CHAPTER 11

PIMS

THE PENSION INSURANCE MODELING SYSTEM

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CHAPTER 11

PENSION INSURANCE MODELING SYSTEM PIMS

I. Introduction

PIMS is a microsimulation model that produces a distribution of PBGC's exposure over a defined time interval. This chapter describes the major components of PIMS, the data types in PIMS, the PIMS simulation process, simulation activities, and current output.

II. PIMS Modules

PIMS has a modular structure. The model consists of several major modules, which PBGC staff refer to as PIMS entities, that interact with one another. These entities also have their own functions that are critical to the model. Figure 1 displays the major entities in PIMS and highlights their relationships. The major functions of these entities is described below.

Economy: The economy entity contains the interest rate and stock market return stochastic processes.

Firm: The firm entity contains the financial and employment conditions of the firm and determines how these variables, as well as the contributions made to the plan, affect the firm's probability of bankruptcy.

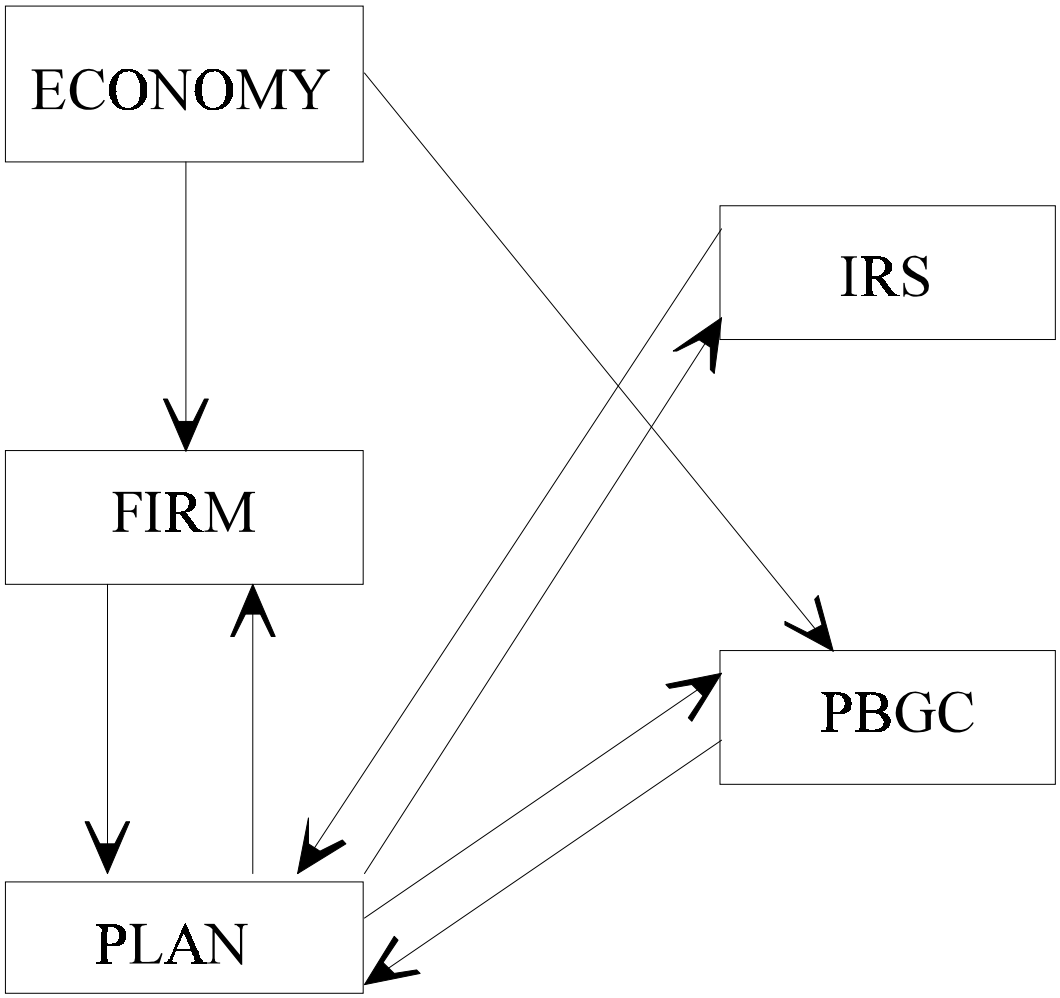
Plan: The plan entity contains the plan demographics, liabilities, and assets. These combine to determine the funding status of the plan, in accordance with Internal Revenue Code (IRC) rules.

