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Projection Methods Used in the Dynamic Simulation of Income Model (DYNASIM3)

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The Program on Retirement Policy

A crosscutting team of Urban Institute experts in Social Security, labor markets, savings behavior, tax and budget policy, and micro-simulation modeling ponder the aging of American society.

The aging of America raises many questions about what's in store for future and current retirees and whether society can sustain current systems that support the retired population. Who will prosper? Who won't? Many good things are happening too, like longer life and better health. Although much of the baby boom generation will be better off than those retiring today, many face uncertain prospects. Especially vulnerable are divorced women, single mothers, never-married men, high school dropouts, and lower-income African Americans and Hispanics. Even Social Security—which tends to equalize the distribution of retirement income by paying low-income people more then they put in and wealthier contributors less—may not make them financially secure.

Uncertainty about whether workers today are saving enough for retirement further complicates the outlook. New trends in employment, employer-sponsored pensions, and health insurance influence retirement decisions and financial security at older ages. And, the sheer number of reform proposals, such as personal retirement accounts to augment traditional Social Security or changes in the Medicare eligibility age, makes solid analyses imperative.

Urban Institute researchers assess how current retirement policies, demographic trends, and private sector practices influence older Americans' security and decisionmaking. Numerous studies and reports provide objective, nonpartisan guidance for policymakers.

The Urban Institute is a nonprofit, nonpartisan policy research and educational organization that examines the social, economic, and governance problems facing the nation.

Many individuals too numerous to mention have contributed to the development of the DYNASIM3 model over the years. Melissa Favreault and Karen Smith codirected the development of the current version. Doug Murray has provided invaluable computer programming assistance. Barbara Butrica and Eric Toder have contributed to the development of the pension and asset models in DYNASIM. Richard Johnson, Sheila Zedlewski, and Eugene Steuerle have provided guidance during the ongoing process of model development.

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Abstract

This paper provides a brief overview of the Urban Institute's Dynamic Simulation of Income Model *(*DYNASIM3*)*. DYNASIM3 is a dynamic microsimulation model that projects the population and analyzes the long-run distributional consequences of retirement and aging issues. The model starts with a representative sample of individuals and families and ages the data year by year, simulating demographic and economic events including all key components of retirement income. Recent uses of DYNASIM3 include distributional analysis of Social Security reform options, the 2008 stock market crash, the Great Recession, and the impact of increased female labor force participation on retirement income.

Introduction

The Dynamic Simulation of Income Model (DYNASIM3) starts with a self-weighting sample of over 113,000 individuals from the 1990 to 1993 panels of the Survey of Income and Program Participation (SIPP) of the U.S. Census Bureau. The model ages this starting sample in yearly increments to 2086, using parameters estimated from longitudinal data sources and macroeconomic and demographic assumptions about the future from the Social Security Trustees.

The model integrates many important trends and group-level differences in life course processes, including birth, death, schooling, leaving home, first marriage, remarriage, divorce, disability, work, retirement, and earnings. It projects the major sources of income and wealth annually from age 15 until death, including employment, earnings, Social Security benefits, benefits from employer-sponsored defined benefit (DB) pensions, Supplemental Security Income (SSI), home equity, retirement accounts (defined contribution (DC) plans, individual retirement accounts (IRAs), and Keoghs), and other assets (saving, checking, money market, certificate of deposit (CD), stocks, bonds, equity in businesses, vehicles, and nonhome real estate, less unsecured debt). Table 1 summarizes the numerous databases and general types of simulation procedures.[1]

DYNASIM3's fertility, disability, mortality, net immigration, employment, earnings, and inflation projections typically are aligned to the 2011 Social Security trustees' intermediate-cost projections.[2]

[1] Additional information about DYNASIM3 is available in Favreault and Smith (2004).

[2] For example, the 2011 Intermediate assumptions project that consumer prices will increase about 2.8 percent per year and real wages will increase 1.2 percent per year.

This report provides a general summary of the procedures that project earnings and retirement income that are critical to the model's projections of future retirement income adequacy.

Employment and Earnings

DYNASIM3 projects the likelihood that an individual works each year as a function of age, sex, race and 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.[3]

DYNASIM3 uses a similar set of explanatory variables to assign hourly wages and annual hours of employment to those projected to work. Annual earnings are the product of the hourly wage and annual hours worked. DYNASIM3 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 underlying price and wage targets affect various other projections, including the Social Security wage base (the taxable maximum), the indexing of wages for the

[3] The random error term follows an autoregressive process with a one-year lag so that random shocks include both a new and lagged effect.

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.

Retirement Income

DYNASIM3 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, and an equation projecting benefit take-up. DYNASIM3 projects payments from employer-sponsored DB pension plans, cash balance (CB) plans, and retirement accounts (401K, 403B, and IRAs) based on equations of job change, retirement plan coverage and participation, and plan contributions. DYNASIM3 projects asset income as a function of projected assets. Finally, DYNASIM3 calculates SSI for eligible individuals based on total family income, assets, and state-specific program rules.

