The Dynamic Simulation of Income Model (DYNASIM3):

A Brief Overview

Updated March 23, 2015

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ACRONYMS

AALTCI	American Association for Long-Term Care Insurance
ACS	American Community Survey
ADLs	Activities of Daily Living
CPS	Current Population Survey
DI	Disability Insurance (Social Security)
DYNASIM	Dynamic Simulation of Income Model
FFS	Fee-for-Service
HCBS	Home and Community Based Services
HMO	Health Maintenance Organization
HRS	Health and Retirement Study
IADLs	Instrumental Activities of Daily Living
LTSS	Long-term Services and Supports
MCBS	Medicare Current Beneficiary Study
MEPS	Medical Expenditure Panel Survey
MSP	Medicare Savings Programs
NA	Not Applicable
NCHS	National Center for Health Statistics
NHATS	National Health and Aging Trends Study
NLMS	National Longitudinal Mortality Study
NLSY	National Longitudinal Survey of Youth
OASI	Old-Age and Survivors Insurance (Social Security)
OACT	Office of the Actuary
OACT 2013	Intermediate assumptions of the 2013 OASDI Trustees Report
OLS	Ordinary Least Squares
PIMS	Pension Insurance Modeling System from the Pension Benefit Guaranty Corporation
PSID	Panel Study of Income Dynamics
PV	Present value
PVE	Present value of lifetime earnings
QI	Qualified Individuals (Medicaid)
QMB	Qualified Medicare Beneficiaries
RHI	Retiree Health Insurance
SCF	Survey of Consumer Finances
SER	Summary Earnings Records
SIPP	Survey of Income and Program Participation
SLMB	Specified Low-Income Medicare Beneficiaries
SOI	Statistics of Income
SSI	Supplemental Security Income
TICS	Telephone Interview for Cognitive Status
UI	The Urban Institute
VS	Vital Statistics

I. Introduction

DYNASIM3 is a dynamic microsimulation model designed to analyze the long-run distributional consequences of retirement and aging issues. Starting with a representative sample of individuals and families, the model "ages" the data year by year, simulating such demographic events as births, deaths, marriages and divorces, and such economic events as labor force participation, earnings, hours of work, disability onset, and retirement. The model simulates Social Security coverage and benefits, as well as pension coverage and participation, and benefit payments and pension assets. It also simulates home and financial assets, health status, living arrangements, and income from non-spouse family members (coresidents). The model also includes detailed payroll and federal income tax calculators. These enable users to consider both gross and net incomes. In addition, it calculates SSI eligibility, participation, and benefits.

In recent years, we have significantly expanded DYNASIM's representation of health-related outcomes. We model the evolution of disability and chronic conditions. The model now projects stylized health insurance coverage, premium cost, and out-of-pocket medical spending including expected changes in coverage and premiums due to the Affordable Care Act. At ages 65 and older, it projects Medicare and out-of-pocket health care spending taking into account anticipated income effects (see McGuire 2014). For older Americans, DYNASIM also projects needs and expenditures for long-term services and supports (LTSS). Together, these capacities enable analysts to examine economic well-being in retirement in a comprehensive framework.

DYNASIM History

DYNASIM has a long history at the Urban Institute (UI). It was originally developed at UI in the 1970s (Orcutt et al. 1976). A revised version of the model, DYNASIM2, was built in the early 1980s specifically to analyze retirement income issues (for an overview of the model's earlier development, see Zedlewski 1990). *DYNASIM3* represents a major update of the model (see Favreault and Smith 2004). It includes a more recent starting sample and recent information on demographics and family economics. *DYNASIM3* also includes new household saving and private pension coverage modules, and Social Security and Supplemental Security Income (SSI) calculators. The model was extended in the late 2000s to cover the 75-year projection horizon used by several federal government forecasting groups. DYNASIM currently projects outcomes as far as 2087. We anticipate release of a new version of DYNASIM, DYNASIM4, later in 2015.[1]

DYNASIM3 Specification

The *DYNASIM3* input file, a self-weighting sample of over 113,000 people and 46,000 families, is based on the 1990 to 1993 Survey of Income and Program Participation (SIPP) panels.[2] We limited the sample to individuals interviewed in the long asset/pension topical

