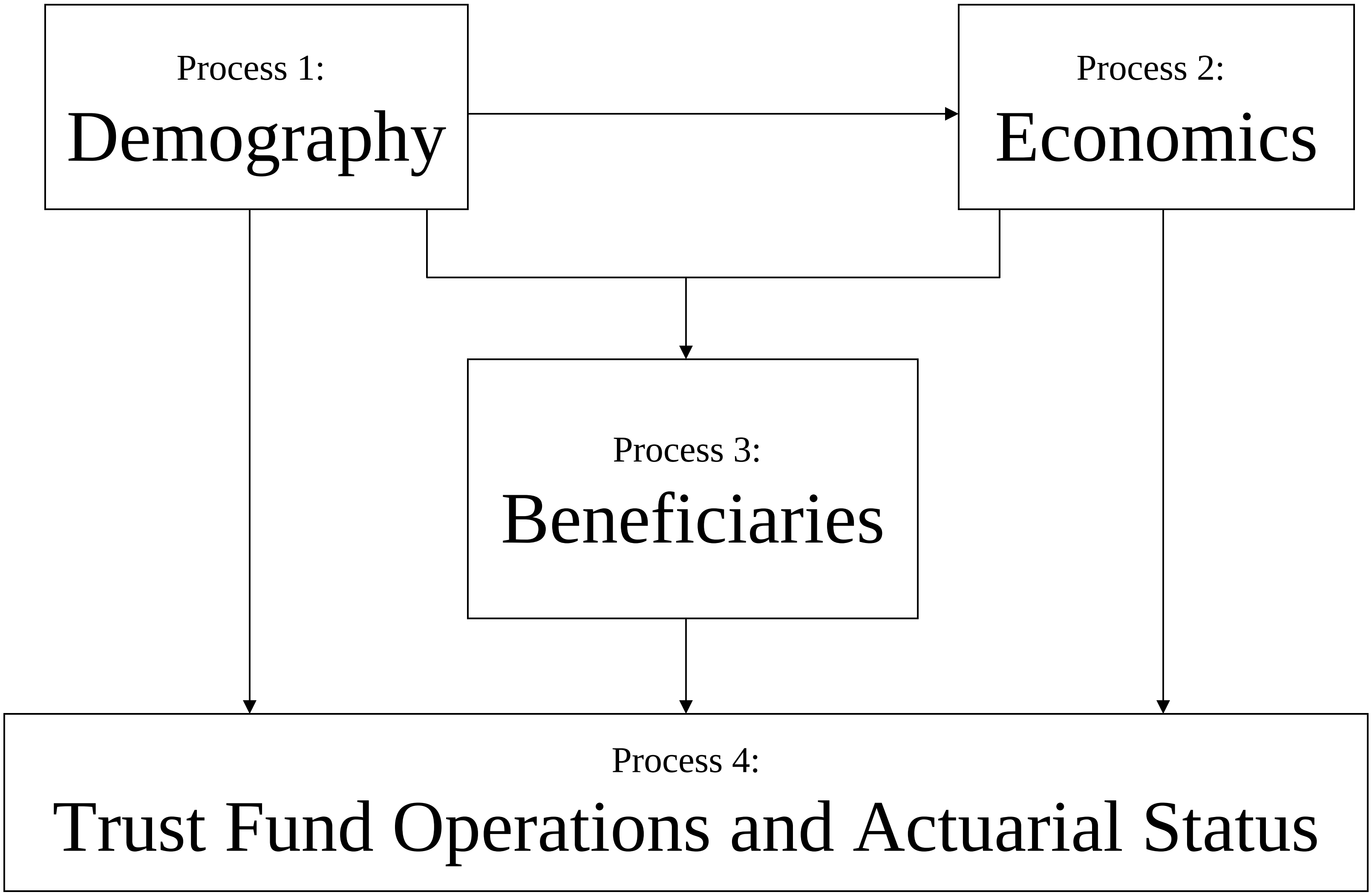
Summary of Long-Range OASDI Projection Methodology

