

CHAPTER 10

THE MACROECONOMIC-DEMOGRAPHIC MODEL OF THE U.S. RETIREMENT INCOME SYSTEM

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CHAPTER 10

THE MACROECONOMIC-DEMOGRAPHIC MODEL OF THE U.S. RETIREMENT INCOME SYSTEM

I. Background

The Macroeconomic-Demographic Model of the U.S. Retirement Income System was first developed for the President's Commission on Pension Policy in 1980-81, and used by the Commission to simulate and evaluate alternative pension policy proposals. The model was extended and documented under the auspices of the National Institute on Aging to study the effects of population aging on the economy and the effects of demographic and economic change on the welfare of the older population. NIA published monographs describing the model and describing illustrative projections of the retirement income system in 1984 and 1990 (National Institute on Aging, 1984; Anderson, 1990). NIA also supported the development of a detailed consumer and health expenditures system in the MDM. Documentation and description of that component of the MDM was published by NIA in Spring 1988 (Anderson, *et al.*, 1988). The consumer expenditures system of the MDM was later expanded to include housing expenditures.

The model was used for the Trustees of the Social Security System in 1987 to investigate alternative approaches to investment of the OASDI trust funds. At that time a more detailed model of the federal government budget and debt was added, showing the interaction between the OASDI and Medicare Trust Funds and the federal deficit and debt. The model has subsequently been used to analyze the effects on retirement savings and the economy of expansion of eligibility for Individual Retirement Accounts and incentives to contribute to IRAs and other tax preferred savings programs. For this application, an individual retirement savings model was developed for the MDM.

The model has been used by government agencies, including the Social Security Administration, Department of Health and Human Services, Department of Labor, National Commission on Employment Policy, National Institutes of Health, Health Care Financing Administration, by state government agencies, by research institutions and associations, and by private corporations for forecasting and research on numerous topics related to retirement income and the welfare of the elderly, pension and social security policy, labor markets, savings and asset accumulation, health care expenditures, and strategic planning.

II. Components of the Macroeconomic-Demographic Model System

The Macroeconomic-Demographic Model (MDM) is composed of a core macroeconomic and demographic modeling system, a model of consumer and health care expenditures which depicts the determination of demographic group and national health care expenditures, and a set

of five retirement income system models that depict the operation and behavior of the major components of the retirement income system. The core model has three major components: a population projection system, a macroeconomic growth model, and a model of the labor market. The five major elements of the retirement income system that are modeled are the Social Security System (OASDI), the private pension system, the public employee retirement system, the Supplemental Security Income (SSI) system, and the various forms of individual retirement savings.

Population Model

The Population Model is based on the population projection methodology used by the U.S. Bureau of the Census. It projects the total U.S. population by single year of age, race, and sex for each year from 1994 through 2060. To the most recent base year population estimated by the Census Bureau, the model applies age-race-specific fertility rates to project the number of births, age-sex-race specific mortality rates to project the number of deaths by age, race, and sex, and age-sex-race specific immigration. The population model can utilize demographic parameters developed by the U.S. Bureau of the Census for population projections, or comparable parameters developed by the Social Security Administration Office of the Actuary, or assumptions specified by the user. The user can specify the ultimate completed cohort fertility rate. An appropriate set of age-specific fertility rates are then calculated and the corresponding population is projected. The rate of change of mortality by cause of death and the level of immigration can also be specified by the user.

The MDM mortality model incorporates the Social Security Administration Office of the Actuary projections model of mortality by cause of death. This model permits the simulation of the effects on population size and composition of changes in mortality rates by cause of death -- e.g. heart disease, vascular diseases, cancer, etc. -- for ten different causes. The model incorporates the interactions among competing risks. It can be used to simulate the effects of changes in assumptions concerning rates of mortality from specific causes on population size and composition and on the labor market, economy, retired population, public and private retirement income programs including social security disability and retirement, and health care expenditures including Medicare and Medicaid.