Pensions

DYNASIM3 projects pensions from employer-sponsored DB plans, CB plans, and retirement accounts (401K, 403B, and IRAs). Starting information about pension coverage on current and past jobs, pension contribution rates, and account balances comes from SIPP self-reported information. Projected DB pension information reflects pension plan structures through December 2008, including DB pension plan freezes and conversions to CB plans. Various data sources and models, as described below, are used to project job changes, pension coverage, pension participation, and pension contributions into the future.

DYNASIM3 projects private DB pensions using the Pension Benefit Guaranty Corporation's (PBGC) Pension Insurance Modeling System (PIMS) DB plan formulas, which are randomly assigned to DB participants based on broad industry, union status, and firm size categories, and an indicator of whether the firm offers dual (DB and DC) coverage. For government pensions, DYNASIM3 uses actual benefit formulas to calculate benefits for federal government workers and military personnel, and uses tables of replacement rates from the U.S. Bureau of Labor Statistics to calculate replacement rates for state and local government workers.

Adjustments to basic worker pensions for spouse coverage and cost-of-living adjustments are also simulated. DYNASIM3 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, state). The model projects conversions of pension plan type (from DB to CB or DB to DC) using actual plan change information for plans included in the PIMS data.

Most DB plan formulas assign pension income as a function of plan earnings and job tenure. Most private plans require five years of employment before workers are vested in the DB plan. Changes in job tenure directly affect expected DB pension income.

Retirement Accounts

DYNASIM3 projects retirement accounts based annual contributions to investment accounts and accumulated investment returns. DYNASIM3 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 DYNASIM3's starting SIPP sample are adjusted to align with asset distributions from the 2007 Survey of Consumer Finances (SCF). Individuals are also 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.

DYNASIM3 uses historical price changes and returns for stocks, long-term corporate bonds, and long-term government bonds through 2011 to grow portfolios. 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 that the market recovers to half of its projected precrash value by 2017 (Butrica, Smith, and Toder 2009, 2010). Specifically, DYNASIM3 uses historic returns through 2011 and assumes a 7.42 percent average real rate of return on stocks from 2012 to 2017 before resuming its historic average real return of 6.5 percent. DYNASIM3 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.[4] 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.

[4] The assumed rates of return are those recommended by the Social Security Administration's Office of the Chief Actuary for the President's Commission to Strengthen Social Security (2001). The standard deviations are derived from real returns over the 58-year period between 1952 and 2010 for large company stocks and Treasury bills reported in Ibbotson Associates (2011). Inflation assumptions follow the 2011 intermediate assumptions used by the Social Security trustees (Social Security Board of Trustees 2011).

DYNASIM3 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 seamlessly from one job to another. High unemployment contributes to lower lifetime DC pension savings through hardship withdrawals and loss of contributions (and returns on lost contributions) when out of work.

Financial Assets

DYNASIM3 uses random-effects models developed for the Social Security Administration's MINT model to project financial assets. DYNASIM3 starts with SIPP self-reported assets (saving, checking, money market, CD, stocks, bonds, 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 one who remained 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 that couples split assets at divorce and survivors inherit the assets of deceased spouses.

DYNASIM3 projects nonpension financial assets over three separate age ranges: up to age 50, from age 51 to retirement, and from retirement to death. Equations projecting assets to age 50 were estimated on the Panel Study of Income Dynamics (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 data sets included historic earnings from the Social Security Administration's Summary Earnings Record data.

Home Equity

As with financial assets, DYNASIM3 uses random-effects models developed for the Social Security Administration's MINT model to project home equity. DYNASIM3 starts with SIPP self-reported homeownership status and home equity. In addition, DYNASIM3 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). They project home equity over three separate age ranges: from age 25 to 50, from age 51 to 70, and from age 70 to death. Equations projecting home equity to age 50 were estimated on the PSID (Toder et al. 2002). Equations projecting equity from age 51 to 70 were estimated on the first seven waves of the Health and Retirement Study (Smith et al. 2007), and DYNASIM3 holds real home equity constant after age 70.

Alternate Measures of Retirement Income

Users can make different assumptions about how to measure income from assets. These include (1) a standard Census measure that includes the interest, dividends, rental income, and withdrawals from retirement accounts; (2) an annuity measure that converts 80 percent of assets into annuities; and (3) a rate of return measure that assumes retirees earn a specified rate of return on all assets. We can also optionally include imputed rental income based on a real rate of return on home equity in retirement income. Asset withdrawals are calculated based on estimated models of asset decumulation from retirement until death. They are a function of age, race, marital status, DB pension status, homeowner status, life expectancy, and market rates of return. DYNASIM3 assumes individuals withdraw from assets outside of retirement accounts before they withdraw from assets inside of retirement accounts, but they must meet the minimum distribution requirements after age 70½.

Census measure. The Census measure is the most commonly used measure of asset income. It includes interest, dividends, and rental income on assets outside of retirement accounts. The Census measure also includes amounts withdrawn from retirement accounts.