[1] DYNASIM4 will be based on the 2004 and 2008 panels of SIPP and will start projecting from 2006.
[2] Users also have the option of using a larger starting sample with 1.056 million people in 461,000 families. We do not simulate this larger population over such a lengthy time horizon, however. We typically only process these simulations through 2040 rather than 2087.

module wave. We then randomly output families based on the panel-adjusted average person weight. *DYNASIM3* focuses on nuclear families; subfamilies and unrelated individuals are treated separately. After randomly outputting families, we make a variety of adjustments to the sample (most notably, increasing the representation of those in historically undercounted groups) so that it closely aligns to target figures for the Social Security Area Population.

The final *DYNASIM3* input file is treated as though all interviews were conducted in December 1992. We adjusted all year-specific variables to correspond to this date. For example, year of birth is calculated based on 1992 minus age. We divided all income variables (earnings, Social Security benefit, pension income, wealth) by the year-specific economy-wide average earnings.

To calculate Social Security benefits for individuals, lifetime Social Security–covered earnings are needed. We create synthetic earnings histories for individuals in the SIPP input data by statistically matching SIPP records with earning histories constructed from the Panel Study of Income Dynamics (PSID) from 1968 to 1993. We also statistically matched earnings from 1951 through 1968 using an exact match of the 1972 Current Population Survey (CPS) and the SER. See Favreault and Smith (2004) for additional detail on the starting sample and earnings match.

Figure 1 illustrates the model's processing sequence. Tables I.1 through I.6 provide a quick overview of the aging modules for demographics (I.1), health status (I.2), health care usage (I.3), long-term services and supports (I.4), economics (I.5), and program participation and benefit calculators (I.6). The tables describe the numbers and types of equations used in each module and the datasets from which parameters are estimated.

Outcomes from many key aging processes are aligned to targets from the Social Security Trustees' Report (OASDI Board of Trustees 2014).[3] We use the Trustees' intermediate assumptions on age-specific employment, fertility, and mortality rates, Disability Insurance incidence, and numbers of immigrants and emigrants throughout the projection period. We also calibrate to the Trustees' assumptions about inflation, real wage growth, and wage dispersion (namely, the share of aggregate earnings that are taxable).

Selected studies that have used DYNASIM3

We have used DYNASIM for numerous analyses including the following:

- How Social Security options affect benefits and retirement income (Favreault 2009a; Favreault and Karamcheva 2011; Favreault and Mermin 2008; Favreault, Goldwyn, Smith, Thompson, Uccello, Zedlewski 2004; Favreault and Steuerle 2007, 2012; Uccello, Favreault, Smith, Thompson 2003);
- Demographic and economic trends of boomers and their likely impact on the distribution of retirement income and assets (Favreault, Johnson, Smith, Zedlewski 2012);

[3] For discussion of the Social Security trustees' assumptions, see, for example, 2011 Technical Panel on Assumptions and Methods (2011).

- Analysis of the budgetary and distributional effect of including employer sponsored health insurance premiums in the income and OASDI payroll tax base (Smith and Toder 2014);
- Impact of delayed retirement on government budgets and retirement income (Smith and Johnson 2013; Butrica, Smith, and Steuerle 2007);
- Impact of the Great Recession and 2008 stock market crash on retirement income (Butrica, Johnson, and Smith 2012; Butrica, Smith, and Toder 2010);
- How tax policy affects retirement savings (Butrica, Smith, and Toder 2008);
- How taxes and benefits affect work incentives (Butrica, Johnson, Smith, and Steuerle 2006);
- How changes in marital status and female earnings will affect retirement income of baby boomers (Butrica and Uccello 2006);
- The implications of recent earnings inequality patterns for future retirement income and Social Security's long-term fiscal balance (Favreault 2009b);
- Family structure and its importance for Social Security benefits (Favreault, Sammartino, Steuerle 2002);
- Future use of long-term care services (Johnson, Toohey, and Wiener 2007).

