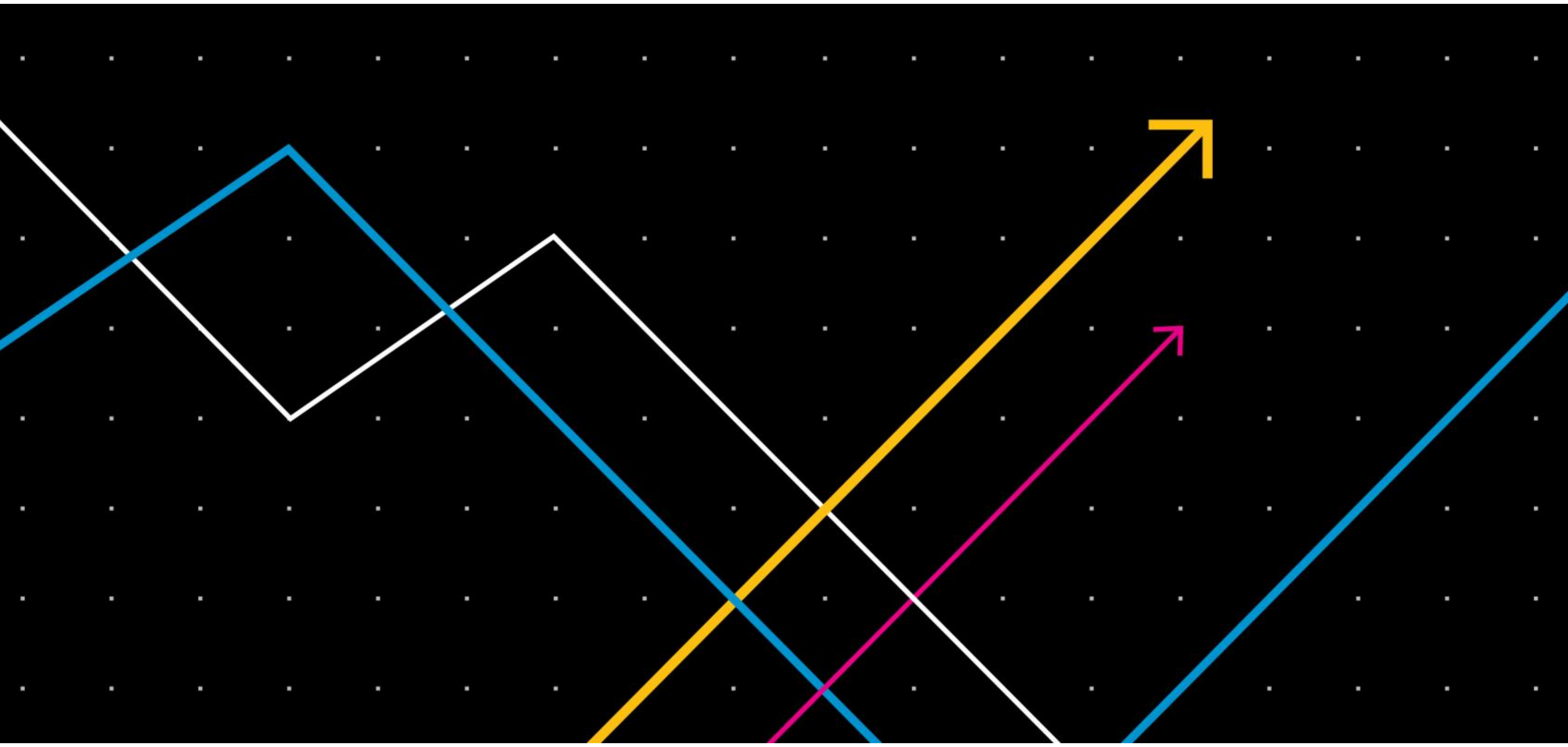

RESEARCH REPORT

# The Dynamic Simulation of Income Model (DYNASIM)

## An Overview

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# Abbreviations

| | |
|---|---|
| ACA | Affordable Care Act |
| ACS | American Community Survey |
| ADLs | activities of daily living |
| CB | cash balance |
| CPS | Current Population Survey |
| DI | disability insurance (Social Security) |
| DB | defined benefit |
| DC | defined contribution |
| DER | detailed earnings records |
| DYNASIM | dynamic simulation of income model |
| ESI | employer-sponsored health insurance |
| 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 |
| NLSY | National Longitudinal Survey of Youth |
| OASI | old age and survivors insurance (Social Security) |
| OASDI | old age, survivors, and disability insurance (Social Security) |
| OASDHI | old age, survivors, disability, and health insurance (Social Security and Medicare) |
| OACT | Office of the Actuary |
| OACT 2014 | intermediate assumptions of the 2014 OASDI trustees' report |
| PBGC | Pension Benefit Guaranty Corporation |
| PIMS | pension insurance modeling system from PBGC |
| PSID | Panel Study of Income Dynamics |
| QI | qualified individuals (Medicaid) |
| QMB | qualified Medicare beneficiaries |
| SCF | Survey of Consumer Finances |
| SIPP | Survey of Income and Program Participation |
| SLMB | specified low-income Medicare beneficiaries |
| SOI | Statistics of Income |
| SSA | Social Security Administration |
| SSI | Supplemental Security Income |
| VA | Veterans Administration |
| VS | vital statistics (from the CDC) |

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# Introduction

The older population is surging as people live longer and the baby boom generation ages, creating significant challenges for the nation. With the number of workers per retiree shrinking, how can we enable people to maintain their living standards after they retire, help them cover the cost of acute medical care and long-term services and supports (LTSS) when they need basic personal care, and ensure all seniors have enough income to cover basic living expenses? Achieving these goals will likely require changes in Social Security, Medicare, and Medicaid, as well as fresh ideas about how to finance LTSS and new housing options that allow older adults to live independently as long as possible.

The Urban Institute's unique dynamic simulation of income model (DYNASIM) helps sort through the various policy choices. Using the best and most recent data available, it projects the size and characteristics of the US population for the next 75 years, assuming current policies and practices continue. DYNASIM provides estimates nationally and for states with large and medium-sized populations. Projected characteristics include basic demographics, economic outcomes, health and disability status, and spending on acute medical care and LTSS.

DYNASIM can also describe "what if" scenarios by showing how outcomes would likely evolve under various changes to public policies, business practices, or individual behaviors. Because it projects outcomes for a representative sample of the entire population, not just for typical individuals and families, the model can show how different groups will fare over time, who is moving ahead and who is being left behind, and which groups would win and lose under various policy options.

This report describes how DYNASIM works. It discusses the technical approach, identifies the underlying datasets, and summarizes the various equations embedded in the model. We devote special attention to describing how DYNASIM projects financial status, health and disability status, health insurance coverage, medical spending, and use of LTSS.