Annuity measure. The annuity 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 total wealth (using a 3 percent annual real return). We use the calculated annuity value to assign only that year's income from retirement accounts and financial assets. The annuity factor is recalculated each year to reflect changes in wealth as individuals age, based on DYNASIM3 projections of wealth accumulation and spend-down and changes in life expectancy and marital status as individuals survive to older ages. For married couples, DYNASIM3 assumes a 50 percent survivor annuity.

The annuity measure ensures comparability with DB pension and Social Security benefits, which are also annuities. Without this adjustment, DYNASIM3 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, while 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.[5]

Return measure. The return measure computes asset income as a 6.0 percent nominal rate of return on financial and retirement account balances. This 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 does not include a factor based on life expectancy. A problem with the annuity measure is that it 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 nonhomeowners. DYNASIM3 imputes a rate of return (3 percent) to housing equity

[5] We calculate annuitized retirement accounts and financial (nonpension) assets using the same annuity factors.

(imputed rent), which represents the saving in rent from owning a home, net of costs of interest and home maintenance. DYNASIM3 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 (Standard & Poors 2011). Instead, it projects normal growth in home equity through this period based on PSID and HRS estimated models of home equity.

Summarizing Results

DYNASIM3 projects income and assets annually from 1993 to 2086 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 singles. Per capita lifetime work years is the sum of years with positive earnings since 1951.[6] In years where 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. DYNASIM3 also calculates the income of nonspouse family members, which is used only for calculating poverty status.

[6] Early cohorts have censored work years because DYNASIM3's earnings data begin in 1951. We do not measure work years before 1951.

Specific Definitions of Alternative Income Measures

As noted above, DYNASIM3 can generate three separate per capita income measures that vary by the asset income source and by the inclusion of imputed rental income. Per capita income is the sum of husband's and wife's income divided by two for married individuals and own income for singles. 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. 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 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. 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.

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

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Table 1

Core Demographic and Economic Processes

Process	Data	Form and predictors
Birth	NLSY (1979–94), NLSY97 (1997-2005), VS, OACT 2010	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 (2001–2004), OACT 2010	Three equations; time trend from OACT 1992–2075; includes socioeconomic differentials, health status, and ADLs/IADLs; separate process for the disabled based on age, sex, and disability duration derived from Zayatz (2005--pending).
Immigration	SIPP (1990-93), OACT 2010	Observed immigrants from historical data are used as donors. Targets are derived from OACT.
First marriage	NLSY (1979–93), NCHS	Eight 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)	Three 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)	Ten cross-tabulations based on age, race, sex, and parents' education.
Disability	SIPP (1990–93)	Discrete-time logistic hazard model incorporates various socioeconomic differences (age, education, lifetime earnings, race/ethnicity, marital status and nativity).
Health status (Age 51+)	HRS (1992-2006)	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).
Limitations in activities of daily living, instrumental activities of	HRS (1994-2006)	Ordered logit models (initial conditions for those not observed on the SIPP, and then lagged status-specific transition models) incorporate health status. IADLs predict ADLs.

daily living		
Economic Sector		
Labor supply and earnings	PSID (1981–2007), NLSY (1979–89), OACT 2010	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, Social Security beneficiary status, and education level interacted with age splines; also number and ages of children. Model forms vary by outcomes. Special processes project earnings for the highest earners.
Job change	SIPP (2001-2004)	Assigned from age 25 using a series of age-centered regressions (based on age, gender, education, industry, tenure, and union status).
Pension coverage	SIPP (2001-2004), PIMS	Accumulation of defined contribution plans based on self-reports; assignment of replacement rates for defined benefit plans with reductions in replacement rates based on number of job changes.
Saving/ Consumption	SIPP, PSID (1984–94), HRS, SIPP 1990–93 matched to administrative data (1951–99)	Separate models estimated for housing and nonhousing wealth based on income and demographic characteristics using random effects and annual hazard models; each model includes an individual-specific error term.
Benefits sector		
OASI	SIPP (2001–2004) matched to administrative data (1951–2007)	Benefit claiming simulated beginning at age 62; model uses discrete-time hazard models to determine age at take-up based on age, benefit amount, spousal characteristics, and Social Security policy parameters.
DI	SIPP (1990–93) matched to 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.
SSI	SIPP (1990–93) matched to administrative data (1951–99)	Uses program rules (income and asset tests) to determine eligibility and a participation function based on potential benefit and demographic and economic characteristics including age, education, race, family structure, home ownership, and sources of income.

CPS = Current Population Survey; HRS = Health and Retirement Study; NA = Not Applicable; NCHS = National Center for Health Statistics; NLMS = National Longitudinal Mortality Study; NLSY = National Longitudinal Survey of Youth; OASI = Old-Age and Survivors Insurance (Social Security); DI = Disability Insurance (Social Security); OACT 2010 = Intermediate assumptions of the 2010 OASDI Trustees Report; PIMS = Pension Insurance Modeling System from the Pension Benefit Guaranty Corporation; PSID = Panel Study of Income Dynamics; SIPP = Survey of Income and Program Participation; VS = Vital Statistics.