Macroeconomic Growth Model

The MDM Macroeconomic Growth Model provides the core of the Macroeconomic-Demographic Model because it projects the long-term trends of the United States economy. The Macroeconomic Growth Model is fully integrated with the Labor Market Model, so that forecasts of all major macroeconomic variables -- GDP, investment, savings, etc. -- are completely consistent with all labor market variables -- employment, hours worked, wages, compensation, etc. These aggregate results provide much of the information required for simulating each of the retirement income systems included in the MDM.

The Macroeconomic Growth Model identifies four general types of goods and services – capital services, labor services, consumption goods and services, and investment goods. These are defined so that they account for all output and transactions. There is a market, or set of markets, corresponding to each of these types of goods and services. Four groups of decision-makers participate in these markets – households, producers, government, and the rest of the world.

The MDM Macroeconomic Growth Model incorporates the economic growth simulation model and growth accounting system developed by Prof. Dale Jorgenson and collaborators at Harvard University. It depicts the determination of labor supply, spending, and savings plans by households, and production, investment, and employment plans by businesses. It projects the demand for and supply of flows of goods and services and depicts the equilibration of demand and supply by price adjustments and changes in consumption and production decisions. The model forecasts the aggregate level of output each year by estimating levels of capital and labor input and the rate of technological change. The model depicts the various forms of taxation, including taxes on labor income, capital of various forms, and consumption. It has been used extensively to analyze the effects of taxes on the economy.

The MDM Macroeconomic Growth Model is based on modern macroeconomic growth theory and a theoretically consistent growth accounting system including human and physical capital of various forms and productivity change. This system has provided the basis for studies of productivity change and of the role of education and training, as well as investment in physical capital and technology change, in determining productivity growth and incomes. (See Jorgenson, *et al.*, 1987; Jorgenson and Fraumeni, 1992a, 1992b.)

Labor Market Model

The Labor Market Model depicts three basic aspects of the U.S. labor market: the demand for labor, the supply of labor, and the simultaneous determination of labor and capital services input and compensation, output and unemployment. The derived demand for labor inputs of three age groups is simulated by modeling the aggregate production technology of the private U.S. economy. Labor supply is measured in total annual labor hours worked for each of 22 age-sex groups. The labor market model depicts labor force participation, employment, hours worked, and compensation of the 22 age-sex groups and the effects of changes in the demographic composition of the population on labor force structure, compensation, and employment. The labor force is disaggregated in particular detail for age groups near retirement ages, permitting analysis of labor force participation, employment, hours worked, compensation, and retirement of males and females age 45-54, 55-58, 59-61, 62-64, 65-67, 68-71, and 72 and over. This demographic group-specific labor market detail enables the labor market model to provide the aggregate projections suitable for aging the labor market experience of a microdata base. A flexible functional form specification of aggregate production technology (a translog production function) permits investigation and modeling of the substitutability among the various

age groups of labor and capital. The simultaneous labor supply-demand model is fully integrated into and solved simultaneously with the Macroeconomic Growth Model for the level of input and price of capital services and of labor for each of the 22 age-sex groups, for the unemployment and participation rates of each group, for the level of output, consumption and investment and their prices, and other economic variables.

Retirement Income System Models

The retirement income system models comprise an integrated actuarial-economic simulation and forecasting system. All major components of the U.S. retirement income system and their interactions are represented -- the social security retirement and survivors insurance and disability insurance systems; the Supplemental Security Income (SSI) system; the several types of public employee retirement systems, including federal civil service, military retirement, state and local general and administrative workers' systems, higher education employees, elementary and secondary education employees, and public safety and emergency service workers systems; and private pension systems including defined benefit, defined contribution, and individual retirement saving plans, such as IRAs, Keoghs, and 401(k) type plans. The integrated MDM system depicts the effects of demographic change, economic change, or changes in public policy, laws, and institutions on these systems, and the effects of changes in retirement income systems on the economy.