# Model Overview

DYNASIM 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 demographic events, such as births, deaths, marriages, and divorces, and economic events, such as labor force participation, earnings, hours of work, disability onset, and retirement. The model simulates Social Security coverage and benefits, pension coverage and participation, and benefit payments and pension assets. It also simulates home and financial assets, health status, living arrangements, and income from nonspouse family members (coresidents). DYNASIM includes detailed payroll and federal income tax calculators that enable users to examine incomes net of tax as well as gross incomes. In addition, it calculates Supplemental Security Income (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 and project health insurance coverage, premium costs, and out-of-pocket medical spending, including expected changes in coverage and premiums related to the Affordable Care Act (ACA). At ages 65 and older, projections for Medicare and out-of-pocket health care spending account for the possibility that the rising financial burden of health care spending might induce consumers to use fewer health care services (McGuire 2014). For older Americans, DYNASIM also projects needs and expenditures for LTSS. Together, these capacities provide a comprehensive picture of economic security at older ages.

## DYNASIM History

DYNASIM has a long history at the Urban Institute. It was originally developed at Urban in the 1970s (Orcutt, Caldwell, and Wertheimer 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, the current version of the model, represents a major update (Favreault and Smith 2004). It includes a more recent starting sample and updated information on demographics and family economics. DYNASIM3 also includes new household saving and private pension coverage modules and Social Security and SSI calculators. The model was extended in the late 2000s to cover the 75-year projection horizon used by several federal government forecasts.

DYNASIM currently projects outcomes as far as 2087. We expect to release a new version of the model—DYNASIM4—in early 2016.[1]

## DYNASIM Specifications

The DYNASIM input file, a self-weighting sample of over 113,000 people and 46,000 families, is based on the 1990 through 1993 Survey of Income and Program Participation (SIPP) panels.[2] We limited the sample to individuals interviewed in the long asset–pension topical module wave. We then randomly output families based on the panel-adjusted average person weight. DYNASIM 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 it closely aligns to target figures for the Social Security Area Population.

The final DYNASIM 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 benefits, pension income, wealth) by the year-specific economywide average earnings.

To calculate Social Security benefits for individuals, lifetime Social Security–covered earnings are needed. We created 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 through 1993. We also statistically matched earnings from 1951 through 1968 by using an exact match of the 1972 Current Population Survey (CPS) and summary earnings records. See Favreault and Smith (2004) for additional detail on the starting sample and earnings match.

Figure 1 illustrates the model's processing sequence. Tables 1 through 6, respectively, provide overviews of the aging modules for demographics, disability and health status, health care coverage and use, LTSS, economics, and program participation and benefit calculators. The tables describe the numbers and types of equations used in each module and the datasets from which parameters are estimated. All acronyms used in the figure and tables are defined at the beginning of this report.

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).

## Select Studies Based on DYNASIM

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 et al. 2004; Favreault and Steuerle 2007, 2012; Uccello et al. 2003);
- Demographic and economic trends of baby boomers and their likely impact on the distribution of retirement income and assets (Favreault et al. 2012);
- Analysis of the budgetary and distributional effects of including employer-sponsored health insurance (ESI) premiums in the income and old age, survivors, and disability insurance (OASDI) payroll tax base (Smith and Toder 2014);
- Impact of delayed retirement on government budgets and retirement income (Butrica, Smith, and Steuerle 2007; Smith and Johnson 2013);
- 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 et al. 2006);
- How changes in marital status and female earnings will affect retirement income of baby boomers (Butrica and Uccello 2007);
- 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, and Steuerle 2002); and
- Future use of long-term care services (Johnson, Toohey, and Wiener 2007).

FIGURE 1

**DYNASIM Processing Sequence**

**Core FORTRAN Model**

(Loops annually from 1992 to 2087)

↓

Schooling

↓

Work limits (disability) / DI take-up

↓

Health status (age 51+: excellent to poor)

↓

Limitations in IADLs and ADLs (age 51+)

↓

Birth

↓

Death

↓

Marriage

↓

Leave home

↓

Divorce

↓

State-to-state migration

↓

Employment and earnings

↓

Retirement and benefit take-up *

↓

Occupational information related to pensions (job tenure, unionization, sector) *

↓

Pension coverage (DB, DC, and CB)*

↓

Financial assets & home equity prior to "retirement"*

↓

Immigration / emigration

↓

↓

**SAS Postprocessor (mostly benefit calculators):**

Note: Everything determined above is available from 1992-2087

↓

Pension benefit levels

(Loops from 1992 to 2087)

↓

Social Security benefits

(Loops from 1992 to 2087)

↓

FIGURE 1 (CONTINUED)

**Final Income and Health Insurance Sector**

(Loops annually from 1992 to 2087)

Note: Everything determined above loop is available from 1992-2087

↓

Living arrangements

↓

Health insurance for working age adults

↓

SSI benefits (includes stylized state supplements)

↓

Co-resident (non-spouse) family income

↓

Preliminary Medicaid eligibility determination

↓

Severe disease indicator counts

↓

Cognitive impairment

↓

Coverage by private long-term care insurance

↓

Use and costs of long term services and supports

↓

Second Medicaid eligibility determination

↓

Aged health sector loops from 2008 onward from age 65 until death

Health insurance status equations/algorithms:

For those not receiving Medicaid, choose one status from below.

Other public (mostly VA)

Employer provided Medicare Advantage

Employer provided Fee for Service

Self-purchase Medicare Advantage

Self-purchase Medigap

Traditional Medicare only (i.e. no supplemental insurance)

↓

Equations for health spending conditional on insurance status

1. Expected spending

1a. Baseline spending

1b. Growth function

2. Actual spending = Expected + AR-1 error

↓

Determine whether medically needy for Medicaid given spending

↓

Allocate medical spending to payers

(out of pocket, Medicare, Medicaid, insurers, uncompensated care)

↓

Premiums for Next Period

↓

Final Medicaid eligibility determination

↓

Allocate LTSS spending to payers

(out of pocket, Medicare, Medicaid, insurers, other public)

↓

Financial assets & home equity: retirement accruals / spend down

↓

Taxes (federal & state income, payroll)