IRS: The IRS entity determines the rules under which the plan calculates minimum and maximum permitted contributions.

PBGC: The PBGC entity receives plans that terminate due to firm bankruptcy and provides benefit payments to those recipients under the insurance program. It maintains a portfolio of assets and liabilities similar to a private pension plan. It also collects premiums and pays administrative expenses.

FIGURE 1

MODULAR STRUCTURE OF PIMS



III. Input Data and Parameters

A PIMS simulation is driven primarily by the data that are stored in a series of relational tables. User-defined input data control a simulation and enhance the flexibility of PIMS. As a data driven model, various alternative simulations and sensitivity analyses can be run without code modifications.

There are four major data types used in PIMS: simulation parameters, initial values, temporal parameters, and policy parameters. These data types control the simulation; other variables in the tables are linking variables that primarily establish the relationships among the data.

Simulation Parameters

Simulation parameters determine the scope of the simulation. These parameters include the number of scenarios and cycles to be run, the number of years for each scenario, the number of firms included in the simulation, whether the simulation is deterministic or stochastic, and other user-determined simulation controls.

Initial Values

Initial values consist of the data that describe the state of the economy, firm, and plan at the beginning of the simulation. These values include macroeconomic variables (e.g., interest rates, stock market returns), firm (plan sponsor) variables (e.g., debt-equity ratios, cash flow, employment levels), and pension plan variables (e.g., liabilities, assets, stocks of plan participants, salary levels). PIMS also requires information on the initial financial condition of the PBGC (e.g., assets, liabilities, benefit payments).

Interest rates and stock returns are taken from lbbotson Associates, *Stocks, Bonds, Bills, and Inflation*. Firm data are obtained from corporate annual reports. Pension plan data are taken from Internal Revenue Service Form 5500 Annual Pension Plan Reports. The initial financial condition of the PBGC is obtained from data that underlie the agency's *Annual Report*. These data include assets, liabilities, underlying demographic distributions, and benefit payments.

Temporal Parameters

The temporal parameters determine how a simulation advances from year to year, generating a path for the economy, the firm, the plan, and the PBGC. These parameters include the estimated bankruptcy and stochastic model parameters, the parameters that describe actuarial interest rate behavior, and parameters that describe the portfolio distribution and return behavior of pension plans, as well as all estimated joint distributions. Other temporal parameters are the rates that describe how each pension plan's population advances over time (e.g., rates of mortality, retirement, separation, hiring, etc.).

Policy Parameters

Policy parameters in PIMS define the regulations and policies under which the pension plan must operate. These include the pension funding rules provided under the Internal Revenue Code, such as the amortization period required for gains and losses experienced by the plan and the limits on the interest rate used to calculate current liabilities. They also include various PBGC rules and procedures that determine the premium amount and the status of a plan once it is taken over by the PBGC.

IV. Simulation Procedure

A PIMS simulation consists of a user-specified number of scenarios. The results of these scenarios comprise the distribution of outcomes that characterize PBGC's exposure. The time needed to complete a simulation is a function of the number of scenarios specified, the number of years being projected, the number of firms and plans in the simulation, the mix of plans (flat, salary, and hybrid), and the computer platform being used to run the simulation.

Each scenario consists of one time path of up to 20 years. Each scenario in a simulation starts with initial conditions for the economy, firm, plan, and PBGC condition that correspond to the baseline year of the simulation (PIMS “year 0"). Due to lags in the availability of pension plan data, PIMS is designed to advance plans with data from up to four years prior to the PIMS starting year to the starting year using the actual economic and PBGC conditions for the update period. This provides the broadest possible sample of pension plans available to PIMS. Lags in the availability of firm data are handled by advancing firm values stochastically or deterministically to PIMS year 0.