Intermediate Assumptions of the 2007 Trustees Report

November 2007

I. Flow Charts

Overview of Long-Range OASDI Projection Methodology



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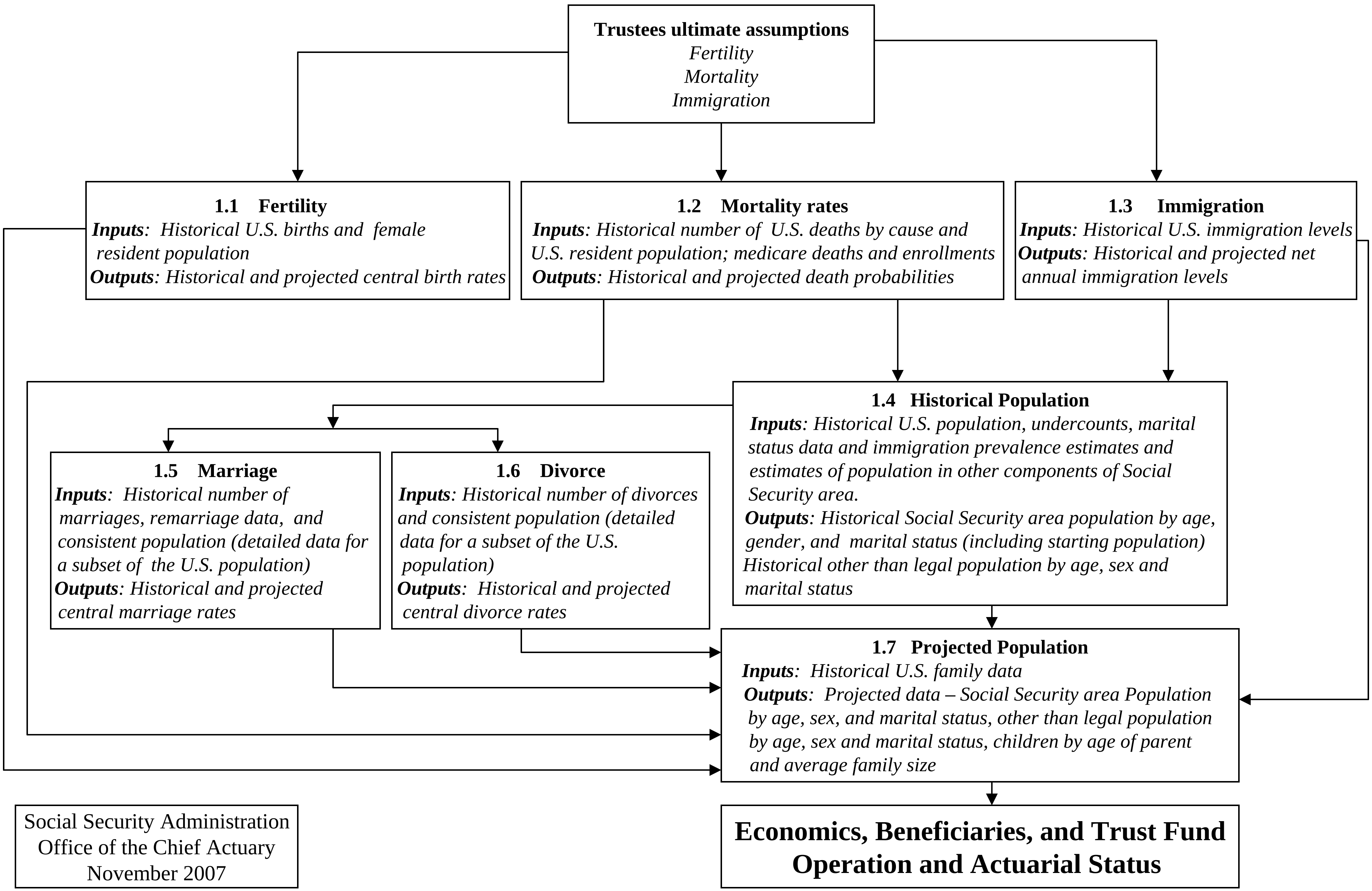
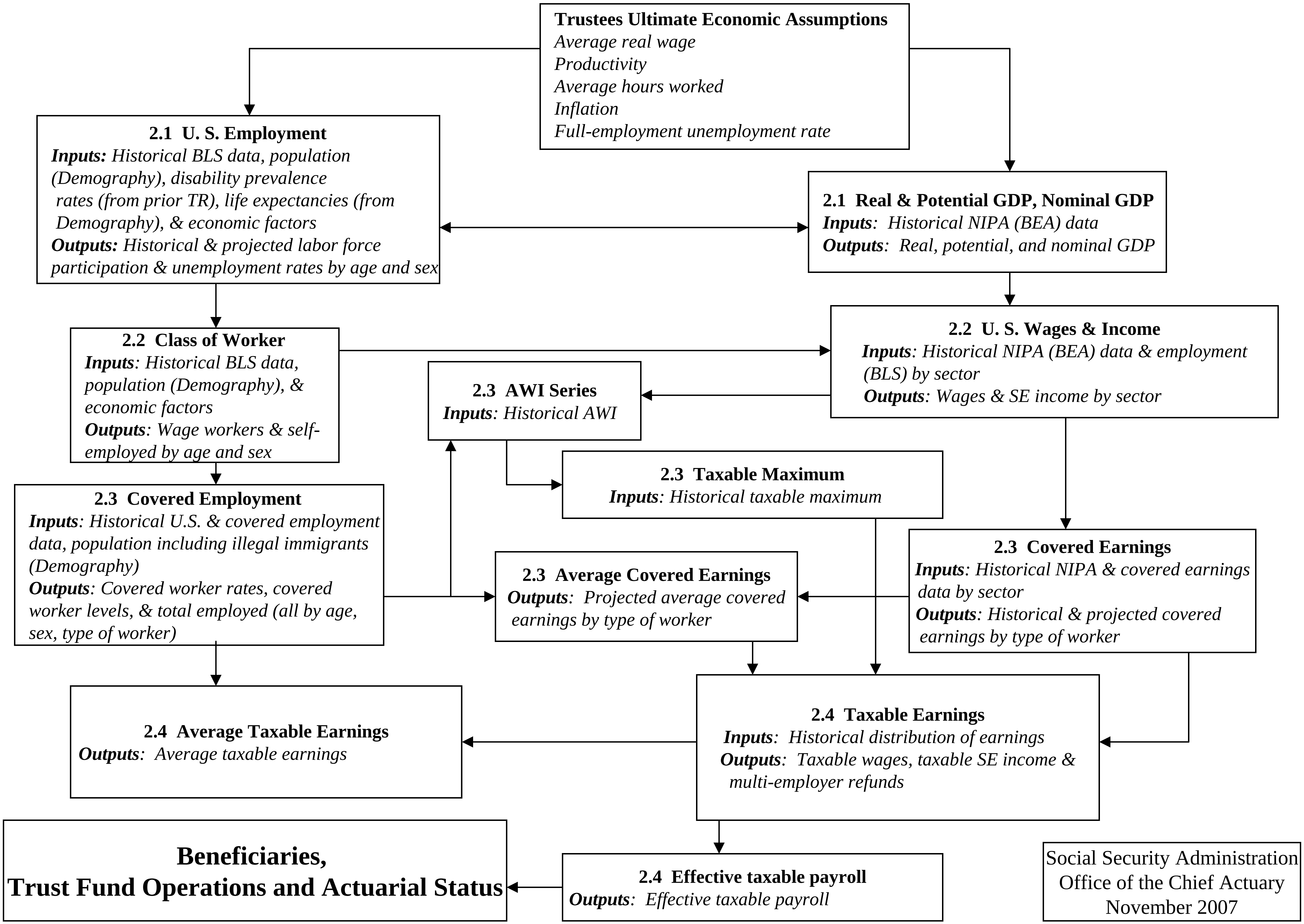
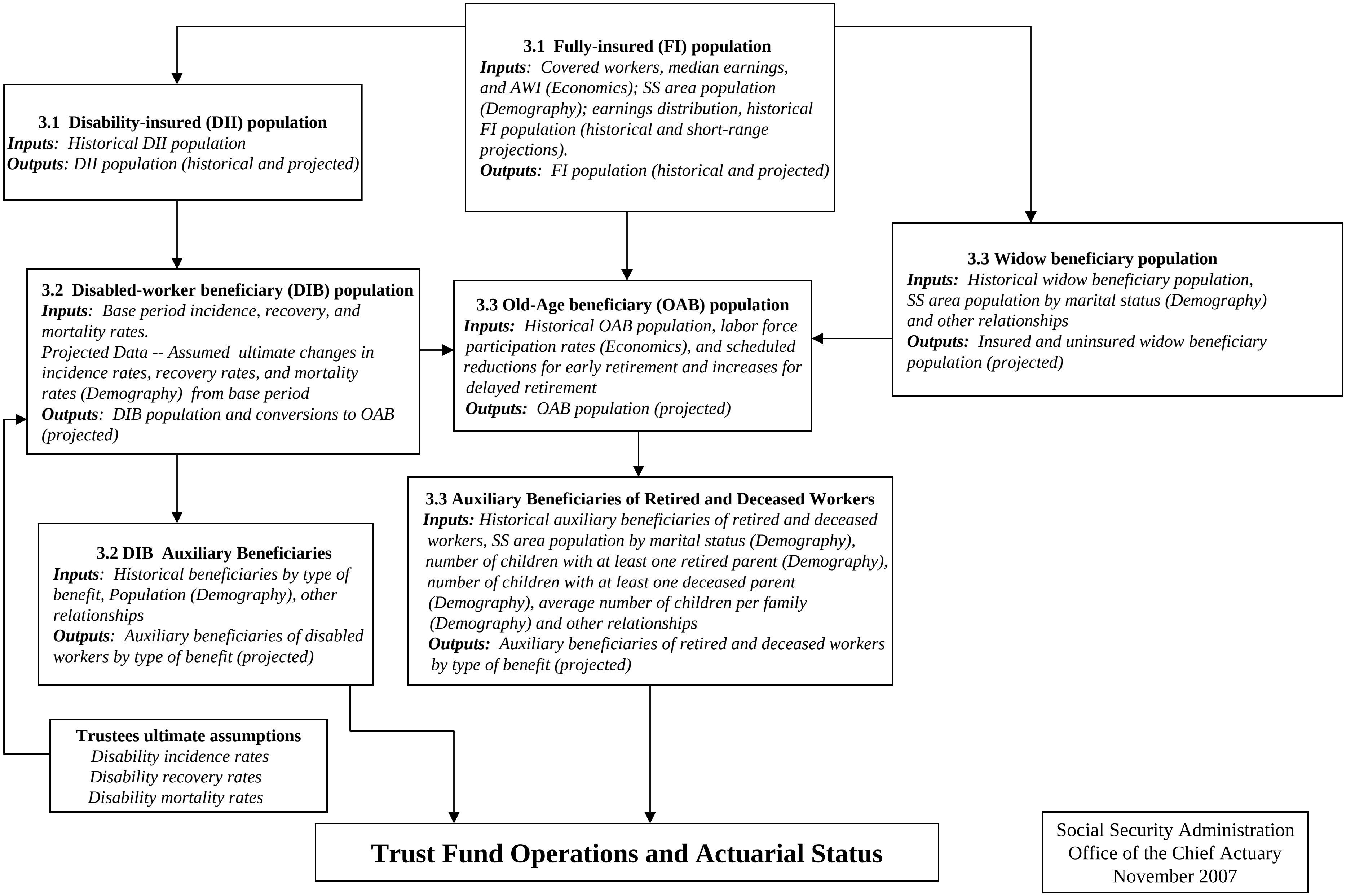
Process 1: Demography