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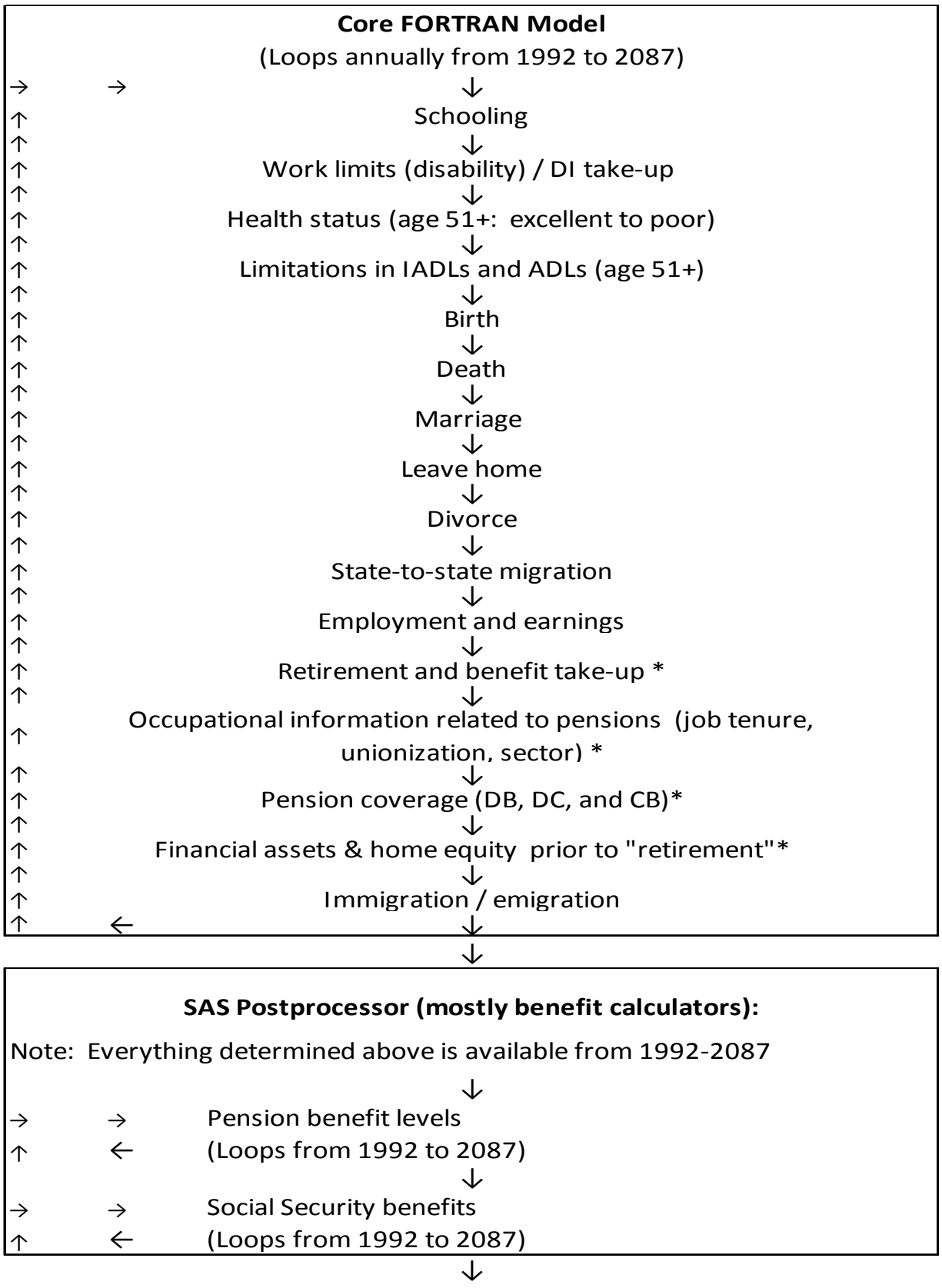
Figure 1. DYNASIM processing sequence



DYNASIM processing sequence (continued)