Social Security Model

The Social Security Model depicts the determination of contributions into and benefit payments from the social security retirement (OASI) and disability (DI) insurance systems. Annual contributions are derived from the estimates of total compensation by age and sex generated by the Labor Market Model by estimating covered earnings and the taxable earnings base and applying statutory and projected tax rates. Total annual benefit payments are calculated by estimating average benefits and number of beneficiaries by age and sex for each of fourteen benefit categories. A primary insurance amount (PIA) is estimated for individuals classified by year of birth, sex, and initial year of eligibility by applying the statutory provisions for the calculation of average indexed monthly earnings (AIME) to the simulated earnings records of typical individuals in each age-sex cohort, generated by the Labor Market Model, and using the statutory benefit formula. Average benefit payments for the fourteen types of benefits are keyed to the estimated primary insurance amounts and number of primary beneficiaries. The model projects balances for each of the trust funds each year from 1980 through 2080. It can be used to estimate the level of tax collections that would be required to finance projected benefits under alternative scenarios and the implications of alternative social security policies.

Private Pension Model

The Private Pension Model depicts the aggregate behavior of three types of plans--defined benefit plans, defined contribution plans, and individual plans (such as IRA, Keogh, and 401(k) plans). The model projects levels of private pension coverage, participation, and vesting by age and sex. Contributions to each type of plan are estimated by applying appropriate contribution rates to the earnings of each age-sex group. The model applies age-sex specific pension benefit acceptance probabilities to estimate the beneficiary population of each age and sex. It calculates average pension benefits by applying prototypical pension benefit formulae to the estimated earnings records (for defined benefit plans) or contributions (for defined contribution and individual plans) of the individuals of each age-sex cohort. Estimates of pension fund assets for each type of plan are derived from estimates of annual contributions and benefit payments and rates of return.

Public Employee Pension Model

The Public Employee Pension Model divides public employment into seven sectors: Federal Civil Service, military officers, military enlistees, state and local hazardous duty, state and local general administrative, state educators, and local educators. Seven sectors are distinguished because the characteristics of the work forces and pension plans differ significantly among these groups. The model specifies that the employees in each sector are covered by a defined benefit plan. Levels of coverage, participation, and vesting in the working population and benefit receipt in the retired population are estimated using the same techniques as used by the Private Pension Model, drawing on data from the actuaries of the Federal Civil Service and the Department of Defense, the Employee Benefit supplements to the Current Population Survey, and other sources. Contribution and benefit payments are calculated separately for each sector of employment.

Supplemental Security Income Model

The Supplemental Security Income (SSI) Model depicts separately the operation of the means tested programs for the blind, disabled, and aged. The eligible aged population is projected by applying a simple income distribution model to the population and earnings levels forecast by the Population and Labor Market Models to estimate the earnings, social security benefits, and other income of the elderly population. Age-specific SSI participation rates calculated from Social Security Administration (SSA) data are applied to the eligible population to estimate the number of beneficiaries. Average benefits are projected using data on average federal benefit payments and average state supplements. Blind and disabled beneficiaries by age and sex are estimated by applying historic incidence rates to the projected population.

Health Care Expenditures and Consumer Expenditures Model

The health care expenditures and consumer expenditures model is an integrated and consistent system of consumer expenditures. It is estimated within a consistent framework using both micro and macro data, based on the theory of exact aggregation, developed by Lawrence Lau (1977a, 1977b, 1982). A three-stage system is estimated by pooling time series and cross-section data on consumer expenditures and health expenditures. The first stage projects health insurance coverage status of a large number of demographic groups of the population. The second stage forecasts consumer expenditures of demographic groups in six categories of expenditure. The third stage forecasts health expenditures for each of nine types of service and twelve sources of payment for a large number of demographic groups using the National Health Accounts framework developed by the Health Care Financing Administration (HCFA) Office of the Actuary. The health expenditures model depicts the effects of demographic, economic, and policy and institutional changes on health insurance coverage and health care expenditures by type (hospital, physician, etc.) and source of payment (private out of pocket, private insurance, Medicare, etc.) of various demographic groups.