↓

Total incomes, poverty

↓

TABLE 1

**Summary of Core Processes Modeled in DYNASIM: Demographics**

| Process | Data | Form and predictors |
|---|---|---|
| Birth | NLSY (1979–94), NLSY97 (1997–2005), VS, OACT 2014 | Seven-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, National Longitudinal Mortality Study for youth | Three equations; time trend from OACT 1992–2087; includes socioeconomic differentials, health status, and ADLs and IADLs; separate process for the disabled based on age, sex, and disability duration derived from Zayatz (2011). |
| Internal migration | 1993–2012 CPS, 2001–12 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 and Dowhan and Duleep (2002) and vary by gender, age at immigration, and source region. |
| Emigration | Social Security Administration (SSA) administrative data | Hazard model that includes age of entry and origin country as predictors. |
| First marriage | NLSY (1979–93), National Center for Health Statistics | Eight discrete-time logistic hazard models for persons ages 15 to 34; depends on age, education, race, earnings, presence of children (for females); uses VS rates at ages outside this range. |
| Remarriage | National Center for Health Statistics | Table lookups; separate by sex for widowed and divorced. |
| Mate matching | Not applicable | Closed marriage market (spouse must be selected from among unmarried, opposite-sex persons in the population); match likelihood depends on age, race, and education. |
| Divorce | PSID (1985–93) | Couple-level outcome; discrete-time logistic hazard model depends on marriage duration, age and presence of children, and earnings of both spouses; includes a separate model to predict separation. |
| Leaving home | NLSY (1979–94) | Three equations; family size, parental resources, and school and work status are important predictors. |
| Living arrangements | SIPP (1990–93) | Projected at ages 62 and older; predictors include number of children ever born, income sources, and demographic characteristics. |
| Education | NLSY (1979–94), CPS (1995–98) | Ten cross-tabulations based on age, race, sex, and parents' education. |

TABLE 2

**Summary of Core Processes Modeled in DYNASIM: Disability and Health Status**

| Process | Data | Form and predictors |
|---|---|---|
| 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 (five categories) | HRS (1992–2012) matched to earnings data | Ordered logit models (initial conditions for those not observed in 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 IADLs | HRS (1994–2012) 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 in SIPP, and then lagged status-specific transition models) incorporate health status, socioeconomic differences (relative age, education, lifetime earnings, race/ethnicity, marital status, and nativity), prior period lags, and age interactions. IADLs predict ADLs. |
| Counts of chronic health conditions | 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, IADL limits, ADL limits, mortality, and socioeconomic differences (age, education, race/ethnicity, marital status, and nativity). |
| Cognitive status (Telephone Interview for Cognitive Status) | HRS (1994–2010) | Projected at ages 65 and older. Probit for presence of a score and then 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, and family income as a percentage of poverty. Error term for subsequent status is redrawn once between age 67 and death. |

TABLE 3

**Summary of Core Processes Modeled in DYNASIM: Health Care Coverage and Use (Excluding LTSS)**

| Process | Data | Form and predictors |
|---|---|---|
| **Medicare (including retiree health insurance)** | | |
| Medicare and total spending | MCBS (2007–09) | Projected 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, ADL and IADL limits, ln(per capita income), region, nursing home status, and household size. Growth function takes into account technological change and growth in costs shares (premiums and out-of-pocket expenses). |
| 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) projected at ages 65 and older. Multinomial logit for baseline. Baseline predictors include age, education, employment status, health status, limitations in ADLs and IADLs, race/ethnicity, marital status, mortality, gender, chronic conditions, and household size. Transition model takes into account premiums and health status. |
| Premiums | Rule-based | Takes into account spending growth, changes in insurance status, and load factors. |
| Out-of-pocket | MCBS (2007–09) | Varies by insurance type and decile of spending. |
| **Medicaid** | | |
| Medicaid eligibility | Rule-based, state-specific | Separate full-scope pathways for SSI eligibility and receipt, percentage of poverty, medically needy, and non-SSI in nursing home if income near SSI limits; also QMB, SLMB, and QI. Accounts for cost shares, spousal impoverishment, partnership programs, and other details. |
| Medicaid take-up | Stochastic, with grounding in related literature | For medically needy, varies by spending quintile and income quintile; lower for Medicare savings programs than for full-scope pathways, with QMB higher than SLMB, and SLMB higher than QI. Because home and community-based services 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). |
| **ESI** | | |
| Health insurance coverage | SIPP (2004 and 2008) | Logistic regression among workers. Predictors: firm size (eight groups), region (four groups), employer sector (four groups), education, union, average indexed earnings in last three years * sex, and year. |
| Out-of-pocket expenses | Medical Expenditure Panel Survey (2007–11), Kaiser Family Foundation (2012) | Logistic for presence, ordinary least squares for ln amount, separate by married and 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, and 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. |

TABLE 4

**Summary of Core Processes Modeled in DYNASIM: Long-Term Services and Supports**

| Process | Data | Form and predictors |
|---|---|---|
| Use of home care, nursing home, and residential care | HRS (1994–2010) | Projected at ages 65 and older. Trivariate probit model incorporates various socioeconomic differences (age, education, race/ethnicity, family income, insurance status, marital status, nativity and number of children, and 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 (2002–10), National Health and Aging Trends Study (2011) | Separate zero-truncated negative binomial models for individuals projected to have either type of expense; incorporates various socioeconomic differences (age, education, race/ethnicity, family income, insurance status, marital status, nativity and number of children, and wealth). Also includes chronic conditions, cognitive impairment, IADLs, ADLs, and health status. For home care, use National Health and Aging Trends Study table to translate monthly into annual. |
| LTSS prices, Medicaid | Various (e.g., Eljay LLC 2009, 2012, 2014; Mollica 2009; Ng et al. 2014) | Use state-specific Medicaid rates from various review articles when attributing costs for LTSS. Indexed to wage inflation after baseline. |
| LTSS prices, non-Medicaid | Genworth (2014) | State specific. Use median, semiprivate nursing home rooms, home health aide rates. Indexed to wage inflation after baseline. Assume user-provided share of individuals with family income of at least five times poverty level pays above-market rates and user-provided share of individuals with family income of less than three times poverty level pays below-market rates. |
| Private long-term care insurance (coverage, plan features) | HRS (2002–10), parameters from American Association for Long-Term Care Insurance and private industry data | Project unlapsed coverage as of age 65 (using sample of 60- to 65-year-olds). Predictors include education, life expectancy, health status, wealth, number of children and nativity, race/ethnicity, and gender. Plans have varied daily and lifetime maximum (five and six groups, respectively), elimination periods (four groups), inflation protection (yes or no). Lapse is projected from ages 66 onward. |
| 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, and 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 historical aggregates provide targets. |
| VA nursing home | MCBS (2007–09) | Applied only to those in nursing homes. Predictors include gender, education, race, IADL limitations, health status, chronic conditions, and Medicaid status. |

TABLE 5

**Summary of Core Processes Modeled in DYNASIM: Economics**

| Process | Data | Form and predictors |
|---|---|---|
| Labor supply and earnings | PSID (1980–2007), NLSY (1979–2009), OACT 2014 (employment rates, wage and 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 2001–04 (update pending) | Assigned from age 25 using a series of age-centered regressions (based on age, gender, education, industry, tenure, and union status). |
| Pension coverage and benefit levels | US Bureau of Labor Statistics, Employee Benefits Research Institute, SIPP/DER, PIMS (PBGC), Morningstar | Uses SIPP reports for initial values; accumulation of DC plans based on SIPP/DER; stock and bond portfolios varied by individual risk and age; assignment of DB income based on job tenure and career earnings. DC 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 | Four random-effects models for ownership and 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, and 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. |

TABLE 6

**Summary of Core Processes Modeled in DYNASIM: Program Participation for Cash Transfers and Benefit and Tax Calculators**

| Process | Data | Form and predictors |
|---|---|---|
| **Tax calculators** | | |
| OASDHI payroll tax | Rule-based | The OASDI payroll tax equals the Congressionally set percentage of earnings (up to the taxable maximum for OASDI), depending on self-employment status. High earners face a higher Medicare payroll tax. The taxable maximum increases each year in accordance with OACT 2014. |
| 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 (e.g., 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 or 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 and economic and demographic characteristics including age, education, race, family structure, home ownership, and income sources. |

# Projecting Financial, Health, and Disability Status

This section describes how DYNASIM projects financial status, health and disability status, health insurance coverage and medical spending, and use of LTSS.

