal, a decline in national saving and domestic investment, which causes a lower economic growth rate and a higher marginal productivity of capital, and hence a higher mean equity return, than if there had been no Social Security deficits.

Retirement program characteristics

The only retirement programs that SSASIM represents are the OASI and DI programs.

Retirement behavior

The timing of OASI and DI receipt, which is the closest event to retirement in SSASIM, is modeled using age- and gender-specific Markov transition probabilities of moving onto and off of each program. The affect on these transition probabilities of any policy reform must be estimated by the model user.

Savings and asset accumulation

The national saving rate is assumed to be constant except for the effects of certain OASDI reform-induced changes in national savings (e.g., the introduction of mandatory OASI individual saving accounts), which include both direct and indirect or offset effects. The SSASIM model does not represent the accumulation of any retirement assets outside of such OASI saving accounts.

Government behavior

Limited to assumptions about OASDI policy and to assumptions about whether changes in the OASDI budget deficit would be offset to any degree by changes in the non-OASDI government deficit.

Federal budget

See response under "Government behavior" above.

Social Security and Health Insurance Trust Funds

SSASIM contains a detailed representation of the OASI and the DI trust funds. Trust fund income includes payroll taxes as well as a share of federal income revenue generated by the taxation of Social Security benefits. Trust fund outgo includes benefit payments and administrative costs. In addition to income and outgo, the asset holdings of the trust fund are characterized in the exact detail described in the Trustees' Report. This means that not only the bond holding of the trust fund by maturity and coupon rate are simulated into the future, but that the interest income to the trust fund is calculated. There are capabilities to specify a wide range of alternative asset allocation rules for the trust fund (including some degree of equity investment) as well as to calculate the contingent payroll tax rate that would be required to avoid trust fund deficits in each future scenario year.

Regulations

None are included except if the trends in the assumed DI incidence and recovery factors are interpreted as, at least partially, measuring changes in DI administrative procedures rather than measuring only the health status of the population.

Taxes

SSASIM represents the payroll tax for the OASI and the DI programs, as well as the trust fund revenues generated by the income taxation of Social Security benefits.

Public retirement income programs

Social Security Retirement, Disability and Survivors Insurance

SSASIM represents the OASI and the DI programs.

Means tested old age or disability income transfers

SSASIM does not represent the SSI program.

Government employee pension programs

Federal civil service

SSASIM does not represent federal government employee pensions.

Military

SSASIM does not represent military pensions.

Provincial and local government, types

SSASIM does not represent state or local government employee pensions.

Private pensions

Defined benefit

SSASIM does not represent private employer-sponsored pensions.

Defined contribution

SSASIM does not represent private employer-sponsored pensions.

Supplemental

SSASIM does not represent private employer-sponsored pensions.

Individual retirement saving arrangements (IRA, Keogh, etc.)

SSASIM does not represent any existing voluntary individual retirement saving arrangements.

Public sector health care finance programs

Medicare

The current version of SSASIM does not represent the HI (Medicare) program.

Medicaid

SSASIM does not represent the Medicaid program.

Military

SSASIM does not represent military health insurance programs.

Veterans

SSASIM does not represent veteran health insurance programs.

Indian Health Service and others

SSASIM does not represent Indian health insurance programs.

Private sector health care finance programs

SSASIM does not represent any private health insurance programs.

Private health insurance, especially retiree health insurance

SSASIM does not represent any private retiree health insurance programs.

Employer/plan sponsor behavior

None beyond what is encompassed in the aggregate model.

Worker behavior

None beyond what is encompassed in the aggregate model.

Health care provider behavior

None.

Insurer behavior

OASI saving accounts can be (or must be, in some reform options) converted into annuities. The annuity pricing algorithm incorporates insurer behavior if one imagine insurance companies as providers of annuities.

Institutionalization

None.

Assumptions, Parameters, Methodology

Key Assumptions

Input assumptions concerning the 13 key stochastic assumption variables highlighted in Trustees' Report; a broad range of historical starting values for the population, economy, and programs; and a broad range of behavioral response parameters.

Types of Parameters, Decrements, Transition Rates/Probabilities

Too numerous to list; see selective discussion above and below.

Experience considered, origins of decrements

Experience is that of the entire U.S. population.

Consistency with other experience and other assumptions of model

All model assumptions pertain to the whole U.S. population.

Internal consistency

Not aware of any internal inconsistencies.