Operations of the Model

Figure 9-1 illustrates the operational linkages between these models within the Macroeconomic-Demographic Model. At the start of any simulation year, the Population Model initially projects the new size and composition of the population. These population projections are input into the Macroeconomic Growth and Labor Market Models, which operate simultaneously to project levels of aggregate economic activity and the labor market outcomes for 22 different age-sex groups. These projections of the state of the economy and the demographically disaggregated labor market are input into each of the four pension system models and the consumer expenditures model. The major models--Population, Macroeconomic Growth, Labor Market, and pension systems--employ many lagged variables in their equations ensuring that one year's results play an important part in determining the next year's results.

The model is estimated using several widely used aggregate time series data bases. The basic time series data underlying the macroeconomic growth model are the National Income and Product Accounts (NIPA) collected by the Bureau of Economic Analysis of the Department of Commerce. The model also uses data from the BLS Consumer Expenditure Survey. Labor force data and incomes data are derived from the Current Population Survey (CPS) and employer survey data for each year from 1948 through 1993. Pension system data are derived from the CPS Employee Benefit Supplements and other sources. For the retirement income system models program data are used, from the Social Security Administration and from the Federal Civil Service Office of the Actuary and Department of Defense actuary. Federal Reserve Board Flow of Funds data are used to calibrate pension fund asset balances and other asset amounts. All of

these data sets are heavily used by the public and the research community and are validated by users verifying data and results against other sources of data.

The variables represented in the model are central to economic analysis and public discourse and are easily understood. Consistency is maintained between models because the outputs of the macroeconomic and labor market models serve as inputs to the pension models and consumer expenditures model. The entire model operates from a consistent set of accounting relationships. All major variables--wages, GDP, population, etc.--are defined identically throughout the model.

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FIGURE 10-1

STRUCTURE OF THE MACROECONOMIC-DEMOGRAPHIC MODEL

Methodological Features of the Macroeconomic-Demographic Model

The Macroeconomic-Demographic Model draws on several advances in knowledge of econometric methodology and economic modeling. The MDM is a demographic cell-based aggregative model, which permits analysis and projection of labor market behavior and outcomes, the operation of the components of the U.S. retirement income system and other sources of income of the elderly population, health expenditures and consumer expenditures in great demographic detail. The specification of production technology and estimation of the roles of labor force age groups in production draw on advances in economic and econometric theory and represent innovations in econometric modeling. The model of consumer and health care expenditures and health insurance choice draws on advances in economic and econometric theory. (The theoretical background and development of the consumer and health expenditure system is described in detail in Appendices A and B of the 1988 NIA monograph describing the health expenditures model. See Anderson, *et al.*, 1988).

The MDM economic growth model incorporates important methodologies for growth accounting and data development, as well as advances in empirical implementation and simulation techniques.

The MDM represents an innovative approach to the development of an aggregative or macro simulation model incorporating considerable demographic detail by utilizing both micro and aggregate data and combining household survey data with employer establishment data (in the labor market model), program data (in the retirement income and health expenditures models), National Income and Products Accounts data (in the consumer expenditures model), and HCFA National Health Accounts data (in the health expenditures model).

ANNEX 10-1

**MACROECONOMIC-DEMOGRAPHIC MODEL
OF THE U.S. RETIREMENT INCOME SYSTEM
Summary Description**

MACROECONOMIC-DEMOGRAPHIC MODEL OF THE U.S. RETIREMENT INCOME SYSTEM

Summary Description

Purpose and Objective of Model

- Simulate behavior of all major components and sources of income of the elderly population of the United States.
- Investigate and depict the effects of demographic and economic changes on retirement income and retirement income system.
- Depict effects of retirement income system on U.S. economy.
- Model effects of demographic change on U.S. labor market and economy.
- Estimate effects of social security and pension policy changes on retirement income and economy.