## Financial Status

### Employment and Earnings

DYNASIM projects the likelihood that an individual works each year as a function of age, sex, race/ethnicity, education, health and disability status, geographic region, marital status, student status, number of young children, spouse characteristics (employment, age, disability, and education), immigrant status, Social Security benefit status, cohort, and the state-specific unemployment rate. The likelihood also includes an estimated individual-specific error term that captures nonvarying individual preferences that are independent of observed characteristics. The model classifies an individual as employed if his or her expected probability of working exceeds a given random number. The selection criteria are adjusted so that our employment projections for men and women within particular age groups hit the trustees' targets.[4]

DYNASIM uses a similar set of explanatory variables to assign hourly wages and annual hours of employment to those projected to work. Annual earnings are computed as the product of the hourly wage and annual hours worked. DYNASIM adjusts the underlying predicted annual wage for real wage growth based on the trustees' economic assumptions. It also aligns the annual earnings of workers to hit the trustees' annual earnings targets. The model has a special projection procedure for very high earners—those in the top one-tenth of 1 percent—because of the relatively high share of aggregate earnings that such earners garner.

The underlying price and wage targets from the Social Security trustees affect various other projections, including the Social Security wage base (the taxable maximum), the indexing of wages for the calculation of Social Security benefits, SSI benefit parameters, stock and bond rates of return, and interest rates. Changes in economic conditions also affect retirement and Social Security benefit claiming, as do marriage, divorce, fertility, and schooling outcomes.

## Income and Payroll Tax

DYNASIM calculates federal income tax liabilities by using an income tax calculator developed by Jon Bakija (Smith et al. 2007). The tax calculator uses annual projected tax unit income and assets from the SIPP panels matched to a Statistics of Income (SOI) data file that includes itemized deductions and other variables needed to calculate income tax. The tax calculator assumes current-law federal income tax rules, including the provisions in the American Tax Relief Act of 2012. Tax provisions affecting the treatment of Social Security benefits have not changed since 1993, but the share of Social Security benefits included in taxable income is continually increasing under current law partly because the threshold levels for including benefits in taxable income are not indexed for inflation. Other than the Social Security thresholds, DYNASIM inflates thresholds by projected changes in the consumer price index through 2024 and by wage growth after 2024. DYNASIM also calculates Social Security coverage and annual payroll taxes by using current-law payroll tax rates. Only earnings in Social Security–covered employment are subject to payroll taxes.

## Retirement Accounts

DYNASIM projects retirement accounts based on annual contributions to investment accounts and accumulated investment returns. DYNASIM starts with the self-reported SIPP retirement account balances. Because of documented deficiencies in the SIPP asset data (Czajka, Jacobson, and Cody 2003; Smith, Favreault, and Cashin 2005), asset balances in retirement accounts—as well as financial assets outside of retirement accounts—in DYNASIM's starting SIPP sample are adjusted to align with asset distributions from the 2007 Survey of Consumer Finances (SCF).

DYNASIM grows stock, long-term corporate bond, and long-term government bond portfolios by using historical price changes and returns through 2013. Investment experience varies for each individual because the model sets rates of return stochastically, using historical means and standard deviations. The model accounts for the 2008 stock market crash, which reduced equity values by 37 percent, by assuming the market recovers to half its projected precrash value by 2017 (Butrica, Smith, and Toder 2009, 2010). DYNASIM implements this assumption by using historic returns through 2013 and assumes a 7.42 percent average real rate of return on stocks from 2014 to 2017 before stocks resume their historic average real return of 6.5 percent after 2017. DYNASIM assumes mean real rates of return of 3.5 percent for corporate bonds, 3.0 percent for government bonds, and standard deviations of 17.28 percent for stocks and 2.14 percent for bonds.[5] The 6.5 percent real return on stocks reflects a capital appreciation of about 3.5 percent and a dividend yield of around 3.0 percent, in line with the long-term performance of the S&P 500. The model subtracts one percentage point from annual stock and bond returns to reflect administrative costs.

Individuals are assigned an individual-specific risk tolerance based on SCF data. An individual's share of retirement account assets invested in equities varies by age and risk tolerance, with high-risk and younger individuals investing more in equities than low-risk and older individuals.

DYNASIM assigns a growing share of workers to invest in target-date funds over time by using prevalence rates from the Employee Benefits Research Institute (Copeland 2011). DYNASIM assigns target-date investors to specific target-date funds based on the dollar-weighted share of the 40 largest target-date funds (Morningstar 2012, table 3). Workers with target-date funds use the stock and bond portfolio mix of their assigned fund at each age. All investors rebalance portfolios annually to preserve the target mix of stocks and bonds.

DYNASIM assumes 40 percent of firms offering defined contribution (DC) plans implement automatic enrollment beginning in 2008. Automatic enrollment increases the probability new hires will participate in DC plans in the first year on the job, but workers can still opt out.

DYNASIM allows some workers to cash out retirement account balances with job changes or job losses. Younger workers, workers with lower account balances, and workers who lose their jobs are more likely to cash out retirement account balances than are older workers, those with higher balances, and those who move from one job to another without a break in employment. High unemployment contributes to lower lifetime DC pension savings through workers' hardship withdrawals and loss of contributions (and lost returns on those lost contributions) when out of work.

## Financial Assets

DYNASIM uses random-effects models developed for the Social Security Administration's (SSA) MINT model to project financial assets. DYNASIM starts with SIPP self-reported assets (saving, checking, and money market accounts; certificates of deposit; stocks; bonds; and equity in businesses, vehicles, and nonhome real estate, less unsecured debt). As with retirement accounts, we adjust the SIPP starting values to align with the household asset distribution from the 2007 SCF.

Financial assets accumulate and decumulate as a function of family characteristics and earnings and projected wage differentials. The main economic explanatory variable is the individual's lifetime earnings relative to the cohort average. Individuals with above-average lifetime earnings accumulate assets faster than those with below-average lifetime earnings. A spell of unemployment will lower a worker's average compared with a worker who remains employed continuously. The longer the unemployment spell, the greater is the differential in lifetime earnings relative to the cohort average, and the greater is the impact on projected assets. Assets accumulate at the family level, so husbands and wives equally share family assets. We assume couples split assets at divorce and survivors inherit the assets of deceased spouses.