Process 2: Economics

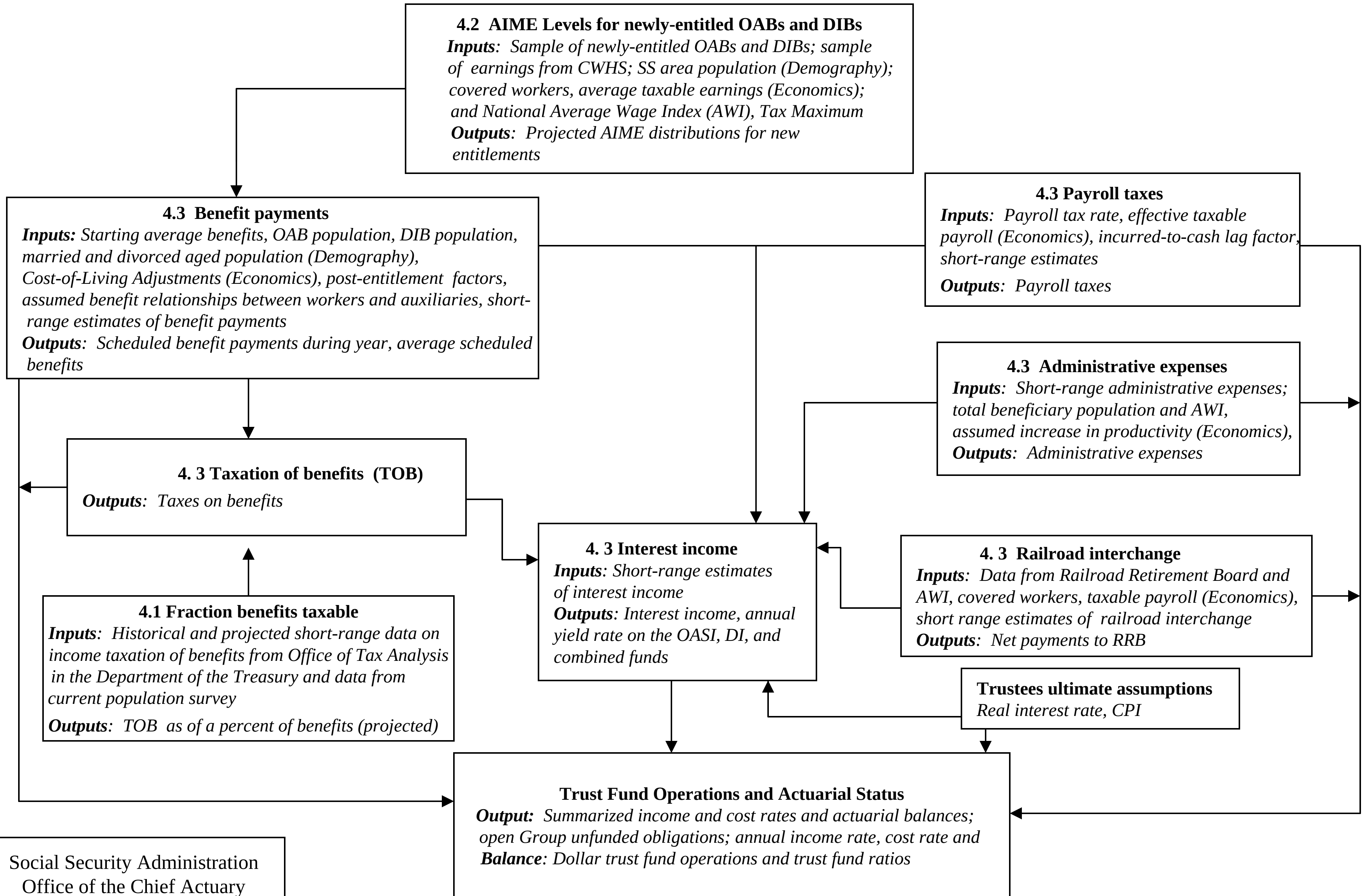


Process 3: Beneficiaries



Note: Insured widow refers to widow beneficiaries who are insured for OAIB benefits, but not receiving those benefits

Process 4: Trust Fund Operations and Actuarial Status



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II. Process Descriptions

The long-range programs used to make projections for the annual Trustees Report are grouped into four major processes. These include Demography, Economics, Beneficiaries, and Trust Fund Operations and Actuarial Status. Each major process consists of a number of subprocesses.

This overview attempts to provide a general description of the purpose of each subprocess. Key projected variables used in the subprocess are introduced. Some variables are represented as being dependent in an equation, where the dependent variable is *defined* in terms of one or more independent variables. Independent variables may include previously calculated dependent variables or data provided from outside the subprocess. Other key variables are referenced by "(·)" following the variable name. This indicates that the calculation of this variable can not easily be communicated by an equation and, thus, requires a more complex discussion.

More detailed descriptions are available upon request. Please email your request for the detailed model documentation to: actuary@ssa.gov Indicate which of the following sections you want: 1) Demography; 2) Economic; 3) Beneficiaries; or 4) Trust Fund Operations and Actuarial Status.

1. Demography

OCACT uses the Demography Process to project the Social Security Area population (estimates of population potentially covered by the Social Security program). The Demography Process receives input data mainly from other government agencies and provides output data to the Economics, Beneficiaries, and Trust Fund Operations and Actuarial Status processes.

The Demography Process is composed of seven subprocesses: FERTILITY, IMMIGRATION, MORTALITY, HISTORICAL POPULATION, MARRIAGE, DIVORCE, and PROJECTED POPULATION. As a rough overview, FERTILITY projects birth rates by age of mother; IMMIGRATION projects numbers of immigrants by age and sex; and MORTALITY projects probabilities of death by age and sex. HISTORICAL POPULATION combines population estimates from different sources to obtain historical estimates of the Social Security Area population by single year of age, sex and marital status. MARRIAGE projects marriage rates by age-of-wife crossed with age-of-husband and DIVORCE projects divorce rates by age-of-husband crossed with age-of-wife. PROJECTED POPULATION starts with the latest estimates of the Social Security Area population from HISTORICAL POPULATION and projects the population by age, sex, and marital status using projected values from FERTILITY, IMMIGRATION, MORTALIY, MARRIAGE, and DIVORCE.

1.1. FERTILITY

The National Center for Heath Statistics (NCHS) collects data on annual numbers of births and the U.S. Census Bureau produces estimates of the resident population. Birth rates for historical years are calculated from these data by single year of age of mother. Age-specific birth rates b_x^z for a given year *z* are defined as the ratio of (1) births during the year to mothers at the specified age *x* (B_x^z) to (2) the midyear female population at that age (P_x^z). The total fertility rate TFR^z summarizes the age-specific fertility rate for a given year. The total fertility rate for a given year *z* is defined as the sum of the age-specific birth rates for all ages *x* during the year *z*. It can be interpreted as the number of children born to a woman if she were to survive her childbearing years and experience the age-specific fertility rates of year z throughout her childbearing years.

FERTILITY *projects* annual age-specific birth rates. The primary equations of this subprocess are given below:

$$b_x^z = b_x^z(\cdot) \tag{1.1.1}$$

$$TFR^z = \sum_x b_x^z \tag{1.1.2}$$

1.2 MORTALITY

The NCHS collects data on annual numbers of deaths and the U.S. Census Bureau produces estimates of the U.S. resident population. Central death rates (${}_yM_x$) are defined as the ratio of (1) the annual number of deaths occurring during the year to persons between exact age *x* and *x+y* to (2) the number of people in the population as of midyear between exact age *x* and *x+y*. For historical years prior to 1968, ${}_yM_x$, are calculated from these data by sex. For historical years after 1968, the same data are used in the calculations for ages 65 and under but data from the Centers for Medicare and Medicaid Services (CMS) are used for ages 65 and over. Based on death by cause data from NCHS, the ${}_yM_x$, are distributed by cause of death for years 1979 and later[1].