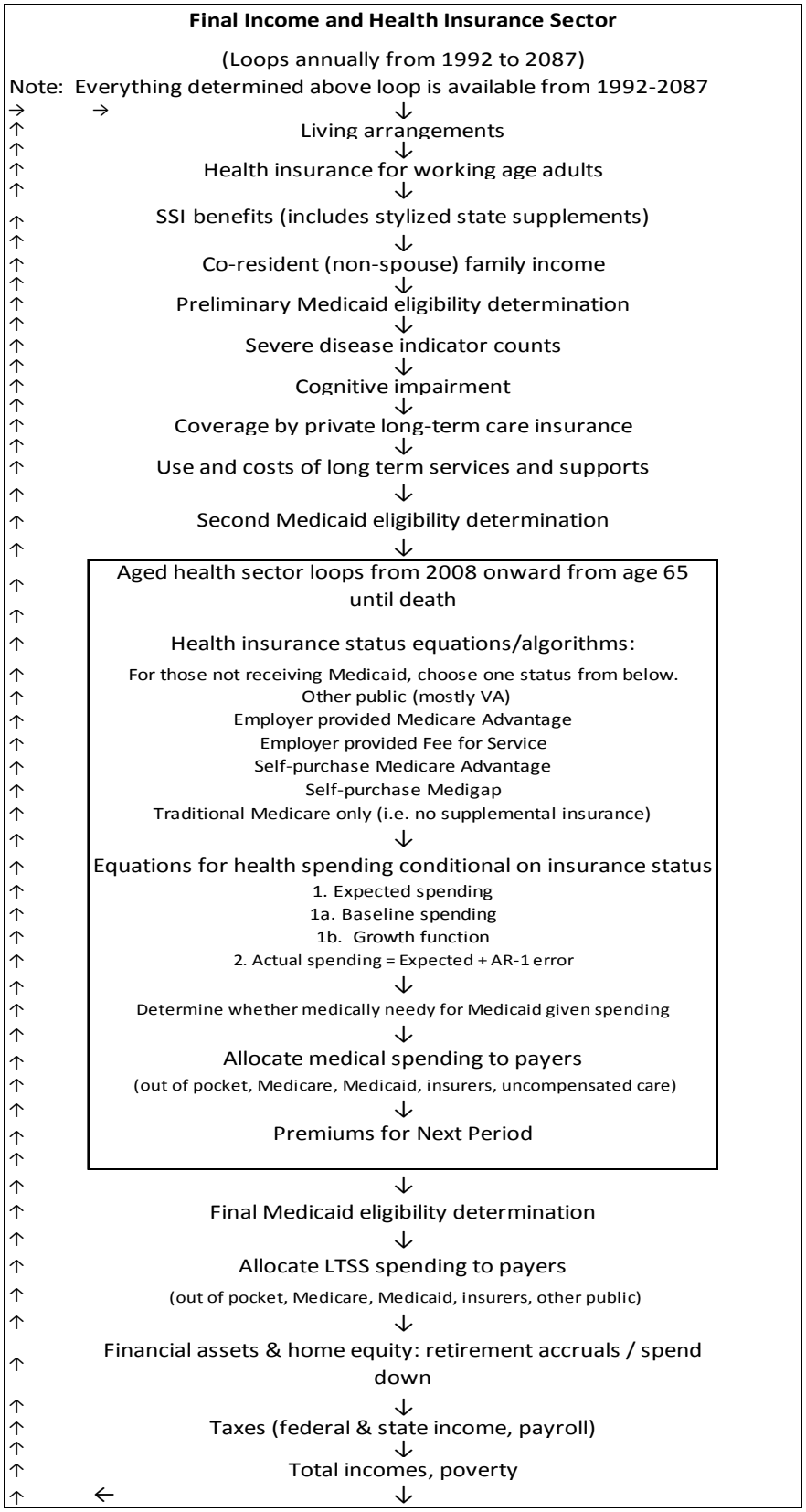


Table I.1. Summary of Core Processes Modeled in DYNASIM3: Demographics

Process	Data	Form and predictors
Demographic sector		
Birth	NLSY (1979–94), NLSY97 (1997-2005), VS, OACT 2014	7-equation parity progression model; varies based on marital status; predictors include age, marriage duration, time since last birth; uses vital rates after age 39; sex of newborn assigned by race; probability of multiple birth assigned by age and race.
Death	SIPP (1996–2008), OACT 2014, NLMS for youth	3 equations; time trend from OACT 1992–2087; includes socioeconomic differentials, health status, and ADLs/IADLs; separate process for the disabled based on age, sex, and disability duration derived from Zayatz (2011).
Internal migration	1993-2012 CPS 2001-2012 ACS	CPS estimated state move logistic model based on age, sex, marital status, nativity, race, education, number of children, and annual state unemployment rate. State migration transition matrix by current state and race from pooled ACS.
Immigration	SIPP (1990-93), OACT 2014	Observed immigrants' (post-1980) life histories are used as donors. Targets are derived from OACT, Dowhan and Duleep (2002), and vary by gender, age at immigration, source region.
Emigration		Varies based on time in U.S.
First marriage	NLSY (1979–93), NCHS	8 discrete-time logistic hazard models for persons age 15 to 34; depends on age, education, race, earnings, presence of children (for females); uses Vital Statistics rates at ages outside this range.
Remarriage	NCHS	Table lookups; separate by sex for widowed and divorced.
Mate matching	NA	Closed marriage market (spouse must be selected from among unmarried, opposite-sex persons in the population); match likelihood depends on age, race, education.
Divorce	PSID (1985–93)	Couple-level outcome; discrete-time logistic hazard model depends on marriage duration, age and presence of children, earnings of both spouses. (Also includes a separate model to predict separation.)
Leaving home	NLSY (1979–94)	3 equations; family size, parental resources, and school and work status are important predictors.