DYNASIM projects nonpension financial assets over three age ranges: up to age 50, from 51 to retirement, and from retirement to death. Equations projecting assets to age 50 were estimated based on the PSID (Toder et al. 2002). Equations projecting assets from age 51 to retirement were estimated on the first seven waves of the Health and Retirement Study (HRS) (Smith et al. 2007). Equations projecting assets from retirement to death were estimated on a synthetic panel of SIPP data (Toder et al. 1999). The latter two datasets include historic earnings from the SSA's summary earnings records data.

Asset decumulation includes simulated sharp reductions in assets associated with health shocks, institutionalization, and end of life.

## Home Equity

As with financial assets, DYNASIM uses random-effects models developed for the SSA's MINT model to project home equity. DYNASIM starts with SIPP self-reported homeownership status and home equity. In addition, DYNASIM projects home purchases among renters and home sales among homeowners. The home purchase and sale hazard models were estimated on the PSID from age 25 until death (Toder et al. 2002). These models project home equity over three age ranges: 25 to 50, 51 to 70, and 71 to death. Equations projecting home equity to age 50 were estimated based on the PSID (Toder et al. 2002). Equations projecting equity from age 51 to 70 were estimated based on the first seven waves of the HRS (Smith et al. 2007). DYNASIM holds real home equity constant after age 70 for individuals who continue to own their homes.

## Retirement Income

DYNASIM projects income from various other sources to generate a measure of total household income. Social Security income is computed based on the benefit formula, projected lifetime earnings, marriage history, and an equation projecting benefit take-up. DYNASIM projects retirement plan coverage and participation, plan contributions, and payments from employer-sponsored defined benefit (DB) pension plans, cash balance (CB) plans, and retirement accounts based on equations of job change. DYNASIM also projects asset income as a function of projected assets. Finally, DYNASIM calculates SSI for eligible individuals based on total family income, assets, and state-specific program rules.

## Pensions

DYNASIM projects pensions from employer-sponsored DB plans, CB plans, and retirement accounts, including 401(k) and 403(b) plans, Keoghs, and IRAs. Starting information about pension coverage on current and past jobs, pension contribution rates, and account balances comes from SIPP self-reported information. DYNASIM projects employer characteristics and employer benefits (pensions and health insurance) at each simulated job change.

DYNASIM projects private DB pensions by using DB plan formulas from the Pension Benefit Guaranty Corporation's pension insurance modeling system (PIMS). These DB plan formulas are randomly assigned to DB participants based on broad industry, union status, and firm size categories, as well as an indicator of whether the firm offers both DB and DC plans. For government pensions, DYNASIM uses actual benefit formulas to calculate benefits for federal government workers and military personnel; to estimate pension benefits for state and local government workers, it uses tables of replacement rates from the US Bureau of Labor Statistics.

Projected DB pension information reflects pension plan structures through December 2008, including DB pension plan freezes and conversions to CB plans.[6] DYNASIM assumes all nonunion private-sector DB pensions will experience a hard freeze between 2008 and 2016 and also assumes two-thirds of state and local pensions will experience a soft freeze between 2008 and 2016.[7] (Users can run alternative scenarios by changing these assumptions.)

DYNASIM adjusts worker DB pensions and survivor pensions after initial pension receipt for cost-of-living adjustments. DYNASIM varies the probability of selecting a joint and survivor annuity by gender, education, family health status, wealth, and expected pension income. It also varies DB cost-of-living adjustments by employment sector (i.e., private, federal government, and state and local government).

Most DB plan formulas assign pension income as a function of workers' earnings and job tenure. Most private-sector workers must complete five years of service before they vest in the DB plan. Changes in job tenure directly affect expected DB pension income.

## Total Retirement Income

DYNASIM projects income and assets annually from 1993 to 2087 by age, gender, marital status, race and ethnicity, poverty status, geographic region, educational attainment, per capita lifetime work years, nativity, and per capita income quintile. Results can be summarized for any individual year and in numerous ways. Typically income and assets are measured on a per capita basis in current price-adjusted dollars. Per capita values are half the sum of husband's and wife's values for married individuals and own values for single individuals. Our measure of per capita lifetime work years is the sum of years with positive earnings since 1951.[8] In years when both the husband and wife have positive earnings, both partners get one year of work credit. If only one partner works, both partners get half a year of work credits. If neither partner works, both partners get zero work credits. Single individuals get work credits based on their own earnings in years they are single. DYNASIM also calculates the income of nonspouse family members, which is used only for calculating poverty status.

DYNASIM can generate three per capita income measures (Census, annuity, and return income) that vary by the asset income source and by the inclusion of imputed rental income. Per capita income is the sum of the husband's and wife's income divided by two for married individuals and own income for single individuals. The model also can use these optional measures in replacement rate calculations based on the highest 35 years of earnings between ages 20 and 70 or the average of earnings received between ages 50 and 54. Poverty measures used to assess well-being in retirement also include the income of nonspouse family members.

*Census income* is the sum of per capita earnings, Social Security, SSI, DB pension, interest, dividends, net rental income, and retirement account withdrawals. Except for the per capita conversion, this is the standard measure the US Census Bureau uses to calculate personal income. The Census income poverty rate includes family Census income (including nonspouse family members) divided by the family poverty threshold.

*Annuity income* is the sum of per capita earnings, Social Security, SSI, DB pension, and annuitized asset income. The annuity income poverty rate uses family annuity income (including nonspouse family members) divided by the family poverty threshold.

The annuitized asset income measure calculates income from retirement accounts and financial assets each year as the real (price-indexed), actuarially fair annuity income a family would receive if it annuitized 80 percent of its retirement accounts and other financial assets (using a 3 percent annual real return). The annuity factor is recalculated each year to reflect changes in wealth as individuals age, based on DYNASIM projections of wealth accumulation and spenddown and changes in life expectancy and marital status as individuals survive to older ages. For married couples, DYNASIM assumes a 50 percent survivor annuity.

The annuity measure ensures comparability with DB pension and Social Security benefits, which are also annuities. Without this type of adjustment, DYNASIM would overstate the loss in retirement well-being from the shift from DB pension income to DC assets. A dollar in DB pension wealth produces more income by standard measures than a dollar in DC wealth because measured DB income counts both a return on accumulated assets and some return of principal, but measured income from financial wealth includes only the return on accumulated assets and realized retirement account withdrawals. The annuity measure differs conceptually from the Census measure, which includes only the rate of return on assets (interest, dividends, and rental income) and excludes the potential consumption of capital that could be realized if a person spent down his or her wealth.[9]

*Return income* is the sum of per capita earnings, Social Security, SSI, DB pension, and a 6 percent return on retirement and financial assets. The return income poverty rate includes family return income (including nonspouse family members) divided by the family poverty threshold.