Over the last century, death rates have decreased substantially. The historical improvement in

[1] Data needed in order to project central death rates by cause of death were obtained from Vital Statistics tabulations for years since 1979. For the years 1979-1998, adjustments were made to the distribution of the numbers of deaths by cause. The adjustments were needed in order to reflect the revision in the cause of death coding that occurred in 1999, making the data for the years 1979-1998 more comparable with the coding used for the years 1999 and later. The adjustments were based on comparability ratios published by the National Center for Health Statistics.

mortality is quantified by calculating the average annual percentage reduction (${}_{y}AA_{x}$) in the central death rate. In order to project future ${}_{y}M_{x}$, the Board of Trustees of the OASDI Trust Funds determines the ultimate average annual percentage reduction that will be realized during the projection period (${}_{y}AA_{x}^{u}$).

The basic mortality outputs of the mortality subprocess that are used in projecting the population are probabilities of death by age and sex (q_x). The probability that a person age x will die within one year (q_x) is calculated from the central death rates (the series of ${}_{y}M_{x}$). Period life expectancy ($\mathring{e}_x$) is generated from the probabilities of death for a given year and is a summary statistic of overall mortality for that year. Period life expectancy ($\mathring{e}_x$) is defined as the average number of years of life remaining for people who are age x and are assumed to experience the assumed probabilities of death throughout their lifetime.

Age-adjusted death rates (*ADR)* are also used to summarize the mortality experience of a single year, making different years comparable to each other. Age-adjusted death rates are a weighted average of the ${}_{y}M_{x}$, where the weights used are the numbers of people in the corresponding age groups of the standard population, the 2000 U.S. Census resident population (${}_{y}SP_{x}$). Thus, if the age-adjusted death rate for a particular year and sex is multiplied by the total 2000 U.S. Census resident population, the result gives the number of deaths that would have occurred in the 2000 U.S. Census resident population if the ${}_{y}M_{x}$ for that particular year and sex had been experienced. Age-sex-adjusted death rates (*ASDR*) are calculated to summarize death rates for both sexes combined and are calculated as a weighted average of the ${}_{y}M_{x}$, where each weight is the number of people in the corresponding age and sex group of the 2000 U.S. Census resident population.

MORTALITY projects annual ${}_{y}\mathrm{M}_{\mathrm{x}}$ which are then used to calculate the program's additional outputs. The equations for this subprocess, 1.2.1 through 1.2.6, are given below:

$${}_{y}M_{x} = {}_{y}M_{x}\,(\cdot) \qquad (1.2.1)$$

$${}_{y}AA_{x} = {}_{y}AA_{x}\,(\cdot) \qquad (1.2.2)$$

$$q_{x} = q_{x}\,(\cdot) \qquad (1.2.3)$$

$$\mathring{e}_x = \mathring{e}_x(\cdot) \tag{1.2.4}$$

$$ADR_s^z = \frac{\sum_x {}_ySP_x \cdot {}_yM_{x,s}^z}{\sum_x {}_ySP_x} \tag{1.2.5}$$

$$ASDR^z = \frac{\sum_s \sum_x {}_ySP_{x,s} \cdot {}_yM_{x,s}^z}{\sum_s \sum_x {}_ySP_{x,s}} \quad , \tag{1.2.6}$$

where ${}_yM_{x,s}^z$ refers to the central death rate between exact age x and $x+y$ by sex in year z;
${}_ySP_x$ denotes the number of people in the standard population (male and female combined) who are between exact age x and $x+y$; and
${}_ySP_{x,s}$ denotes the number of people by sex in the standard population who are between exact age x and $x+y$.

1.3. IMMIGRATION

For each fiscal year, the U.S. Citizenship and Immigration Services collect data on the number of legal immigrants entering the country by sex and age group. The U.S Census Bureau provided OCACT with an unpublished estimate of the annual number of emigrants, by sex and age, based on the change between the 1980 and 1990 census. The Census Bureau also estimated the aggregate number of net other immigrants who entered the country during 1975-1980, by age and sex.

For each year z of the projection period, the Trustees provide assumptions for the annual total number of new legal immigrants (I^z), legal emigrants (E^z), and net other immigrants (O^z). By subtracting the number of legal emigrants from the number of legal immigrants, total net legal immigration (N^z) is calculated. Total net immigration (T^z) is the sum of net legal immigration and net other immigrants. The term “other immigration” refers to persons entering the U.S. in a manner other than being lawfully admitted for permanent residence. This includes temporary immigrants (persons legally admitted for a limited period of time) in addition to undocumented immigrants living in the U.S.

These historical data are used to calculate an age-sex distribution that is applied to the Trustees’ aggregate immigration assumptions to produce total net immigration levels by age and sex.

The primary equations of IMMIGRATION are summarized below:

$$I^z = I^z(\cdot) \qquad (1.3.1)$$

$$E^z = E^z(\cdot) \qquad (1.3.2)$$

$$N^z = I^z - E^z \qquad (1.3.3)$$

$$O^z = O^z(\cdot) \qquad (1.3.4)$$

$$T^z = I^z - E^z + O^z = N^z + O^z \qquad (1.3.5)$$

1.4. HISTORICAL POPULATION

The U.S. Census Bureau collects population data and tabulates it by age, sex, and marital status every ten years for the decennial census. The decennial census includes data from the 50 states, DC, U.S. territories and citizens living abroad. Each subsequent year, a current population survey (CPS) is conducted on the U.S. population, from which the Census Bureau estimates the post-censal population as of July 1. The July 1 population estimates for the most recent two years are averaged to produce the starting January 1 population used by the POPULATION PROJECTION subprocess.

For each historical year, the Historical subprocess *combines* the population components mentioned in sections 1.1 to 1.3 and *smoothes* them into Social Security area population by single year of age and sex ($P^z_{x,s}$). Combining this population with a marital status matrix provides the Social Security area population by single year of age, sex, and marital status ($P^z_{x,s,m}$). The primary equations for this subprocess, 1.4.1 and 1.4.2 are given below:

$$P^z_{x,s} = P^z_{x,s}(\cdot) \qquad (1.4.1)$$

$$P^z_{x,s,m} = P^z_{x,s,m}(\cdot) \qquad (1.4.2)$$

1.5. MARRIAGE

The National Center for Heath Statistics (NCHS) collected detailed data on the annual number of new marriages in the Marriage Registration area (MRA), by age of husband crossed with age of wife, for the period 1978 through 1988 (excluding 1980). In 1988, the MRA consisted of 42 States and D.C. and accounted for 80 percent of all marriages in the U.S. Estimates of the unmarried population in the MRA were obtained from NCHS by age and sex. Marriage rates for this period are calculated from these data.

NCHS stopped collecting data on the annual number of new marriages in the MRA in 1989. Less detailed data on new marriages from a subset of the MRA were obtained for the years 1989-1995. These data are used to determine marriage rates by adjusting the more detailed age-of-husband crossed with age-of-wife data from the earlier years to match the aggregated levels for these years.

Age-specific marriage rates ($\hat{m}^z_{x,y}$) for a given year z are defined as the ratio of (1) number of marriages for given age-of-husband (x) crossed with age-of-wife (y) to (2) a theoretical midyear unmarried population at that age ($P^z_{x,y}$). The theoretical midyear population is defined as the geometric mean[2] of the midyear unmarried males and unmarried females.

An age-adjusted central marriage rate ($A\hat{M}R^z$) summarizes the $\hat{m}^z_{x,y}$ for a given year. The standard population chosen for age adjusting is the unmarried males and unmarried females in the marriage registration area (MRA) as of July 1, 1982. The first step in calculating the total age-adjusted central marriage rate for a particular year is to determine an expected number of marriages by applying the age-of-husband age-of-wife specific central marriage rates for that year to the square root of the product of the corresponding age groups in the standard population. The $A\hat{M}R^z$ is then obtained by dividing:

- The expected number of marriages by

- The square root of the product of (a) the number of unmarried males, ages 15 and older, and (b) the unmarried females, ages 15 and older in the standard population.