A simulation begins with the first of the user specified number of scenarios. In a scenario, the interest rates and stock returns are projected for the number of years required using the estimated economy equations and joint distributions. PIMS uses this information to determine the financial conditions and size of the firm in the first year and the funding status of each plan the firm sponsors.

The firm component of the model begins by initializing and updating the plan and firm data so that all pension plans and firms are updated to the PIMS base year, referred to as “year 0.” The firm's stochastic variables (asset to debt ratio, cash flow, equity and employment) are then simulated using estimated equations and associated joint distributions. The pension plans sponsored by the firm are advanced using the stochastic variables in the model. Changes in the firm's employment determine the number of active participants in each plan; asset returns reflect equity and interest rate changes; and liabilities are increased or decreased due to changing interest rates. In addition, deterministic variables are updated. For example, benefit payments in flat benefit plans and benefits for retirees are updated for inflation, and salaries are increased based on inflation and productivity gains. Finally, the minimum and maximum contribution required by the plan and the benefit payments are determined. Then, underfunding levels are calculated given developments in the economic scenario.

These calculations are repeated for each plan sponsored by the firm for that year. The overall funding ratio for all plans and the contributions required by the firm are calculated. These data, along with firm and economy data, are used to determine the probability that the firm will go bankrupt according to the estimated bankruptcy equation. A stochastic probability equation determines actual bankruptcies based on these probabilities. The probability of bankruptcy is applied to each firm over a predetermined number of "cycles" for each economic scenario. Using cycles allows the model to efficiently use the economic scenario information generated by PIMS.

Cycling Procedure

Within each PIMS scenario, firms are simulated several times. This "cycling" is designed to provide a more efficient estimate of the true expected costs of any given scenario, and reduce the number of (costly) scenarios that must be simulated to get results with acceptable standard errors. It also provides a measure of the residual risk, or the idiosyncratic risk component, given that a scenario occurs.

Bankruptcy and Plan Termination

If the firm is simulated to go bankrupt, the type of bankruptcy (Chapter7 or 11) is determined using a threshold level for bankruptcy probabilities and overall plan funding. For "Chapter 7" firms, the associated plan's liabilities are valued in accordance with rules that regulate termination basis calculations. If a failed firm's plan is overfunded, the plan is assumed to distribute its assets to participants. If the plan is underfunded, the plan's asset and liabilities are transferred to the PBGC module. For "Chapter 11" bankruptcies, the associated firm continues to operate and is returned to the model with reestablished firm level variables and continuing pension plan(s).

When the PBGC receives the claim, the plan's assets and liabilities are transferred to the PBGC. The liabilities are valued using PBGC's assumptions regarding interest and mortality rates, and the benefits are limited to the amount insured by the PBGC. A fixed, user-specified, rate of recovery from the plan sponsor is also assumed and transferred to the PBGC.

A set of statistics is updated and periodically output during a simulation. These statistics provide a summary of the PBGC's exposure and the events that occurred during each scenario.

V. PIMS Output

PIMS produces a set of output files that contain the simulation results. These output files provide various levels of simulation detail, and summary information.

- A plan level output file reports the assets, liabilities, and contributions for a single plan during one scenario, both specified by the user. The file is used primarily to review the actuarial calculations for a plan.

- A comprehensive plan file provides detailed plan data for all plans specified in the PIMS run.

- A bankruptcy output file records each bankruptcy, the bankruptcy scenario number, the year of the bankruptcy, the bankruptcy probability, and the various firm level variables such as employment and equity.

- A plan-bankruptcy file reports plan level information for plans whose sponsors go bankrupt.

- A single firm file reports information for a selected plan sponsor.

- An economy level output file reports the interest rates and stock market returns for each year in each scenario.

- A PBGC output file reports the financial status of the PBGC, including the net worth, assets, and liabilities of the PBGC.

- The overall results file contains summary statistics for each year, such as the number of bankruptcies, the number of claims, the claims amount, and other information for each scenario. It also produces simulation level summary statistics, such as the mean number of bankruptcies.