The return income measure provides a measure of well-being from both income-generating assets (like stocks, bonds, and savings accounts) and non-income-generating assets (like vehicles and vacation property), but it does not include a factor based on life expectancy. A problem with the annuity measure is that it typically shows asset income increasing with age because the remaining assets support fewer years of remaining life. In reality, the assets of seniors generally decline with age. The return measure captures this pattern. Unlike the Census measure, which excludes asset values inside of retirement accounts unless they are withdrawn, the return income includes notional returns on retirement accounts.

The model optionally captures the amount by which homeowners are better off than those without any home equity. DYNASIM imputes a 3 percent rate of return to housing equity (imputed rent) that represents the savings in rent from owning a home, net of costs of interest and home maintenance. DYNASIM does not project the rapid increase in home values between 2004 and 2006, nor does it project the rapid decline in home values between 2006 and 2009.[10] Instead, it projects steadier, smoothed growth in home equity through this period based on PSID and HRS estimated models of home equity. It accounts for the housing bubble and bust by using an out-of-the-model adjustment.

## Health and Disability Status

DYNASIM projects several health and disability measures. For all individuals ages 16 and older, the model projects work disability based on discrete-time logistic hazard models estimated from 1990 through 1993 SIPP data that incorporate various demographic and socioeconomic differences including earnings, education, age, race, and marital status.

Using HRS data from 1994 through 2010, DYNASIM also projects health status (excellent, very good, good, fair, poor), counts of limitations with activities of daily living (ADLs) and instrumental activities of daily living (IADLs), and counts of chronic medical conditions for individuals ages 51 and older. The limitations counts are based on the number of activities for which HRS respondents report difficulty because of a physical health or memory problem expected to last at least three months. Chronic conditions include cancer, diabetes, heart problems, lung disease, and stroke.[11]

DYNASIM starts with self-reported ADL, IADL, and chronic conditions at the SIPP interview and assigns initial conditions for those not observed in the SIPP input file. Outcomes for future years are projected using lagged status-specific transition models based on HRS data. All the estimating equations control for age, education, lifetime earnings, race/ethnicity, marital status, and nativity. Additionally, the ADL and IADL limitations equation controls for health status, and the chronic conditions equation controls for health status and ADL and IADL limitations.

The Social Security trustees' projected improvements in mortality generate improvements in morbidity. We implement this trend by assuming a longevity gain of one year translates into a half-year reduction in morbidity (or a half-year increase in healthy life span). Specifically, we use mortality-adjusted age as the predictor in the ADL and IADL equations in the simulation year.

Our DYNASIM projections include a measure of cognitive impairment based on a two-part model estimated on HRS data on scores from the Telephone Interview for Cognitive Status test. We first project whether the respondent has the ability to take the test of cognitive impairment; the inability to take the survey is itself considered an indicator of cognitive impairment. We then project the cognitive function score for those respondents we predict are capable of taking the test.[12] Predictors in these models include age, education, health status, and ADL and IADL limitations.

We project the initial cognitive level (typically at age 65, but later for individuals older than 65 at the 1992 baseline). In subsequent years, we project a new impairment level conditional on the previous year's outcome. We draw separate errors for each equation but hold the error terms constant for all subsequent years.[13]

One set of projections of ADL and IADL limitations is based on survey responses in the HRS about difficulty with activities due to physical health or memory problems that are expected to last three months or more. However, to receive tax-qualified benefits from a private long-term care insurance plan under Health Insurance Portability and Accountability Act regulations, policyholders must meet a stricter disability threshold based on needing help with ADLs (not simply having difficulty with them). DYNASIM includes a second equation to project these more severe ADL limitations. Predictors in that equation include age, education, race, health status, number of IADL limitations, number of chronic conditions, year of death, and lagged service use.

# Health Insurance and Medical Spending

Recent DYNASIM enhancements have added health insurance coverage, health insurance premiums, and out-of-pocket medical spending to the model. Coverage and spending models differ for the Medicare and non-Medicare populations. The non-Medicare module uses methods developed for MINT7 (Smith and Favreault 2013). A goal for these models is to capture the effect of out-of-pocket spending on total income to compute more detailed measures of economic well-being. They were not developed to perform policy analyses of health care reform, though we have used them to examine changes to Social Security policy.[14] The Medicare module, which projects Medicare and Medicaid spending as well as out-of-pocket spending, relies on a sophisticated spending model developed under a grant from the National Institute on Aging (McGuire 2014).[15]

## Non-Medicare Population

DYNASIM projects ESI coverage and premiums. DYNASIM's premiums are derived from the Kaiser Family Foundation and Health Research Educational Trust annual employer surveys (Kaiser Family

Foundation 2012). Projections include the total and worker's share of the premium. Both health insurance coverage and premium projections differ by age, education, earnings level, job characteristics, and family characteristics, including the employment status and job characteristics of spouses and the number of dependent children in the family. DYNASIM also projects whether the worker's premium contribution is paid from pretax or after-tax dollars.[16]

DYNASIM models the purchase of health insurance at the family level. Families generally select the health insurance plan that generates the lowest out-of-pocket premium cost. However, the probability of selecting a low-cost, high-deductible plan (given a choice) declines as age and family income increase. When both spouses are eligible for ESI, couples with children select the lowest-cost family coverage plan, and couples without children select either two single plans or one family plan, whichever provides the lowest combined out-of-pocket cost. If only one member of a couple has employer coverage, the couple selects family coverage from that plan.

The model assumes a modest increase in ESI beginning in 2015 as a result of the employer mandate included in the 2010 ACA. We assume families whose ESI premiums would exceed 9.5 percent of their adjusted gross income opt out of employer coverage and instead purchase subsidized insurance through the new health care exchanges. Otherwise, if the family is offered ESI, we assume they take it.

When couples select family coverage, only one worker in the family pays the family premium. When couples select two single plans, each worker pays a single premium. Families who itemize taxes can deduct the taxable ESI premiums and out-of-pocket medical spending.[17]

Individuals without access to ESI, Medicare, or Medicaid have the option to purchase private health insurance. DYNASIM assigns premiums for nongroup plans based on distributions of region-level ESI premiums under the assumption that the health exchanges will offer premiums comparable to group health plans. DYNASIM assumes that, beginning in 2014, the ACA will grant individuals access to health insurance exchanges and low-income families access to subsidized health insurance. Prior to the ACA, some low-income individuals not eligible for Medicaid remain uncovered. After the ACA, DYNASIM assumes all legal residents have access to health insurance either through an employer, Medicare or Medicaid, or privately purchased plans with or without a subsidy.

For workers, DYNASIM assumes health insurance offers and workers' out-of-pocket price-adjusted premium shares remain unchanged for the duration of a job, but the selection of a health insurance plan among available offers can change annually if family circumstances shift (such as changes in marital status, family composition, and access to other health insurance coverage).