The MARRIAGE subprocess projects annual $\hat{m}^z_{x,y}$ by age-of-husband crossed with age-of-wife. The equations for this subprocess, 1.5.1 and 1.5.2, are given below:

$$\hat{m}^z_{x,y} = \hat{m}^z_{x,y}(\cdot) \qquad (1.5.1)$$

[2] The square root of the product of the midyear unmarried male and unmarried female populations.

$$A\hat{M}R^{z} = \frac{\sum_{x,y} P_{x,y}^{S} \cdot \hat{m}_{x,y}^{z}}{\sum_{x,y} P_{x,y}^{S}} \qquad (1.5.2)$$

where $P_{x,y}^{S}$ is the theoretical unmarried population in the MRA as of July 1, 1982 (the square root of the product of the corresponding age groups in the standard population) and x and y refer to the age of males and females, respectively.

1.6. DIVORCE

For the period 1979 through 1988, the National Center for Heath Statistics (NCHS) collected data on the annual number of divorces in the Divorce Registration area (DRA), by age-group-of-husband crossed with age-group-of-wife. In 1988, the DRA consisted of 31 States and accounted for about 48 percent of all divorces in the U.S. These data are then inflated to represent an estimate of the total number of divorces in the Social Security Area. This estimate for the Social Security Area is based on the total number of divorces during the corresponding calendar year in the 50 States, the District of Columbia, Puerto Rico, and the Virgin Islands. Divorce rates for this period are calculated using this adjusted data on number of divorces and estimates of the married population by age and sex in the Social Security Area.

An age-of-husband crossed with age-of-wife specific divorce rate ($\hat{d}_{x,y}^{z}$) for a given year z is defined as the ratio of (1) the number of divorces in the Social Security area for the given age of husband and wife ($\hat{D}_{x,y}^{z}$) to (2) the corresponding number of married couples in the Social Security area ($P_{x,y}^{z}$) with the given age of husband (x) and wife (y). An age-adjusted central divorce rate ($A\hat{D}R_{x,y}^{z}$) summarizes the $\hat{d}_{x,y}^{z}$ for a given year.

The $A\hat{D}R^{z}$ is calculated by determining the expected number of divorces by applying :

- The age-of-husband crossed with age-of-wife specific divorce rates to
- The July 1, 1982 population of married couples in the Social Security area by corresponding age-of-husband and age-of-wife.

The expected number of divorces are then divided by the total number of married couples in that year.

The DIVORCE subprocess projects annual $\hat{d}_{x,y}^{z}$ by age-of-husband crossed with age-of-wife. The primary equations, 1.6.1 and 1.6.2, are given below:

$$\hat{d}^{z}_{x,y} = \hat{d}^{z}_{x,y}\ (\cdot) \tag{1.6.1}$$

$$A\hat{D}R^{z} = \frac{\sum_{x,y} P^{S}_{x,y} \cdot \hat{d}^{z}_{x,y}}{\sum_{x,y} P^{S}_{x,y}} \tag{1.6.2}$$

where $P^{S}_{x,y}$ *is the number of married couples in the Social Security area population as of July 1, 1982 and x and y refer to the age of husband and age of wife, respectively.*

1.7. POPULATION PROJECTION

The Social Security area population is projected using the component method. For the 2007 Trustees Report, the *starting year* of the population projections is 2005 and the *starting dat*e is January 1, 2005. The components of change are then applied to this base population by age and sex to project the population through 2101. The population (P^z) for a particular year *z* is projected by sex and single year of age (0-99 and the age group 100+) using the following equation:

$$P^{z+1} = B^{z} - D^{z} + T^{z} \quad \text{for age 0}$$
$$P^{z+1} = P^{z} - D^{z} + T^{z} \quad \text{for ages > 0} \tag{1.7.1}$$

where,

P^z = population at beginning of year z
B^z = births in year z
D^z = deaths in year z
T^z = total net immigration in year z

The population is further disaggregated into the following four marital statuses: single (never married), married, widowed, divorced.

2. Economic

The Office of the Chief Actuary (OCACT) uses the Economic process to project OASDI employment and earnings-related variables, such as the average wage for indexing and the effective taxable payroll. The Economic process receives input data from the Demography process and provides output data to the Beneficiaries and the Trust Fund Operations & Actuarial Status processes.

The Economic process is composed of four subprocesses, U.S. Employment (USEMP), U.S. Earnings (USEAR), Covered Employment and Earnings (COV), and Taxable Payroll (TAXPAY). As a rough overview, USEMP and USEAR project U.S. employment and earnings data, respectively, while COV converts these employment and earnings variables to OASDI covered concepts. TAXPAY, in turn, converts OASDI covered earnings to taxable concepts, which are eventually used to estimate future payroll tax income and future benefit payments.

USEMP and USEAR produce quarterly output, while COV's output is annual. TAXPAY produces both.

2.1. U.S. Employment (USEMP)

The Bureau of Labor Statistics (BLS) publishes historical monthly estimates for civilian U.S. employment-related concepts from the Current Population Survey (CPS). The principal measures include the civilian labor force (LC) and its two components – employment (E) and unemployment (U), along with the civilian noninstitutional population (N). The BLS also publishes values for the civilian labor force participation rate (LFPR) and the civilian unemployment rate (RU). The LFPR is defined as the ratio of LC to N, while the RU is the ratio of U to LC, expressed to a base of 100.

USEMP projects quarterly values for these principal measures of U.S. employment. Equations 2.1.1 through 2.1.4 outline the subprocess' overall structure and solution sequence of this subprocess.

$$\text{LFPR} = \mathit{LFPR}(\cdot) \qquad (2.1.1)$$

$$\text{LC} = \text{LFPR} * \text{N} \qquad (2.1.2)$$

$$\text{RU} = \mathit{RU}(\cdot) \qquad (2.1.3)$$

$$\text{E} = \text{LC} * (1 - \text{RU} / 100) \qquad (2.1.4)$$

2.2. U.S. Earnings (USEAR)

In the CPS data, E is separated by class of worker. The broad categories include wage and salary workers (EW), the self-employed (ES), and unpaid family workers (EU). For the nonagricultural sector, a self-employed participation rate (SEPR) is defined as the ratio of ES to E, the proportion of employed persons who are self-employed. For the agricultural sector, the SEPR is defined as the ratio of ES to the civilian noninstitutional population.

USEAR projects quarterly values for these principle classes of employment. Equations 2.2.1 through 2.2.4 outline the subprocess' overall structure and solution sequence.

$$\text{SEPR} = \mathit{SEPR}(\cdot) \qquad (2.2.1)$$

$$\text{ES} = \text{SEPR} * \text{E} \qquad (2.2.2)$$

$$\text{EU} = \mathit{EU}(\cdot) \qquad (2.2.3)$$

$$\text{EW} = \text{E - ES - EU} \qquad (2.2.4)$$

In the National Income and Product Accounts (NIPA), the Bureau of Economic Analysis (BEA) publishes historical quarterly estimates for gross domestic product (GDP), real GDP, and the GDP price deflator (PGDP). PGDP is equal to the ratio of nominal to real GDP. Potential (or full-employment) GDP is a related concept defined as the level of real GDP that is consistent with a full-employment aggregate RU.

USEAR projects quarterly values for these output measures. Potential GDP is based on the change in (1) full-employment values for E (including U.S. armed forces), (2) average hours worked per week, and (3) productivity. Full-employment values for E are derived by solving USEMP under full-employment conditions, while the full-employment values for the other variables (average hours worked and productivity) are set by assumption. Projected real GDP is set equal to the product of potential GDP and RTP. RTP reaches 1.0 in the short-range period and remains at 1.0 thereafter. Nominal GDP is the product of real GDP and PGDP. The growth rate in PGDP is set by assumptions.

The BEA also publishes quarterly values for the principal components of U.S. earnings, including total wage worker compensation (WSS), total wage and salary disbursements (WSD), and total proprietor income (Y). These concepts can be aggregated and rearranged. Total compensation (WSSY) is defined as the sum of WSS and Y. The total compensation ratio (RWSSY) is defined as the ratio of WSSY to the GDP. The income ratio (RY) is defined as the ratio of Y to WSSY. The earnings ratio (RWSD) is defined as the ratio of WSD to WSS.