What is Representative (Universe)

Determinants of output and growth of U.S. economy; factors of production at aggregate level – capital and labor of various age groups; technological change; labor market; major components of U.S. retirement income system at aggregate level – social security system, private pensions, public employee pensions, Supplemental Security Income system; individual retirement savings accounts; Medicare; Medicaid; health care expenditures and finance; labor market experience and average earnings of demographic groups and cohorts.

Period of historical analysis: 1948-1990

Forecast/simulation horizon: 1980-2080

Frequency: Annual

Base year: 1990

Simulation technique: Deterministic solution of systems of simultaneous and recursive equations; lagged variables incorporate dynamic features.

Solution algorithms and structure: Sequential/recursive with several simultaneous blocks; simultaneous equations systems solved by Newton's Method (macroeconomic growth model) and Gauss-Seidel method (labor market model).

Unit(s) of analysis: Cells – 86 age-sex groups of population, 22 age-sex groups of labor market, birth cohorts; major components of retirement income system.

Databases

Population/demographics: Decennial U.S. Census, 1960, 1970, 1980, 1990; Current Population Survey

Individual/family/household characteristics: none

Employer characteristics: Proportions of employment and types of pension plans in private sector and seven parts of public sector

Industry characteristics: Proportions of employment and types of pension plans in private sector and seven parts of public sector

Retirement plan structure and characteristics: Tabulations of IRS Form 5500; tabulations of Bureau of Labor Statistics Employee Benefit Surveys

Retirement plan coverage, participation: May 1979, May 1983, May 1988 Current Population Survey (CPS) Employee Benefit Supplements

Individual Retirement Account (IRA) participation: May 1979, May 1983, May 1988 CPS Employee Benefit Supplements; 1985, 1989 Survey of Income and Program Participation (SIPP)

Supplementary Security Income (SSI) participation: March 1988 CPS; Administrative program data published in Social Security Bulletin *Annual Statistical Supplement*, 1975, 1976, 1977-79, 1989

Household assets: National Income and Product Accounts, Federal Reserve Board Flow of Funds Accounts; Survey of Consumer Finances 1983, 1986, 1989, 1992

Homeownership: Consumer Expenditure Survey; 1989 SIPP

Macroeconomic data: National Income and Product Accounts

Labor market data: Bureau of Labor Statistics (BLS) Labstat data (derived from Current Population Surveys)

Taxes: National Income and Product Accounts; Social Security Administration Office of the Actuary (OACT)

Health conditions: National Medical Care Utilization and Expenditure Survey (NMCUES) 1980

Health insurance coverage: National Medical Care Utilization and Expenditure Survey (NMCUES) 1980; CPS May 1983

Health care expenditures: National Medical Care Utilization and Expenditure Survey; Health Care Financing Administration National Health Accounts 1980, 1982, 1984, 1986

Consumer Expenditures: Consumer Expenditure Survey (CEX) 1980, 1983

Institutional Population: 1980 Census, 1976 Survey of Institutionalized Persons; 1977 National Nursing Home Survey (NNHS)

Data Quality

Completeness Data are complete. Entire labor market is represented. Total output as recorded in National Income and Product Accounts is represented. All major sources of retirement income are represented. Data are aggregate. No data for individuals are included.

Accuracy Data are from official U.S. National Income and Product Accounts, National Health Accounts, Social Security administrative program data, U.S. government surveys such as CPS, SIPP, Consumer Expenditure Survey (CEX).

Representative Data are complete and representative at aggregate level.

Currency Data used to estimate current version of the model are about 9-10 years old. Model should be re-estimated using more recent data.

Applicability to other contexts Data used are applicable to many research and modeling contexts.

Gaps No gaps. Many data series are out of date.

Applicability of other private/consulting firm data Limited. MDM is aggregate model. No private firm has complete data on national aggregates.