For the non-Medicare population, DYNASIM projects nonpremium out-of-pocket medical spending by using a two-part model. It first projects whether the family incurs any out-of-pocket spending, and for those families with spending, it projects the amount spent. Based on a logistic model estimated from Medical Expenditure Panel Survey data, DYNASIM predicts if the family will have any nonpremium out-of-pocket spending separately for couples and singles as a function of health insurance type, age, race, income, metropolitan status, region, number of children, and impending institutionalization and death. For families projected to have nonpremium medical spending, DYNASIM predicts the amount of spending by using ordinary least squares equations (in which the dependent variable is the natural logarithm of household nonpremium spending divided by the national average wage) separately for couples and singles. Out-of-pocket medical spending increases with age, poor health, rural residence, and number of children in the family. Out-of-pocket spending is also higher for households with private health insurance than for uninsured and Medicaid-covered households. Out-of-pocket medical spending also increases for higher-income and more educated households, all else equal, and for singles who die or become institutionalized in the following year.

## Medicare Population

Our Medicare spending model is motivated by the need to understand how spending growth puts financial pressure on beneficiaries and employers and will likely change future spending behavior. The Medicare benefit does not cover all medical expenses, and most beneficiaries fill these gaps with supplemental coverage. As the cost of supplemental premiums or out-of-pocket spending grows, employers and beneficiaries may scale back coverage. For example, they may switch plans or drop coverage. The reduced generosity of coverage may slow spending growth.

To project these possible outcomes, DYNASIM includes a more detailed, demand-based Medicare spending model.[18] The model crudely captures supply-side factors with a single, time-varying parameter that reflects spending growth in the absence of cost sharing.[19]

This more complicated model is processed toward the end of the DYNASIM processing sequence with the following steps: (1) assign baseline values for insurance, spending, and other relevant traits for each observation in Period 1; (2) define premiums for each person in each insurance alternative for Period 2; (3) apply supplemental rules for wealth and income transitions in Period 2; (4) apply rules for transitions in type of insurance coverage based on health status and premium changes in Period 2; (5) define spending based on the person's traits and updated insurance coverage in Period 2; and (6) repeat the sequence for subsequent periods.

Baseline Medicare spending amounts are assigned using models of spending and coverage estimated from Medicare Current Beneficiary Study (MCBS) data from 2007 through 2009.[20] We consider this step to be akin to matching individuals to MCBS distributions of coverage and spending. Spending is a function of expected spending, adjustments for coverage generosity, and a random error that contains an autoregressive component with a one-year lag.

The Medicare spending model captures seven stylized insurance statuses: (1) Medicaid, (2) other public, (3) employer fee-for-service, (4) employer health maintenance organization (HMO), (5) self-purchased fee-for-service, (6) self-purchased HMO, (7) and no supplemental insurance. Medicaid eligibility is assigned by replicating the eligibility provisions on a state-by-state basis. Transitions among the remaining statuses are a function of current status, premium changes, and health status. The transition model takes into account stickiness in insurance type choice. Within Medicare status, we also account for nonparticipation in Part B and Part D.

In the course of projecting Medicare spending, we also forecast out-of-pocket spending. Out-of-pocket shares are a function of total spending, accounting for insurance type and nonlinearities in coverage. The model takes into account the presence of mechanisms like charity care and bad debt for those with very high spending and limited income and assets who do not qualify (or have not yet qualified) for Medicaid.

A key component of the model is the way it generates premiums. Premiums are computed annually after individuals make changes to insurance status, spending, and wealth. Premium generation takes into account projected spending, administrative costs, and institutional features of Medicare Advantage. This approach imposes internal consistency in the model regardless of the growth assumptions employed.

For workers covered by Medicare, DYNASIM assigns Part B and Part D premiums, including the scheduled income-related premiums based on annual modified adjusted gross income. DYNASIM assumes Medicare beneficiaries with access to ESI (own or spouse) will opt out of Part B and Part D until the employer coverage ends.

The model's growth function incorporates technological change and its impact on individual incomes. Income reductions can reduce demand. Users can supply alternative estimates for elasticities and technological change and thus explore a range of possible outcomes in sensitivity analyses. Users can also impose alternative assumptions for factors like anticipated reductions in employer coverage.

# Long-Term Services and Supports

We have recently expanded DYNASIM to include models of the need for and use of LTSS. This model currently focuses on individuals ages 65 and older, but we plan to extend it to include individuals ages 51 through 64.

## LTSS Equations

*Care use*. DYNASIM models nursing home care, residential care ("assisted living"), and paid home care as functions of personal characteristics measured at the beginning of the period. Estimating equations are based on a pooled sample of respondents ages 65 and older from the 1992 to 2010 waves of the HRS.[21] Explanatory variables include number of ADL and IADL limitations, self-reported health status, marital status, spouse disability status, race and Hispanic origin, number of children, age and its square, sex, nativity status, income, and wealth, as well as nursing home, residential care, and home care received in the previous period. Lagged measures capture the persistence of LTSS use observed in the data. Any nursing home care, any residential care, and any paid home care are jointly estimated as a trivariate probit. The three equations interact through lags and contemporaneous error terms that are joint normally distributed.

DYNASIM also projects the duration of nursing home care and duration and intensity of paid home care. We have estimated equations of the number of nights spent in a nursing home and hours of home care received by using the sample of individuals reporting they use these services in HRS. Both are zero-truncated negative binomial models to account for overdispersion in the observed distributions. Predictors in these models mirror those from the equations that project LTSS use.

One serious limitation of the HRS variables we use for projecting home care is that they ask only about receipt of paid care in the prior month. Given that DYNASIM projects LTSS use for an entire year at a time, we must convert these monthly estimates into annual measures. We use questions from the National Health and Aging Trends Study to project duration of paid care. Using cross-tabulations from that study, we forecast home care duration based on age and prior receipt of care.

*Costs of services*. To project LTSS spending, we assign a dollar cost to each night of nursing home care and hour of paid home care. For those not eligible for Medicaid, we use state-specific price data from Genworth (2013). Daily nursing home care costs are based on the median price for semiprivate rooms; formal home care costs are based on the median price of an hour of help from a home health aide. We inflate prices after 2013 by the change in Social Security's national average wage, under the assumption that LTSS tends to be labor-intensive so cost growth will reflect changes in labor costs. The Genworth data also include minimum and maximum levels that could be used to impute dispersion of costs.

Costs for Medicaid beneficiaries are lower than those for private-pay users because Medicaid imposes lower reimbursement rates. For most Medicaid beneficiaries, we use summary information on Medicaid rates from the literature (see, for example, Eljay LLC 2009, 2012, 2014). We project future rates by wage indexing the most recently observed rate from these survey articles. For most states, the most recent Medicaid rate is the reported 2011 value from Eljay LLC (2014). A relatively small number of aged institutionalized Medicaid beneficiaries reside in intermediate-care facilities for individuals with intellectual disabilities and incur higher costs. We impute these higher costs to a small number of Medicaid nursing home residents each year, using estimates from the *Medicare and Medicaid Statistical Supplement* (Centers for Medicare and Medicaid Services 2001 through 2013), so that our Medicaid spending estimates better track historical experience.