USEAR projects quarterly values for these principle components of U.S. earnings using Equations 2.2.5 through 2.2.11.

$$\text{RWSSY} = \mathit{RWSSY}(\cdot) \qquad (2.2.5)$$

$$\text{WSSY} = \text{RWSSY} * \text{GDP} \qquad (2.2.6)$$

$$\text{RY} = \mathit{RY}(\cdot) \qquad (2.2.7)$$

$$\text{Y} = \text{RY} * \text{WSSY} \qquad (2.2.8)$$

$$\text{WSS} = \text{WSSY} - \text{Y} \qquad (2.2.9)$$

$$\text{RWSD} = \mathit{RWSD}(\cdot) \qquad (2.2.10)$$

$$\text{WSD} = \text{RWSD} * \text{WSS} \qquad (2.2.11)$$

2.3. OASDI Covered Employment and Earnings (COV)

Total at-any-time employment (TE) is defined as the sum of total OASDI covered employment (TCE) and total noncovered employment (NCE). TCE can be decomposed to workers who only report OASDI covered self-employed earnings (SEO) and to wage and salary workers who report some OASDI covered wages (WSW). Combination workers (CMB_TOT) are those who have both OASDI covered wages and self-employed income. Workers with some self-employment income (CSW) are the sum of SEO and CMB_TOT.

Some of these concepts can be rearranged. The total employed ratio (RTE) is defined as the ratio of TE to the sum of EW, ES, and EDMIL, while the combination employment ratio (RCMB) is defined as the ratio of CMB_TOT to WSW.

COV projects annual values for TE and the principle measures of OASDI covered employment. Equations 2.3.1 through 2.3.9 outline the overall structure and solution sequence used to project these concepts.

$$\text{RTE} = \mathit{RTE}(\cdot) \qquad (2.3.1)$$

$$\text{TE} = \text{RTE} * (\text{EW} + \text{ES} + \text{EDMIL}) \qquad (2.3.2)$$

$$\text{NCE} = \mathit{NCE}(\cdot) \qquad (2.3.3)$$

$$\text{TCE} = \text{TE} - \text{NCE} \qquad (2.3.4)$$

SEO	=	*SEO*(·)	(2.3.5)
WSW	=	TCE - SEO	(2.3.6)
RCMB	=	*RCMB*(·)	(2.3.7)
CMB_TOT	=	RCMB * WSW	(2.3.8)
CSW	=	SEO + CMB_TOT	(2.3.9)

Total OASDI covered earnings is defined as the sum of OASDI covered wages (WSC) and total covered self-employed income (CSE_TOT). Both components can be expressed as ratios to their U.S. earnings counterparts. The covered wage ratio (RWSC) is defined as the ratio of WSC to WSD, while the covered self-employed ratio (RCSE) is the ratio of CSE_TOT to Y.

COV projects annual values for the principal measures of OASDI covered earnings using Equations 2.3.10 through 2.3.13.

RWSC	=	*RWSC*(·)	(2.3.10)
WSC	=	RWSC * WSD	(2.3.11)
RCSE	=	*RCSE*(·)	(2.3.12)
CSE_TOT	=	RCSE * Y	(2.3.13)

COV can now project various annual measures of average OASDI covered earnings, including the average covered wage (ACW), average covered self-employed income (ACSE), and average covered earnings (ACE).

ACW	=	WSC / WSW	(2.3.14)
ACSE	=	CSE_TOT / CSW	(2.3.15)
ACE	=	(WSC + CSE_TOT) / TCE	(2.3.16)

The average wage index (AWI) is based on the average wage of all workers with wages from Forms W-2 posted to the Master Earnings File (MEF). By law, it is used to set the OASDI contribution and benefit base (TAXMAX).

COV projects annual values for the AWI and TAXMAX.

$$\text{AWI} = AWI(\cdot) \quad (2.3.17)$$

$$\text{TAXMAX} = TAXMAX(\cdot) \quad (2.3.18)$$

2.4. Effective Taxable Payroll (TAXPAY)

TAXPAY estimates historical annual taxable earnings data including total employee OASDI taxable wages (WTEE), total employer taxable wages (WTER), and total self-employed taxable income (SET). By law, each employee is required to pay the OASDI tax on wages from all covered jobs up to the TAXMAX, while each employer is required to pay the OASDI tax on the wages of each worker up to the TAXMAX. If an employee works more than one covered wage job and the sum of all covered wages exceeds the TAXMAX, the employee but not the employer is due a refund. Hence, WTER is greater than WTEE. The difference (i.e., WTER less WTEE) is defined as multi-employer refund wages (MER).

TAXPAY also estimates the historical annual effective OASDI taxable payroll (ETP). ETP is the amount of earnings in a year which, when multiplied by the combined employee-employer tax rate, yields the total amount of taxes due from wages and self-employed income in the year. ETP is used in estimating OASDI income and in determining income and cost rates and the actuarial balance. ETP is defined as WTER plus SET less one-half of MER.

TAXPAY projects annual values for ETP after first estimating its components. The components in turn are estimated by a collection of ratios. The employee taxable ratio (RWTEE) is defined as the ratio of WTEE to WSC. The multi-employer refund wage ratio (RMER) is defined as the ratio of MER to WSC. The self-employed net income taxable ratio (RSET) is defined as the ratio of SET to CSE_TOT. Equations 2.4.1 through 2.4.8 outline the projection methodology.

$$\text{RWTEE} = RWTEE(\cdot) \quad (2.4.1)$$

$$\text{WTEE} = \text{RWTEE} * \text{WSC} \quad (2.4.2)$$

$$\text{RMER} = RMER(\cdot) \quad (2.4.3)$$

$$\text{MER} = \text{RMER} * \text{WSC} \quad (2.4.4)$$

$$\text{WTER} = \text{WTEE} + \text{MER} \quad (2.4.5)$$

$$\text{RSET} = RSET(\cdot) \quad (2.4.6)$$

$$\text{SET} = \text{RSET} * \text{CSE\_TOT} \quad (2.4.7)$$

$$\text{ETP} = \text{WTER} + \text{SET} - 0.5 * \text{MER} \quad (2.4.8)$$

Over the short-range projection horizon (i.e., first 10 years), TAXPAY also projects annual OASDI wage tax liabilities (WTL) and self-employment tax liabilities (SEL). In Equation 2.4.9, WTL is the product of the effective taxable wages, defined as WTER less one-half of MER, and the combined OASDI employee-employer tax rate (TRW). In Equation 2.4.10, SEL is the product of SET and the OASDI self-employed tax rate (TRSE).

$$\text{WTL} = \text{WTER} * \text{TRW} \tag{2.4.9}$$

$$\text{SEL} = \text{SET} * \text{TRSE} \tag{2.4.10}$$

Also over the short-range horizon, TAXPAY decomposes WTL into quarterly wage tax liabilities (WTLQ) then to quarterly wage tax collections (WTLQC). TAXPAY also decomposes SEL into quarterly self-employed net income tax collections (SELQC).

$$\text{WTLQ} = \mathit{WTLQ}(\cdot) \tag{2.4.11}$$

$$\text{WTLQC} = \mathit{WTLQC}(\cdot) \tag{2.4.12}$$

$$\text{SELQC} = \mathit{SELQC}(\cdot) \tag{2.4.13}$$

Finally, over the first two projected quarters, TAXPAY estimates of WTLQC and SELQC are replaced with ones from the most recent OMB FY Budget. And, over the first four projected quarters, TAXPAY includes estimates for appropriation adjustments (AA).

$$\text{AA} = \mathit{AA}(\cdot) \tag{2.4.14}$$

3. Beneficiaries

OCACT uses the Beneficiaries process to project the fully insured and disability insured population, the number of disabled worker and their dependent beneficiaries, the number of retired worker and their dependent beneficiaries, and the number of dependent beneficiaries of deceased workers. The Beneficiaries process receives input data from the Economics and Demography sections along with data received from the Social Security Administration and other government agencies. Output data is provided to the Economics and Trust Fund Operations and Actuarial Status processes.