Living arrangements	SIPP (1990–93)	Projected at age 62 and older; predictors include number of children ever born, income sources, demographic characteristics.
Education	NLSY (1979–94), CPS (1995–98)	10 cross-tabulations based on age, race, sex, and parents' education.

See acronyms on page ii and references on pages 3-6.

Table I.2. Summary of Core Processes Modeled in DYNASIM3: Disability and Health Status

Process	Data	Form and predictors
Disability and health status sector		
Disability (work limitations)	SIPP (1990–93)	Discrete-time logistic hazard model incorporates various socioeconomic differences (age, education, lifetime earnings, race/ethnicity, marital status and nativity).
Health status (5-category)	HRS (1992-2010) matched to earnings data	Ordered logit models (initial conditions for those not observed on the SIPP, and then lagged status-specific transition models) incorporate various socioeconomic differences (age, education, lifetime earnings, race/ethnicity, marital status and nativity).
Counts of Limitations in (instrumental) activities of daily living	HRS (1994-2010) matched to earnings data; relative age to imply time trend	Projected at ages 51 and older. Ordered logit models (initial conditions for those not observed on SIPP, and then lagged status-specific transition models) incorporate health status, socio-economic differences (age, education, lifetime earnings, race/ethnicity, marital status and nativity). IADLs predict ADLs.
Chronic health conditions Counts	HRS (1994-2010) matched to earnings data	Projected at ages 51 and older. Ordered logit models (initial conditions at baseline, and then lagged status-specific transition models) incorporate health status, IADLs, ADLs, mortality, socio-economic differences (age, education, race/ethnicity, marital status and nativity).
Cognitive status (TICS)	HRS (1994-2010)	Projected at ages 65 and older. Count models (initial conditions at baseline, and then lagged status-specific transition models) that incorporate age, race/ethnicity, sex, education, health status, ADL limitations, IADL limitations, family income as a percent of poverty. Error term for subsequent status is redrawn once between age 67 and death.

See acronyms on page ii and references on pages 3-6.