Methodology used to estimate parameters and relationships

Various econometric methods are described above; other parts of model use what many would call actuarial methods; some behavioral parameters are drawn from other studies or modeling efforts; and others are specified using judgment. Whatever the source of the SSASIM input parameters, they are all contained in an input database, which is read by the model as it starts each run. SSASIM is, therefore, completely database driven, which means a policy analyst using the model can easily change any or all input assumptions without having to modify the logic or code of the model.

Econometric/statistical

See answer above.

Actuarial

See answer above.

Judgmental

See answer above.

Economic/actuarial literature, studies done by others, etc.

See answer above.

Simulation Methodology

SSASIM uses standard Monte Carlo methods to sample the 13 key stochastic assumption variables from their assumed joint distribution.

Stochastic Properties

Monte Carlo methods are inherently stochastic.

Feedback Phenomena

The current version of SSASIM incorporates a number of feedback effects. The embedded neoclassical economic growth model involves several important feedback effects as described above.

Microsimulation adjustment ("aging") methodology (where relevant)

Not relevant for SSASIM because it uses aggregate data.

Policy levers

SSASIM incorporates a wide variety of OASI and DI policy parameters, including payroll tax rates, trust fund asset allocation parameters, initial benefit timing and size parameters, and benefit adjustment policy parameters.

Economic/demographic feedback

Employer costs and behavior

SSASIM does not represent employer costs and behavior in any way beyond what is represented in the aggregate production function and neoclassical economic growth model.

Labor market behavior

The embedded economic growth model determines GDP, which is divided into labor and capital income, and the size of aggregate labor income affects average earnings levels. The use of gender-specific age-earnings profiles are described above.

Taxes, government deficits, etc.

Payroll tax revenues depend on aggregate earnings, and trust fund deficits are totally endogenous as described above.

Capital accumulation

Determined (given the starting-year national saving rate) endogenously as described above.

Interest rates

Determined as described above.

Employment, productivity, economic activity, GDP

Employment determined by population in each age-gender cell, by cell-specific labor force participation and unemployment rates. Productivity determined in the embedded neoclassical economic growth model as described above.

Other

As described above.

Sensitivity Analysis

SSASIM has been used in a wide variety of sensitivity runs.

Model Validation Procedures

SSASIM has been used in a wide variety of "validation" runs, which involve running the model with the same input assumptions as used by another model and determining the comparability of the output results from the two models. This sort of cross-model validation has been conducted by comparing results for the SSA Office of the Actuary's model, which is used to produce Trustees' Report estimates as well as reform analyses, and for the stylized worker lifetime policy performance analysis model described in Steuerle and Bakija, "Retooling Social Security for the 21st Century" (Urban Institute Press, 1994). The results of these cross-model validation exercises indicate that SSASIM produces aggregate financing results and lifetime cohort measures for OASI and DI that are in close agreement with these two other models.

Computer Implementation
Hardware requirements

SSASIM runs on an IBM-compatible personal computer under the Windows NT 4.0 operating system. Processor speed and amount of RAM required to run NT successfully will be sufficient to run SSASIM.

Software

In addition to the SSASIM stochastic simulator program and the SSASIM input database files, the following software is required to run the model: First, Fox Pro (version 2.6 or above) is required to be used as the SSASIM database interface program. Second, some kind of spreadsheet or statistical package is required to conduct post-simulation analysis and graphing of the simulator's output results.

Computer costs

Hardware costs are very low --- for example, in late 1997, Dell is selling a 300 MHz Pentium II machine that would provide a nice platform on which to run the model for about $2,500. The software costs of Fox Pro, etc., would be a few hundred dollars more. And, of course, the runtime computer costs are nil.

Transportability

The SSASIM simulator is written in C++. Because C++ compilers, Fox Pro, spreadsheets, and statistical packages are available under several different operating systems, it would be possible (with some modest degree of effort) to port the model to run under other operating systems.

Applications (Projects, Studies)

SSASIM has been used to analyze the risk implications of investing trust fund balances in equity for the recent Advisory Council on Social Security. It has also been used to analyze the risk and growth implications of individual account reforms to OASI in a December 1996 EBRI policy forum paper and in a longer (June 30, 1997) paper written for EBRI.