The Beneficiaries Process is composed of three subprocesses: INSURED, DISABILITY, and OLD-AGE AND SURVIVORS. As a rough overview, INSURED projects the number of people in the Social Security area population that have sufficient work histories for disability and retirement benefit eligibility. DISABILITY projects the number of disabled worker and their dependent beneficiaries. OLD-AGE AND SURVIVORS projects the number of retired workers, their dependent beneficiaries, and the dependent beneficiaries of deceased workers.

All programs output data on an annual basis.

3.1. INSURED

Insured status is a critical requirement for a worker, who has participated in the covered economy, to receive Social Security benefits upon retirement or disability. The requirement for insured status depends on the age of a worker and his (or her) accumulation of quarters of coverage (QC).

INSURED is a simulation model that estimates the percentage of the population that is fully insured (FPRO) and disability insured (DPRO) throughout the projection period. These estimates are used in conjunction with estimates of the Social Security area population to estimate the number of people that are fully insured (FINPOP) and disability insured (DINPOP). FINPOP is then used by the OLD-AGE AND SURVIVORS INSURANCE subprocess, and both FINPOP and DINPOP are used by the DISABILITY subprocess. FINPOP and DINPOP are projected by age, sex, and cohort.

For each sex and birth cohort, INSURED simulates 30,000 work histories which represent the Social Security area population (SSAPOP). These histories are constructed from past and projected cover worker rates, median earnings, and amounts required for crediting QC.

The equations for this subprocess are given below:

$$\text{FPRO} = \text{FPRO}(\cdot) \qquad (3.1.1)$$

$$\text{DPRO} = \text{DPRO}(\cdot) \quad (3.1.2)$$

$$\text{FINPOP} = \text{FPRO} * \text{SSAPOP} \quad (3.1.3)$$

$$\text{DINPOP} = \text{DPRO} * \text{SSAPOP} \quad (3.1.4)$$

3.2. DISABILITY

The Social Security Administration pays monthly disability benefits to workers who are insured for disability benefits and meet the definition of "disabled". Provided that they meet certain requirements, spouses and children of disabled-worker beneficiaries may also receive monthly benefits.

DISABILITY projects the number of disabled-worker beneficiaries in current-payment status (DIB) at the end of each year by age at entitlement, sex, and duration from entitlement. The number of DIB at the end of year is based on the number of disabled-worker beneficiaries who are currently entitled to benefits (CE). The number of CE at the end of year is obtained by adding the number of newly entitled CE (New Entitlements) during the year and subtracting the number of CE who terminate (Terminations) during the year to the number of CE at the end of the prior year. Disabled-worker beneficiaries who leave the disability rolls (Terminations) do so by recovering from disabilities (Recoveries), by dying (Deaths), or by converting to retired worker status (Conversions). A disabled-worker beneficiary converts to retired worker status upon reaching Normal Retirement Age (NRA), the age at which a person first becomes entitled to unreduced retirement benefit.

DISABILITY also projects the number of future dependent beneficiaries of DIB by category, age, and sex. The six categories are minor child, student child, disabled adult child, young spouse, married aged spouse and divorced aged spouse. The numbers of dependent beneficiaries of DIB are obtained by multiplying the relevant subset of the SSA area population (Exposures) by a series of probabilities that relate to the regulations and requirements for obtaining benefits (Linkages).

$$\text{New Entitlements(year)} = \text{Exposure}_{\text{BOY}} * \text{Incidence Rate(year)} \quad (3.2.1)$$

where BOY is beginning of year.

$$\text{Terminations(year)} = \text{Recoveries(year)} + \text{Deaths(year)} + \text{Conversions(year)} \quad (3.2.2)$$

where $\text{Recoveries(year)} = \text{CE}_{\text{BOY}} * \text{Recovery Rate(year)}$

where $\text{Deaths(year)} = \text{CE}_{\text{BOY}} * \text{Death Rate(year)}$.

$$\text{CE}_{\text{EOY}} = \text{CE}_{\text{EOY-1}} + \text{New Entitlements (year)} - \text{Terminations(year)}, \quad (3.2.3)$$

where EOY is end of year, EOY-1 is end of prior year.

$$\text{Dependent Beneficiaries of DIB}_{EOY} = \text{Exposures}_{EOY} * \text{Linkages}_{EOY} \qquad (3.2.4)$$

3.3. Old-Age and Survivors Insurance

Every month, the Social Security program pays benefits to retired workers and their dependents. It also provides benefits to eligible dependents of deceased workers. The OASI subprocess projects the number of people expected to receive benefits over the next 75 years. The projection method is very similar to that in the Disability subprocess. The projection of beneficiaries is computed by multiplying a subset of the Social Security area population by a series of probabilities of the conditions that a person must meet to receive benefits. The main program receives all necessary input data and performs all preliminary calculations. It then calls each individual beneficiary type subroutine where all beneficiary calculations are made.

Retired workers and their dependent beneficiaries are categorized as follows:

- retired workers (*RWN*) by age (62-95+), sex, and marital status (single, married, widowed, divorced)
- aged spouses of retired workers (*ASRWN*), by age (62-95+), sex of the account holder, and marital status of the beneficiary (married, divorced)
- young spouses of retired workers (*YSRWN*) by age-group (under 25, 25-29,…, 65-69) and sex of the account holder
- minor, student, and disabled adult children of retired workers (*MCRWN*, *SCRWN*, and *DCRWN*, respectively) by age of the child (0-17 for minor, 18-19 for student, age groups 18-19, 20-24, …, 55-59, 60+ for disabled adult) and sex of the account holder

Dependent beneficiaries of deceased workers include:

- aged spouses of deceased workers, *ASDWN*, by age (60-95+), sex of the account holder, marital status (widowed, divorced) and insured status (insured, uninsured)
- disabled spouses of deceased workers (*DSDWN*) by age (50-69), sex of the account holder and marital status (widowed, divorced)
- young spouses of deceased workers (*YSDWN*) by age-group (under 25, 25-29,…, 65-69), sex of the account holder and marital status of the beneficiary (widowed, divorced)
- minor, student, and disabled adult children of deceased workers (*MCDWN*, *SCDWN*, and *DCDWN*, respectively) by age of the child (0-17 for minor, 18-19 for student, age groups 18-19, 20-24,…, 55-59, 60+ for disabled adult) and sex of the account holder

Lastly, the number of deaths of insured workers (*LUMSUM*) is estimated by 5-year age group (20-24, 25-29,…, 80-84, 85+) and sex.

Equations 3.3.1-13 indicate the flow of calculations of beneficiaries.

$$ASDWN = ASDWN(\cdot) \tag{3.3.1}$$
$$RWN = RWN(\cdot) \tag{3.3.2}$$
$$ASRWN = ASRWN(\cdot) \tag{3.3.3}$$
$$DSDWN = DSDWN(\cdot) \tag{3.3.4}$$
$$MCRWN = MCRWN(\cdot) \tag{3.3.5}$$
$$MCDWN = MCDWN(\cdot) \tag{3.3.6}$$
$$SCRWN = SCRWN(\cdot) \tag{3.3.7}$$
$$SCDWN = SCDWN(\cdot) \tag{3.3.8}$$
$$DCRWN = DCRWN(\cdot) \tag{3.3.9}$$
$$DCDWN = DCDWN(\cdot) \tag{3.3.10}$$
$$YSRWN = YSRWN(\cdot) \tag{3.3.11}$$
$$YSDWN = YSDWN(\cdot) \tag{3.3.12}$$
$$LUMSUM = LUMSUM(\cdot) \tag{3.3.13}$$

4. *Trust Fund Operations and Actuarial Status*

OCACT uses the Trust Fund Operations and Actuarial Status Process to project (1) the annual flow of income from payroll taxes, taxation of benefits, and interest on assets in the trust fund and (2) the annual flow of cost from benefit payments, administration of the program, and railroad interchange. The annual flows are projected for each year of the 75-year projection period. In addition, this subprocess produces annual and summarized values to help access the financial status of the Social Security program.