ANNEX 11-1

PIMS

SUMMARY DESCRIPTION

PIMS

Summary Description

Subject: The financial position of the Pension Benefit Guaranty Corporation (PBGC), its insured plan sponsors, and their plans.

Purpose and Objective of Model:

PIMS is designed to quantify the uncertainty that surrounds pension insurance. The primary goal of the model is to portray the range of pension insurance claims on the PBGC over some future period and to attach probabilities to these levels. PIMS produces a distribution of the PBGC's net financial condition given the probabilities attached to the agency's future financial condition (i.e., deficit or surplus).

Although PIMS is not designed to model a single plan sponsor's behavior, the model can be utilized to study the effects of current and proposed laws outside of their impact on the PBGC.

Period of historical analysis: 1926 - 1997

Forecast/simulation horizon: Twenty years

Frequency: Annual

Base year: Currently, PIMS Year Zero = 1997

Simulation technique: Dynamic and stochastic microsimulation

Solution algorithms and structure: Autoregressive equations with correlated random disturbances; application of transition matrices.

Unit(s) of analysis: PBGC, insured sponsoring firms, and insured plans

Cell Structure: Private sector, single-employer defined benefit plans. PBGC financial data; Firm-level financial (debt-equity ratio and cash flow) and employment data; and plan-level demographics (benefits, stocks of plan participants and salary levels), liabilities, and assets. Data are weighted to represent the universe of private sector, single-employer defined benefit plans. (See Attachment One)

Databases

Base Year Database **Legend to Data Sources for PIMS Entities (Modules):**

Economy: 30-year Treasury Bond rates and stock market returns from Ibbotson Associates (1926 - 1997); firm bankruptcy data from Compustat, New Generation Research, Inc., and Professor R. Nachtmann at the University of Pittsburgh (1980 - 1995)

Firm: 10k Annual Reports and Compustat (1972 - 1995)

Plan: IRS 5500 Schedule B and attachments (1993 - 1995)

IRS: Pension provisions of Internal Revenue Code

PBGC: Pension provisions of Internal Revenue Code, ERISA, PBGC Annual Report (FY97)

[PIMS deterministically "advances" all source data to PIMS year zero.]

Population/demographics: Plan
Individual/family/household characteristics: Persons and families are not represented in PIMS. (In PIMS, the individual unit modeled is a pension plan. Sponsors of plans are firms.)
Employer characteristics: Firm
Industry characteristics: Firm
Retirement plan coverage, participation: Plan
Retirement plan vesting: Plan
Retirement plan characteristics: Plan
Individual Retirement Account (IRA) participation, contributions: NA
Supplemental Security Income (SSI) eligibility, participation: NA
Family assets: NA
Home ownership: NA
Macroeconomic data: Economy
Labor market data: NA
Retirement behavior: NA
Taxes: IRS
Health conditions, disability: NA
Health insurance coverage: NA
Institutional population characteristics: NA

Data Quality

Completeness Complete. All model variables are based on empirical data.
Accuracy Accurate, subject to reporting errors of Form 5500 data.
Representative The 263 firms in PIMS (417 plans) represent approximately one-half of liabilities in the private sector, single-employer defined benefit universe.
Currency Current
Applicability to other contexts PIMS can be used to study the effects of current and proposed laws outside of their impact on the PBGC. For example, the model can be used to study the volatility of employer minimum required contributions under the law. In addition, the PIMS database can be used to study the characteristics of insured plans.
Gaps None
Applicability of other private/consulting firm data NA

Characteristics, activities, behaviors that are modeled

Demographic characteristics Determined by the model: deaths, disability, retirement, employment and termination
Economic activity
Short-run/cyclical Represented in the model, but not modeled
Long-run growth, productivity Represented in the model, but not modeled
Inflation Represented in the model, but not modeled