Characteristics, activities, behaviors that are modeled

Demographic characteristics: Age-specific fertility rates; age-sex mortality rates and immigration; age-sex group labor force participation, employment, hours worked, average wage, retirement rates

Aggregate economic activity

Short-run/cyclical: no

Long-run growth, productivity: yes

Inflation: no

Industrial sector detail: private sector, 7 components of public sector

Open or closed economy: closed; aggregate foreign sector is represented

Labor force characteristics and labor market behavior: age-sex group labor force participation, employment, hours worked, average wage, retirement rates

Capital markets: aggregate supply and demand for capital, aggregate private savings, aggregate household sector savings, real rates of return to capital and to various types of securities

Retirement plan characteristics: age-sex group coverage, participation, vesting in private pensions and 7 public employee pension systems; participation in defined benefit, defined contribution, and individual pension arrangements

Retirement behavior: age-sex group retirement rates and labor force participation

Individual/family savings and asset accumulation Individuals and families are not modeled

Pensions: average rates and levels for age-sex groups

IRAs: average rates and levels for age-sex groups

Financial assets: average rates and levels for age-sex groups

Home equity: average rates and levels for age-sex groups

Plan sponsor asset accumulation: aggregate private employer defined benefit and defined contribution pension systems, aggregate pension systems of seven sectors of public employment

Aggregate national saving and capital formation, sources: private saving in employer and individual pensions, financial assets, home equity, real assets; public sector saving in pension funds, OASDI trust funds, other

Government behavior

Federal budget: income taxes, OASDI payroll taxes, HI payroll taxes, other revenues, expenditures, OASDI benefit payments, HI and SMI benefit payments, on-budget and off-budget surplus/deficit, debt by maturity

OASDI and HI trust funds: payroll tax (contribution) revenues, interest earnings, benefit payments, other expenses, trust fund balances

Regulations: OASDI benefit rules

Taxes: federal income taxes, payroll taxes, other taxes, state and local government taxes and other revenues

Public retirement income programs

OASDI: payroll taxes, other revenues, benefits in 14 categories, other expenses, trust fund balances

SSI: participation, federal government expenditures for aged, blind, disabled programs, state supplements

Government employee pension programs

Federal civil service: CSRS, FERS, Federal Employee Thrift Plan

Military: Military Retirement System, disaggregated into officers, enlistees

State and local government, types: general and administrative workers, hazardous duty workers (police, firefighters), state educators, local educators

Private pensions

Defined benefit: modeled as single aggregate system

Defined contribution: modeled as single aggregate system

Supplemental: supplemental plans not explicitly represented *per se*

Individual retirement saving arrangements (IRA, Keogh, etc.): models individual retirement arrangements (IRAs, Keoghs) as one aggregate system

Public sector health care finance programs

Medicare: yes (in health expenditures model version of MDM)

Medicaid: yes

Military/CHAMPUS: yes

Veterans: yes

Indian Health Service and others: yes

Workers Compensation: yes

Private sector health care finance programs: private health insurance, out of pocket, philanthropy and direct employer health services

Private health insurance, especially retiree health insurance: yes

Employer/plan sponsor behavior: aggregate coverage, contributions of private defined benefit, defined contribution plans, seven public sector employer plans

Worker behavior: age-sex group labor force participation, employment, hours worked, average wage, retirement rates

Health care provider behavior: none, health care service prices modeled simplistically

Health Insurer behavior: aggregate premium payments, benefit payments for 7 types of health care services

Sources of family and individual income: employment, asset income

Components of retirement income

Earnings: yes

Social security: yes

Employer pensions: yes – private defined benefit, defined contribution, 7 public employee sectors

Means-tested transfer income: SSI

Income from assets: yes

Individual retirement accounts: yes

Other: personal transfers

Consumer/family expenditures/uses of income:

Taxes: income taxes, payroll taxes

Health care: 7 types of services

Other: 4 categories: food, consumer goods, capital services, consumer services

Assumptions, Parameters, Methodology

Key Assumptions MDM is a general equilibrium model, implicitly assuming that markets effectively clear and relative prices are flexible within each simulation period (one year). Production can be usefully described by an aggregate production function. Preferences of households can be described by well behaved preference function(s). Economic actors – firms and households – behave in optimizing fashion, taking all available information into account in making decisions. Aggregate behavior of labor market and retirement income systems can be usefully characterized in terms of the average experience of age-sex groups or cells (10 year age groups for ages 25-54). This implicitly assumes that distributional changes within age-sex groups (which are not modeled) do not effect average or aggregate results. Technology of individual producers and preferences of individual households can be aggregated consistently. Demographic characteristics of households can be represented by parameters of preference, consumption, expenditure, labor supply functions.

Types of Parameters, Decrements, Transition Rates/Probabilities

Experience considered, origins of decrements: Time series of aggregate and group-specific activity rates and average levels (e.g., labor force participation, pension participation, disability, retirement, fertility, mortality, average compensation per hour, etc.), based on tabulations of cross-section survey data, program activity data, vital statistics. Econometric equations characterizing economic behavior estimated from time series of aggregate and age-sex group-specific rates and data. Pension system participation and benefit receipt rates estimated from tabulations of cross-section data sets and, for federal civilian and military retirement systems on historic program activity data. Social security and SSI coverage, benefit acceptance, and decrements based on historic SSA program data.

Consistency with other experience and other assumptions of model: Model is based upon and consistent with neoclassical economic theory. Aggregate economic data are from National Income and Product Accounts, which are used for other macroeconomic models. National Income and Product Accounts data are augmented with other aggregate time series data and reformulated into an economic growth accounting system designed to identify and measure consistently the aggregate economic variables involved in economic growth.

Internal consistency: Model is internally consistent. Macroeconomic growth accounting system data, demographic group labor market data, and specification of equations of component models are based on neoclassical economic theory.

Methodology used to estimate parameters and relationships

Econometric/statistical: Single equation and simultaneous equations systems estimation methods, including ordinary least squares (OLS), two- and three-stage least squares, generalized least squares (GLS), seemingly unrelated equations estimation techniques, iterative maximum likelihood estimation techniques, discrete choice estimation techniques.

Actuarial: Pension system models and social security model are actuarial models.

Judgmental: Economic theory and prior beliefs serve to inform specification of behavioral models, but all behavioral relationships and equations are estimated.

Economic/actuarial literature, studies done by others, etc.: Economic theory and prior beliefs serve to inform specification of behavioral models. Benefits payments from and contributions to employer pensions are based on standard benefit formulae, such as career average unit benefit formula, and actuarial funding or costing methods, such as the accrued benefit cost method.

Simulation Methodology Deterministic solution of simultaneous and recursive systems of equations within each simulation year. Model is block recursive. Blocks of simultaneous equations are solved, using iterative solution techniques. Solution to one set of equations provides input for later set. Equation systems of some submodels are solved iteratively within larger simultaneous system. For example, block of equations of labor market submodel are solved for labor supply-demand within macroeconomic model, which is solved simultaneously for all macroeconomic variables. Labor market submodel is resolved for each iteration of the solution of the macroeconomic model. Pension system models are solved recursively. In rational expectations mode, model is solved iteratively over entire simulation period, for multiperiod intertemporal equilibrium.

Stochastic Properties Virtually all equations of behavior models are stochastic equations, which are estimated statistically. Actuarial relationships of pension system models are estimated using historical experience rates, decrements, and transition rates. Estimated equations of model are solved deterministically. Current version of model is not stochastic, in the sense of introducing uncertainty into the solution of the model. Many relationships could be made stochastic. The size and complexity of the model and the number of output variables would make stochastic simulation difficult, and could make the results difficult to interpret.