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ANNEX 9-2

SSASIM

POLICY MATRICES

SSASIM -- POLICY MATRIX

1. Effects of Policy Measures on Employer Pensions

Outcome Variable ⟍ Policy Input	Offerings	Types of plans and provisions	Costs of plans	Funding	Contributions and benefits
Tax Policy					
Pension					
General					
Social Security					
Retirement age					
Benefit structure					
Indexation					
Payroll tax					
Trust fund investment					
Individual accounts					
Funding and Guarantees					
PBGC premium					
Funding rules					
Pension Regulation, Policy					
ERISA/IRS					
Employer plans					
Pension and saving incentives/mandates					

Blank cell indicates that the effects of the policy issue or input on that outcome cannot be simulated in this model.

NOTE: SSASIM does not represent employer-sponsored pensions.

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SSASIM -- POLICY MATRIX

2. Effects of Policy Measures on Employees

Outcome Variable \ Policy Input	Job availability	Pension portability	DC accumulations, investments, earnings	Pension benefit accruals	Wage & non-wage compen. levels, mix	Incidence and timing of retirement
Tax Policy						
Pension						
General						
Social Security						
Retirement age	X				X	X
Benefit structure	X				X	X
Indexation	X				X	
Payroll tax	X				X	
Trust fund investment	X				X	
Individual accounts	X				X	X
Funding and Guarantees						
PBGC premium						
Funding rules						
Pension Regulation, Policy						
ERISA/IRS						
Employer plans						
Pension and saving incentives/mandates						

Blank cell indicates that the effects of the policy issue or input on that outcome cannot be simulated in this model.

SSASIM -- POLICY MATRIX

3. Effects of Policy Measures on Retirees

Outcome Variable / Policy Input	Payouts	Funded level of (SocSec) plans	Retirement income	Replacement rates	Poverty levels	Health care costs and insurance	Retirement age and labor mkt outcomes	Inflation protection	Auxiliary benefits
Tax Policy									
Pension									
General									
Social Security									
Retirement age	X	X	X	X			X	X	
Benefit structure	X	X	X	X			X	X	
Indexation	X	X	X	X				X	
Payroll tax		X							
Trust fund investment		X							
Individual accounts	X	X	X	X			X	X	
Funding and Guarantees									
PBGC premium									
Funding rules									
Pension Regulation, Policy									
ERISA/IRS									
Employer plans									
Pension and saving incentives/mandates									

Blank cell indicates that the effects of the policy issue or input on that outcome cannot be simulated in this model.

SSASIM -- POLICY MATRIX

4. Effects of Policy Measures on Industry Outcomes

Outcome Variable Policy Input	Financial strength of plans, sponsors, insurers	Labor costs	Profits	Competitiveness
Tax Policy				
Pension				
General				
Social Security				
Retirement age				
Benefit structure				
Indexation				
Payroll tax				
Trust fund investment				
Individual accounts				
Funding and Guarantees				
PBGC premium				
Funding rules				
Pension Regulation, Policy				
ERISA/IRS				
Employer plans				
Pension and saving incentives/mandates				

Blank cell indicates that the effects of the policy issue or input on that outcome cannot be simulated in this model.

NOTE: SSASIM does not represent separate industries.

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SSASIM -- POLICY MATRIX

5. Effects of Policy Measures on Aggregate Economy

Outcome Variable Policy Input	GDP growth	Saving and capital accumul.	Equity investment	Investment efficiency	Interest rates	Productivity	Inflation	Labor mobility and labor mrkt flexibility
Tax Policy								
Pension								
General								
Social Security								
Retirement age	X	X			X	X		
Benefit structure	X	X			X	X		
Indexation	X	X			X	X		
Payroll tax	X	X			X	X		
Trust fund investment	X	X	X	X	X	X		
Individual accounts	X	X	X	X	X	X		
Funding and Guarantees								
PBGC premium								
Funding rules								
Pension Regulation, Policy								
ERISA/IRS								
Employer plans								
Pension and saving incentives/mandates								

Blank cell indicates that the effects of the policy issue or input on that outcome cannot be simulated in this model.

SSASIM -- POLICY MATRIX

6. Effects of Policy Measures on Government Finances

Outcome Variable / Policy Input	Tax revenue	Expenditures by program	Deficits and debt	Social Security & Medicare
Tax Policy				
Pension				
General				
Social Security				
Retirement age		X	X	X
Benefit structure		X	X	X
Indexation		X	X	X
Payroll tax	X		X	X
Trust fund investment			X	X
Individual accounts	X	X	X	X
Funding and Guarantees				
PBGC premium				
Funding rules				
Pension Regulation, Policy				
ERISA/IRS				
Employer plans				
Pension and saving incentives/mandates				

Blank cell indicates that the effects of the policy issue or input on that outcome cannot be simulated in this model.