Industrial sector detail	Represented in the model, but not modeled
Open or closed economy	NA
Labor market behavior	NA
Capital markets	Represented in the model, but not modeled
Retirement program characteristics	Represented in the model, but not modeled
Retirement behavior	Assumed parameters
Savings and asset accumulation	Determined by the model: pension fund assets, vested benefits
Government behavior	
Federal budget	NA
Social Security and Health Insurance Trust Funds	NA
Regulations	Represented by the model, but not modeled
Taxes	NA
Public retirement income programs	
Social Security Retirement, Disability and Survivors Insurance	NA
Means tested old age or disability income transfers	NA
Government employee pension programs	
Federal civil service	NA
Military	NA
State and local government, types	NA
Private pensions	
Defined benefit	Represented by the model, but not modeled behaviorally
Defined contribution	NA
Supplemental	NA
Individual retirement saving arrangements (IRA, Keogh, etc.)	NA
Public sector health care finance programs	NA
Medicare	–
Medicaid	–
Military	–
Veterans	–
Indian Health Service and others	–
Private sector health care finance programs	NA
Private health insurance, especially retiree health insurance	NA
Employer/plan sponsor behavior	Determined by the model: contributions, premiums, bankruptcy. Not behaviorally.
Worker behavior	NA
Health care provider behavior	NA
Insurer behavior	NA
Institutionalization	NA

Assumptions, Parameters, Methodology

Key Assumptions The basic structure underlying the historical economy, which produced the data for PIMS parameter estimates, is not subject to significant changes within the simulation horizon.

Types of Parameters, Decrements, Transition Rates/Probabilities

Simulation parameters: Includes the number of scenarios and cycles to be run, the number of years for each scenario, the number of firms included in the simulation, whether the simulation is deterministic or stochastic, and other user-defined controls.

Temporal parameters: Includes estimated stochastic and bankruptcy model parameters, actuarial interest rate behavior, portfolio distribution and return behavior of pension plans, as well as all estimated joint distributions.

Policy parameters: Includes regulations and policies from the Internal Revenue Code and PBGC rules and procedures under which a pension plan must operate.

Decrements: retirement, employment/separation, disability, mortality

Transition Rates/Probabilities: The matrix of plan participants is projected from each point in time using decrement rates derived from plan data. Wages and benefits are adjusted to reflect rates of inflation and productivity in the economy; wages are also adjusted to reflect promotions/seniority. (See Attachment Two)

Experience considered, origins of decrements: The rates of decrement come from the actuarial valuations of the plans as they are reported on attachments to Schedule B of IRS Form 5500.

Consistency with other experience and other assumptions of model: No discernible inconsistencies.

Internal consistency: Consistent

Methodology used to estimate parameters and relationships

Econometric/statistical: Ordinary Least Squares, Logit, Tobit, Seemingly Unrelated Regressions, Maximum Likelihood

Actuarial: Generally accepted actuarial principles and decrement probabilities as described above.

Judgmental: Yes

Economic/actuarial literature, studies done by others, etc.: All modeling guided by findings from literature surveys and consultation with outside professionals.

Simulation Methodology Dynamic and stochastic microsimulation, longitudinal imputation

Stochastic Properties Monte Carlo simulation

Feedback Phenomena Yes

Microsimulation adjustment ("aging") methodology (where relevant) Dynamic aging

Policy levers

Retirement Protection Act (RPA) – on/off; when RPA "on", option to select year Variable Rate Premium interest rate goes to 100% and new mortality table associated with it.

Full funding limit – option to select the percentage of current liability that represents the full funding limit in various calendar years.

Lump sum cashouts – select threshold for *de minimis* lump sum cashouts.
PBGC premiums – change PBGC premium parameters ($19 Flat Premium and/or $9 per $1,000 Variable Rate Premium).
Funding standard account – change number of years over which various funding standard account bases must be amortized.
Actuarial value of assets – change corridor for actuarial value of assets.
Maximum benefit and pay limits – change maximum benefit and pay limits under Code sections 415 and 401(a)(17).
Guaranteed benefit: – change PBGC maximum guaranteed benefit amount.