Table I.3. Summary of Core Processes Modeled in DYNASIM3: Health Care Coverage and Use (Excluding Long-Term Services and Supports)

Process	Data	Form and predictors
Medicare (including RHI)		
Medicare and total spending	MCBS (2007-09)	Predicted at ages 65 and older. Square root for baseline, includes AR-1 that varies based on prior spending. Baseline predictors include age, sex, education, mortality, marital status, insurance type, health status, chronic conditions, ADLs/IADLs, ln(per capita income), region, nursing home status, household size. Growth function takes into account technological change and growth in costs shares (premiums and out-of-pocket).
Insurance status	MCBS (2007-09)	Seven stylized statuses (Medicaid, Other public, employer fee-for service, employer HMO, self-pay fee-for-service, self-pay HMO, no supplemental) predicted at ages 65 and older. Multinomial logit for baseline. Baseline predictors include age, education, health status, limitations in ADLs/IADLs, race/ethnicity, marital status, mortality, gender, chronic conditions, household size. Transition model takes into account premiums and health status.
Premiums	Rule based	Take into account spending growth, changes in insurance status, load factors.
Out of pocket	MCBS (2007-09)	Varies by insurance type and decile of spending.
Medicaid		
Medicaid eligibility	Rule based	Separate full scope pathways for SSI receipt/eligibility, Percent-of-poverty, Medically Needy, non-SSI in nursing home if income near SSI limits; also QMB, SLMB, and QI.
Medicaid take-up	Stochastic, with grounding in related literature	For Medically needy, varies by spending quintile and income quintile; lower for MSPs than for full-scope pathways, with QMB higher than SLMB and SLMB higher than QI. Because HCBS programs have waiting lists, take-up is assumed to be 100 percent. Similarly, nursing homes are assumed to require Medicaid application for those qualifying through that pathway (i.e., take up is also 100 percent).
Employer provided insurance for workers		
Health insurance coverage	SIPP (2004, 2008)	Logistic regression among workers. Predictors: firmsize (8 groups), region (4 groups), employer sector (4 groups), education, union, average indexed earnings in last 3 years * sex, year.
Out of pocket expenses	MEPS (2007-2011); Kaiser Family Foundation (2012)	Logistic for presence, OLS for ln amount, separate by married/ unmarried. Age, education, ethnicity/ race, detailed marital status, number of children, homeownership, wealth, detailed health insurance status indicators, SSI, OASDI, earnings, earnings changes, metropolitan status, institutionalization status, state. Uses tabular data from Kaiser Family Foundation Employer Health Insurance survey to impute total and worker share of employer health insurance premium by family size, employment sector, firm size, and earnings.

See acronyms on page ii and references on pages 3-6.

Table I.4. Summary of Core Processes Modeled in DYNASIM3: Long-Term Services and Supports

Process	Data	Form and predictors
Long-term services and support		
Use of home care, nursing home, and residential care	HRS (1994-2010)	Predicted at ages 65 and older. Trivariate probit model incorporates various socioeconomic differences (age, education, race/ethnicity, family income, marital status, nativity and number of children, wealth). Also includes chronic conditions, cognitive impairment, IADLs, ADLs, health status, and mortality.
Intensity of LTSS use (home care hours and nursing home days)	HRS (2002-2010); NHATS (2011)	Separate zero-truncated negative binomial models for those projected to have each type of expense; incorporates various socioeconomic differences (age, education, race/ethnicity, family income, marital status, nativity and number of children, wealth). Also includes chronic conditions, cognitive impairment, IADLs, ADLs, and health status. For home care, use NHATS table to translate monthly into annual.
LTSS prices, Medicaid	Various (e.g., Eljay 2014, 2012, 2009, Ng. et al. 2014)	Use state-specific Medicaid rates from various review articles when attributing costs for LTSS.
LTSS prices, non-Medicaid	Genworth (2014)	State specific. Use median, semi-private NH rooms, home health aide rates. Indexed to wage inflation after baseline. Assume that user provided share of individuals with family income of at least 5 times poverty pays above market rates and a user provided share of individuals with family income of less than 3 times poverty pays below market rates.
Private long-term care insurance	HRS (2002-2010); Parameters from AALTCI	Predict unlapsed coverage as of age 65 (using sample of 60-65 year olds). Predictors include education, life expectancy, health status, wealth, number of children, nativity, race/ethnicity, gender. Plans have varied daily/ lifetime maximum (5 and 6 groups, respectively), elimination periods (4 groups), inflation protection (yes/no).
Indicator of whether limitations meet trigger status	MCBS (2007-09), but calibrated to user targets	Predictors include age, education, health status, number of limitations in IADLs, service use (nursing home and home care), mortality, number of chronic conditions, race, Medicaid receipt.
Allocation of LTSS costs to payers	MCBS (2007-09), plus Medicaid and private plan rules (see above)	Use Medicaid, Medicare, and stylized private plan rules to determine eligibility for payment from different sources. Estimates from MCBS and aggregates provide targets.
Veterans Administra-tion nursing home	MCBS (2007-09)	Applied only to those in nursing homes. Predictors include gender, education, race, IADL limitations, health status, chronic conditions, Medicaid status.