## Medicaid

DYNASIM includes measures of Medicaid eligibility and enrollment. It reflects a composite set of state-specific Medicaid eligibility rules applied each year to the income and assets of individuals in DYNASIM.[22] We compare these eligibility rules to income and assets to determine whether an individual is a recipient of Medicaid in the year of long-term care use.

DYNASIM links wealth spenddown to spending for LTSS by using a relatively simple spenddown equation. We directly model health care spending outside of LTSS and allow such spending to render an individual medically needy.

## Private Long-Term Care Insurance

DYNASIM currently models in-force private long-term care insurance coverage at age 65. Coverage probability is a function of education, housing wealth, financial assets, and mortality probability. The last variable reflects adverse selection and underwriting in the private insurance market. We also model lapse rates after 65 as a function of plan generosity, consistent with data from experience studies.

Among individuals projected to have private long-term care insurance, we impute four plan characteristics: the maximum number of days covered by the plan, the maximum daily benefit, the elimination period, and inflation protection. Data for assigning insured individuals are drawn from a number of sources, including the American Association for Long-Term Care Insurance (2014) and America's Health Insurance Plans.

We assume long-term care insurance generally pays first when an individual needs care and meets the trigger criteria. We track days and hours of coverage used and costs incurred, and we compare these factors to the relevant plan limits. Individuals whose costs exceed their private coverage must turn to other sources to cover LTSS expenses.

# Summary

DYNASIM provides a comprehensive description of the future well-being of the older population. It projects demographic characteristics, income and wealth, health and disability status, and spending on medical care and LTSS for older adults over the next 75 years. The projections are generated by hundreds of equations based on the best available data and estimated with state-of-the-art econometric techniques. DYNASIM shows outcomes under existing policies and practices, but underlying equations can be easily adjusted to show how the older population would fare under various alternative policies. As a result, DYNASIM is a valuable tool for evaluating the impact of potential reforms to Social Security, Medicare, Medicaid, and tax policy, as well as new policy initiatives.

# Notes

1. DYNASIM4 will be based on the 2004 and 2008 SIPP panels and will start projecting outcomes in 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.
3. For discussion of the Social Security trustees' assumptions, see, for example, 2011 Technical Panel on Assumptions and Methods (2011).
4. The random error term follows an autoregressive process with a one-year lag so that random shocks include both new and lagged effects.
5. The standard deviations are derived from real returns over the 58-year period between 1952 and 2010 for large-company stocks and Treasury bills as reported in Ibbotson Associates (2014). Inflation assumptions follow the 2014 intermediate assumptions used by the Social Security trustees (Social Security Board of Trustees 2014).
6. DYNASIM projects conversions of pension plan type (from DB to CB or DB to DC) by using actual plan change information for plans included in the PIMS data through 2008.
7. In a hard freeze, all workers cease accruing DB benefits and the firm switches to a DC plan. In a soft freeze, new workers are offered a DC plan instead of DB plan, and existing workers remain in the DB plan and continue to accrue benefits.
8. Early cohorts have censored work years because DYNASIM3's earnings data begin in 1951. We do not measure work years before 1951.
9. We calculate annuitized retirement accounts and financial (nonpension) assets by using the same annuity factors.
10. Standard & Poor's. 2011. S&P/Case-Schiller Home Price Indices. http://us.spindices.com/index-family/real-estate/sp-case-shiller.
11. The chronic conditions count is based on the number of these conditions with which individuals have ever been diagnosed. However, we cap the projected number at three conditions.
12. We include proxy respondents in these analyses because excluding them would significantly understate levels of cognitive impairment.
13. This approach helps to project a reasonable longitudinal pattern. However, the issue of whether age-related cognitive decline and serious cognitive impairment should be construed as separate processes is unresolved in the literature, with implications for model specification.
14. Smith and Toder (2014) analyze the budgetary and distributional effect of including ESI premiums in the income and Social Security payroll tax base.
15. Grant No. R01AG034417; principal investigator: Michael Chernew.
16. The majority of workers (92 percent) pay their worker share of premiums with pretax dollars, though there are large differences in pretax coverage by firm size, with large firms more likely than small firms to offer pretax payments.
17. The ACA increased the excess medical expense threshold from 7.5 to 10 percent of adjusted gross income beginning in 2013 for those under age 65 and beginning in 2016 for those 65 and older. Only medical expenses exceeding the adjusted gross income threshold are deductible.
18. Further detail on this model is available upon request.
19. As a default value, we use excess cost growth from Medicare trustees' assumptions inflated to account for income effects. However, users can readily supply alternative parameters.

20. We use a square root transformation for the dependent variable. Key predictors in the models include age, health and disability status, number of chronic conditions, income, insurance type, mortality, and interactions. We calibrate these projections for 2010 through 2013 to match the appropriate historical distribution of coverage and spending.

21. As in the model of cognitive impairment, it is critical the samples used to estimate our equations include both proxy respondents and individuals who die between HRS waves, because both groups are much more likely than others to use LTSS.

22. We capture the broad state Medicaid rules regarding income and asset levels as well as certain provisions related to home care and spousal impoverishment. Not all Medicaid nuances are captured, however, because our modeling resources are limited and our model is based on a sample of the population, not the full population. Certain subgroups are simply too small for us to reasonably model in this context

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**Melissa Favreault** is a senior fellow in the Income and Benefits Policy Center at the Urban Institute, where her work focuses on the economic well-being and health status of older Americans and individuals with disabilities. She also analyzes long-term care needs and the distributional effects of Medicare and Medicaid. Her work in this area has focused on how changes in family structure and work/earnings patterns affect economic well-being in retirement, with a special emphasis on effects for women and lower-wage workers. For this research, she has often relied on dynamic microsimulation models. She has helped develop these types of models for both Urban and the Social Security Administration.

**Karen Smith** is a senior fellow in the Income and Benefits Policy Center at the Urban Institute, where she is an internationally recognized expert in microsimulation. Over the past 30 years, she has developed microsimulation models for evaluating Social Security, pensions, taxation, wealth and savings, labor supply, charitable giving, health expenditure, student aid, and welfare reform. Smith has played a lead role in the development of the Social Security Administration's Modeling Income in the Near Term microsimulation model, Urban's Dynamic Simulation of Income microsimulation model, and the Social Security Administration's Policy Simulation Model. Her recent work includes estimating the impact of the Great Recession on retirement well-being; analyzing income and asset accumulation patterns of the adult population; analyzing the retirement decision; evaluating the effect of disability on earnings and mortality; and using statistical matching to impute earnings, taxes, and spouse characteristics.

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