Economic/demographic feedbacks

Employer costs and behavior: Yes; pension benefits keep pace with labor costs and bankruptcy rates are affected by pensions costs.
Labor market behavior: No
Taxes, government deficits, etc.: Yes; PBGC premiums and claims are components of government balances.
Capital accumulation: NA
Interest rates: Yes; interest rates affect pension liability calculations and asset returns, and are correlated with firm variables.
Employment, productivity, economic activity, GDP: NA
Other: NA

Sensitivity Analysis PIMS simulations can be executed with alternative parameter values on a limited or comprehensive basis.

Model Validation Procedures The bankruptcy and firm variable components of the model were "back tested" against 1980 - 1994 historical data. PIMS has had several peer reviews, most notably the PIMS Technical Review Panel in November 1996 (sponsored by the Pension Research Council at the Wharton School, University of Pennsylvania)

Is model proprietary, available to public Model is in the public domain, maintained at PBGC.

Computer implementation

Hardware requirements PC or compatible, Pentium or better processor, 64 MB memory, CD-ROM, and a minimum of 500 MB free disk space. (The amount of additional disk space required is dependent on the simulation parameters and the output generated.)
Software Windows 95/Windows NT, relational database program (PIMS was originally developed using FoxPro). The current PIMS database requires approximately 80 MB of disk space.
Computer costs Low to medium depending on performance and analysis requirements. Simulation run-times are proportional to the number of pension plans, the length of the simulation horizon, and the number of economic scenarios. Run-times are inversely proportional to processor speed and the number of processors devoted to the simulation.

For example, running one pension plan for 100 economic scenarios over 20 years currently takes about two minutes on a Pentium-200 class workstation. Running 417 plans (the complete set) over the same number of economic scenarios would take approximately fourteen hours on the same single machine. (This run-time can be reduced with more and/or faster processors.)

Transportability Yes

Applications (Projects, Studies)

Potential applications: assessment of the risks to the PBGC, analysis of premium adequacy, development of strategies and policies for risk management, and analysis of pension policy effects.

Past applications: analysis of full funding limit effects on pension funding, and analysis of PBGC risk exposures for the Office of Management and Budget.

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ANNEX 11-2

PIMS

POLICY MATRICES

PIMS -- 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					
Pension					
General					
Social Security					
Retirement age					
Benefit structure *			X	X	X
Indexation					
Payroll tax					
Trust fund investment					
Individual accounts					
Funding and Guarantees					
PBGC premium			X		
Funding rules			X	X	X
Pension Regulation and Policy					
ERISA/IRS			X	X	X
Employer plans			X	X	X
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.

* Benefit structure: limited (change parameters), comprehensive (change coding)

PIMS -- 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						
Social Security						
Retirement age						
Benefit structure				X		
Indexation						
Payroll tax						
Trust fund investment						
Individual accounts						
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.

PIMS -- 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									
Social Security									
Retirement age									
Benefit structure		X							
Indexation									
Payroll tax									
Trust fund investment									
Individual accounts									
Funding and Guarantees									
PBGC premium									
Funding rules		X							
Pension Regulation and Policy									
ERISA/IRS	X	X							
Employer plans	X	X							
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.

* Limted (change parameters), Comprehensive (change coding)

PIMS -- POLICY MATRIX

4. Effects of Policy Measures on Industry Outcomes

Outcome Variable **Policy Input**	Financial strength of plans, sponsors, insurers	Labor costs	Profits	Competitiveness
Tax Policy				
Pension				
General				
Social Security				
Retirement age				
Benefit structure				
Indexation				
Payroll tax				
Trust fund investment				
Individual accounts				
Funding and Guarantees				
PBGC premium	X			
Funding rules	X			
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.

PIMS -- POLICY MATRIX

5. Effects of Policy Measures on Aggregate Economy

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

PIMS -- POLICY MATRIX

6. Effects of Policy Measures on Government Finances

Outcome Variable **Policy Input**	Tax revenue	Expenditures by program	Deficits and debt	Social Security and Medicare
Tax Policy				
Pension				
General				
Social Security				
Retirement age				
Benefit structure				
Indexation				
Payroll tax				
Trust fund investment				
Individual accounts				
Funding and Guarantees				
PBGC premium		X		
Funding rules		X		
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.