See acronyms on page ii and references on pages 3-6.

Table I.5. Summary of Core Processes Modeled in DYNASIM3: Economics

Process	Data	Form and predictors
Economic sector		
Labor supply and earnings	PSID (1980–2007), NLSY (1979–2009), OACT 2013 (employment rates, wage/price growth)	Separate participation, hours decisions, wage rates for 16 age-race-sex groups; all equations have permanent and transitory error components; key predictors include marital status, education level, age splines, region of residence, disability status, whether currently in school, birth cohort, job tenure, health status, OASDI beneficiary status, and education level interacted with age splines; also number and ages of children. Model forms vary by outcome. Special process projects the highest earners' earnings.
Job change	SIPP 2001-2004 (Update pending)	Assigned from age 25 using a series of age-centered regressions (based on age, gender, education, industry, tenure, union status).
Pension coverage and benefit levels	BLS, EBRI, SIPP/DER, PIMS (PBGC), Morningstar	Uses SIPP reports for initial values; accumulation of defined contribution plans based on SIPP/DER; stock and bond portfolios vary by individual risk and age; assignment of defined benefit income based on job tenure and career earnings. Defined contribution models include innovations such as autoenrollment and target date funds.
Wealth	SIPP, PSID (1984–94), HRS, SIPP 1990–93 matched with SSA administrative data (1951–99); SCF	4 random-effects models for ownership/value given ownership separately for housing and nonhousing wealth; additional model for spenddown after first OASDI receipt; key predictors include age, race, marital status, family size, birth cohort, dual-earner status, pension coverage, recent and lifetime earnings; each model includes an individual-specific error term. Model of spenddown at older ages takes into account uninsured acute and LTSS expenditures. Optional SCF calibration.

See acronyms on page ii and references on pages 3-6.

Table I.6. Summary of Core Processes Modeled in DYNASIM3: Program Participation for Cash Transfers and Benefit and Tax Calculators

Process	Data	Form and predictors
Tax calculators		
OASDHI Payroll tax	Rule-based	
Personal Income tax	Rule-based	Incorporates revisions to the tax law through 2014. Specific components DYNASIM does not project (e.g., charitable contributions) are imputed from a donor file based on the SOI.
Donor records	SOI (2001)	Elements for donors are wage-adjusted, and trends (for example interest, dividends) are calibrated to more recent SOI files.
Benefits sector		
OASI take-up	SIPP (2001–04) matched to SSA administrative data (1951–2008)	Eligibility is deterministic; benefit claiming simulated beginning at age 62 (60/61 for survivors); discrete-time hazard models to determine age at take-up based on age, benefit amount, spousal characteristics, and Social Security policy parameters.
DI take-up	SIPP (1990–93) matched to SSA administrative data (1951–99)	Benefit claiming predicted through discrete-time hazard model including age, education, lifetime earnings, race, ethnicity, marital status, nativity, and disability status in t - 1.
OASDI benefits	Rule-based	Sophisticated calculator incorporates entire work and marriage histories, auxiliary benefits for spouses/survivors and former spouses, and the retirement earnings test.
SSI take-up and benefits	SIPP (1990–93) matched to SSA administrative data (1951–99)	Uses program rules (income and asset tests, plus stylized state supplements) to determine eligibility and benefit level among participants; participation is based on potential benefit, economic and demographic and characteristics including age, education, race, family structure, home ownership, and income sources.

See acronyms on page ii and references on pages 3-6.