Feedback Phenomena Extensive. The MDM is a general equilibrium model. Virtually every behavioral equation interacts with every other equation. The model equations are solved simultaneously involving extensive feedbacks.

Microsimulation adjustment ("aging") methodology (where relevant) NA MDM is not a microsimulation model.

Policy levers Extensive and numerous policy levers. Social security: payroll tax rates, AIME computation years, benefit formulae, normal retirement age, trust fund investment policies and practices. Private pension coverage mandates, vesting periods, funding rules. Public employee pension benefit rules, funding rules. SSI benefit formulae. Federal taxes and expenditures. Medicare tax rates and benefit rules. Health care finance policies.

Economic/demographic feedbacks

Employer costs and behavior: In aggregate. Labor costs affect factor proportions and costs of output. Individual industries or employers are not modeled.

Labor market behavior: Compensation and wealth affect labor force participation and hours worked. Demographic structure of labor force affects employment, relative compensation rates, and productivity. Wages and prices affect demand for labor.

Taxes, government deficits, etc: Taxes, expenditures, and deficits affect government saving, which affects national saving and capital formation, which affects output, rates of return, prices, wages.

Capital accumulation: Capital accumulation is affected by private and public saving, which is affected by tax incentives for retirement saving, pension funding, social security surpluses and trust fund investment policy. Capital accumulation affects output, rates of return, prices, wages.

Interest rates: Rates of return to capital are affected by level of capital stock, labor input, productivity growth. Rates of return determine interest rates. Interest rates determine OASDI trust fund interest earnings, asset income of households.

Employment, productivity, economic activity, GDP: All are determined simultaneously in general equilibrium. Employment, capital input, and productivity determine output and GDP.

Sensitivity Analysis Can be performed readily by varying assumptions, values of exogenous variables, and parameter values. Model simulation setup and simulation times are short, so it easy to carry out sensitivity analysis.

Model Validation Procedures Model has been validated by simulating past periods, 1970-1990 and 1980-1990, and comparing to actual history.

Is model proprietary, available to public Model is in public domain.

Computer implementation

Hardware requirements PC with 386 or higher processor, 8 MB RAM, hard disk with 22 MB free disk space; or mainframe.

Software Fortran compiler

Computer costs Runtime cost is minimal. Model simulation times are modest. PC hardware and software acquisition costs are modest.

Transportability Model is easily transportable.

Applications

Projections of income levels of various cohorts of the elderly.

Projections of social security trust fund balances under alternative tax, benefit policies, and alternative demographic and economic scenarios.

Projections of health care expenditures by type of service and source of payment of various age groups and cohorts, under alternative demographic and economic scenarios.

Effects on pensions and the economy of mandating employer pensions, minimum participation and vesting requirements.

Effects of alternative social security trust fund accumulation and investment policies on trust fund balances and the economy.

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Effects of changing eligibility rules, limits, and tax incentives for Individual Retirement Accounts on retirement income; government revenues, expenditures and deficits; and national savings and the economy.

Effects on health care expenditures of alternative health care finance policies and programs.

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ANNEX 10-2

**MACROECONOMIC-DEMOGRAPHIC MODEL
OF THE U.S. RETIREMENT INCOME SYSTEM
POLICY MATRICES**

MDM -- POLICY MATRIX

1. Effects of Policy Measures on Employer Pensions

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

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

MDM -- POLICY MATRIX

2. Effects of Policy Measures on Employees

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

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

MDM -- POLICY MATRIX

3. Effects of Policy Measures on Retirees

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

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

MDM -- POLICY MATRIX

4. Effects of Policy Measures on Industry Outcomes

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

Blank cell indicates that the effects of the policy issue or input on that outcome cannot be simulated in this model.
Individual industries are not represented in MDM. This Table refers to effects on aggregate production sector.

MDM -- POLICY MATRIX

5. Effects of Policy Measures on Aggregate Economy

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

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

MDM -- POLICY MATRIX

6. Effects of Policy Measures on Government Finances

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

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