The Trust Fund Operations and Actuarial Status Process is composed of three subprocesses: TAXATION OF BENEFITS, AWARDS, and COST. As a rough overview, TAXATION OF BENEFITS projects, for each year during the 75-year projection period, the amount of income from taxation of benefits as a percent of benefits paid. AWARDS projects information needed to determine the benefit levels of newly awarded retired workers and disabled workers by age and sex. COST uses information from the AWARDS and TAXATION OF BENEFITS subprocesses, as well as information from other processes, to project the annual flow of income and cost to the trust funds. In addition, COST produces annual and summarized measures of the financial status of the Social Security program.

4.1. TAXATION OF BENEFITS

The 1983 Social Security Act specifies including up to 50 percent of the Social Security benefits to tax return filer's adjustable gross income for tax liability if tax return filer's adjusted gross income plus half of his (or her) Social Security benefits is above the specified income threshold amount of $25,000 as a single filer (or $32,000 as a joint filer). The proceeds from taxing up to 50 percent of the Social Security benefits, as a result of the 1983 Act, are credited to the OASI and DI Trust Funds.

Projected ratios of income from taxes on Social Security benefits to Social Security benefits (RTB) for the OASI and DI programs are computed with the following formula for each year (yr) of the long range projection years (11^{th} through 75^{th} year).

RTB(yr) = RTB(tryr+9) * {AWI(tryr+9)/AWI(yr)}^P +
RTB(ultimate)*{1- AWI(tryr+9)/AWI(yr)}^P, where

tryr = first year of the projection period (year of the Trustees Report)

RTB(ultimate) = ratio of taxes on benefits to benefits assuming income threshold amounts equal zero.

AWI = SSA average wage index series

P = exponential parameter for a trend curve line

4.2. AWARDS

Each year over 2 million workers begin receiving either retired-worker or disabled-worker benefits. The monthly benefits for these new awards are based on their primary insurance amount or simply PIA. The PIA is computed using the PIA benefit formula as specified in the 1977 amendments and the average indexed monthly earnings (AIME). The AIME depends on the number of computation years, Y, and the amount earned (earnings level) by a worker in each year. For retired-worker benefits, $Y = 35$.

The AWARDS subprocess selects records from a 10% sample of newly entitled worker beneficiaries obtained from the 2003 Master Beneficiary Record (MBR).[3] The selected sample, referred to as "sample", contains 207,826 beneficiary records, and each record, r, includes a worker's history of taxable earnings under the OASDI program as well as additional information such as sex, birth date, month of entitlement, and type of benefit awarded. To estimate the benefit levels of future newly awarded worker beneficiaries, the earnings records in the sample are modified to reflect the expected work histories and earnings levels of future beneficiaries (equation 4.2.1). After the modifications, an AIME is computed for each record in the future sample of beneficiaries (equation 4.2.2). Each AIME value is then subdivided into *bend point subintervals*[4] (equation 4.2.3). As input to the Cost subprocess, the AIME values are used to calculate aggregate percentages of AIME in each *bend point subinterval* for each age at entitlement, sex and trust fund (equation 4.2.4). Equations 4.2.1 through 4.2.4 outline the overall structure and solution sequence. The subscript n refers to the *bend point subinterval* and r refers to the sample record.

$$\text{Projected Earnings} = \text{Projected Earnings}\,(\cdot) \qquad (4.2.1)$$

$$\text{AIME}(r) = \frac{\sum \text{Highest } Y \text{ Indexed Earnings}(r)}{Y * 12} \qquad (4.2.2)$$

$$\text{AIME}_n(r) = \text{AIME}_n(\cdot) \qquad (4.2.3)$$

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[3] For an OASI beneficiary, a record is selected if the year of entitlement equals 2003 and the beneficiary is in current pay status as of Dec. 2003. [3] For a DI beneficiary, a record is selected if the year of entitlement equals 2003 and the beneficiary is in current pay status as of Dec. 2003, Dec. 2004, or Dec. 2005.

[4] The current formula has two bend points. For the purposes of PAP, the two bend points are further divided, resulting in 10 intervals.

$$\mathrm{PAP}_n = \frac{\sum_r \mathrm{AIME}_n(r)}{\sum_r \mathrm{bp}_n} \qquad (4.2.4)$$

where bp_n is the length of the nth bend point subinterval,
Y is the number of computation years, and
AIME_n (r) is the AIME amount contained within the nth interval for record r.

4.3. COST

The Cost subprocess projects, for each year of the long-range 75 year period, the trust fund operations. The Cost subprocess projects the income and cost for each trust fund (OASI and DI). The two components of non-interest income are tax contributions and taxation of benefits. The other component of income is interest earned on the trust fund assets. The three components of cost are scheduled benefits, administrative expenses, and the railroad interchange. Each of these components is projected for each trust fund (OASI and DI). The end-of-year assets is computed by taking the beginning-of-year assets (*ASSETS*), adding tax contributions (*CONTRIB*), taxation of benefits (*TAXBEN*), and interest income (*INT*), and subtracting scheduled benefits (*BEN*), administrative expenses (*ADM*), and the railroad interchange (*RR*).

Equations 4.3.1 through 4.3.6 outline this overall structure and sequence.

$$CONTRIB = CONTRIB(\cdot) \qquad (4.3.1)$$

$$BEN = BEN(\cdot) \qquad (4.3.2)$$

$$TAXBEN = TAXBEN(\cdot) \qquad (4.3.3)$$

$$ADM = ADM(\cdot) \qquad (4.3.4)$$

$$RR = RR(\cdot) \qquad (4.3.5)$$

$$INT = INT(\cdot) \qquad (4.3.6)$$

$$ASSETS_{EOY} = ASSETS_{BOY} + CONTRIB + TAXBEN + INT - BEN - ADM - RR$$

The Cost subprocess produces annual values which help assess the financial status of the OASI, DI, and combined funds. These include the annual income rate (ANN_INC_RT), annual cost rate (ANN_COST_RT), and trust fund ratio (TFR) as outlined below.

$$ANN\_INC\_RT = ANN\_INC\_RT(\cdot) \quad (4.3.7)$$
$$ANN\_COST\_RT = ANN\_COST\_RT(\cdot) \quad (4.3.8)$$
$$TFR = TFR(\cdot) \quad (4.3.9)$$

The Cost subprocess also produces summarized values. These values are computed for the entire 75-year projection periods, as well as 25- and 50-year periods. These include the actuarial balance (*ACT_BAL*), unfunded obligation (*UNF_OBL)*, summarized income rate (*SUMM_INC_RT)*, summarized cost rate(*SUMM_COST_RT)*, and closed group unfunded obligation (*CLOSEDGRP_UNFOBL*).

$$ACT\_BAL = ACT\_BAL(\cdot) \quad (4.3.10)$$
$$UNF\_OBL = UNF\_OBL(\cdot) \quad (4.3.11)$$
$$SUMM\_INC\_RT = SUMM\_INC\_RT(\cdot) \quad (4.3.12)$$
$$SUMM\_COST\_RT = SUMM\_COST\_RT(\cdot) \quad (4.3.13)$$
$$CLOSEDGRP\_UNFOBL = CLOSEDGRP\_UNFOBL(\cdot) \quad (4.3.14)$$

The following notation is used throughout this documentation:

- *ni* represents the first year of the projection period-2007 for the 2007 TR
- *ni+74* represents the final year of the projection period-2081 for the 2007 TR
- *nf* represents the last year the cost program will project-2085 for the 2007 TR
- *nim1* is equal to *ni-1*
- *nim2* is equal to *ni-2*
- *ns* is equal to *ni+9*