

FINANCIAL MARKET DYNAMICS
AN ANALYSIS OF CREDIT EXTENSION AND SAVINGS ALLOCATION

by

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SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE
OF
DOCTOR OF PHILOSOPHY
at the
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
June 1977

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Alfred P. Sloan School of Management, April 28, 1977

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Submitted to the Alfred P. Sloan School of Management on
April 27, 1977, in partial fulfillment of the requirements
for the degree of Doctor of Philosophy

ABSTRACT

This study describes a system dynamics model of credit extension, savings allocation, and interest rates. The model constitutes the financial sector of the National Model of socio-economic processes, which is currently under development at the Sloan School.

Chapter I outlines the structure and purpose of the National Model and summarizes the remaining chapters. Chapter II introduces the system dynamics approach to financial modeling, focusing on basic structural elements that permit one to analyze disequilibrium behavior and public policy alternatives. Chapter III describes the institutions and functions of the model. The "Savings Investor" channels all private savings to fiduciary institutions or direct investments. Three aggregate lending institutions in the model extend short-term credit (the "Bank"), long-term credit to business firms (the "Corporate Lender"), and residential mortgage credit to households (the "Mortgage Lender").

Chapter IV analyzes the response of the model to deterministic and random noise inputs. These simulations test the internal logic of the model structure and, on the whole, successfully replicate the observed behavior patterns of financial variables. Chapter V employs data-based inputs and tests the model's capacity to track quarterly time-series data on lending and interest rates over the period 1960-74. The statistical and qualitative fit is acceptable in most cases.

Chapter VI addresses some of the missing elements and weaknesses of the model structure and identifies issues for which the financial sector, combined with the rest of the National Model, is well-suited. These issues include the contribution of monetary factors to economic instability and inflation, the appropriate targets for official monetary policy, the vulnerability of the financial system to changing modes of economic behavior, and the inflation component and term structure of interest rates.

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ACKNOWLEDGEMENTS

Uta comes first on this page. When the thesis was no laughing matter, she made me smile; when it seemed to lead nowhere, she kept the goal in sight; when it all became too important, she helped me realize what really counts. So, to Uta, special thanks.

I am also grateful to my colleagues and friends at MIT, who added pleasure and challenge to the life of a belated graduate student; to Jay Forrester, whose uncompromising intellect and holistic worldview have marked indelibly the way I relate to my environment; to the other members of my thesis committee, Lester Thurow and Donald Lessard, who encouraged me to examine carefully the contribution of system dynamics to economic analysis.

The other participants in the National Modeling Project--Al Graham, Nat Mass, Dale Runge, Charlie Ryan, Pete Senge, and Bill Shaffer--gave me tremendous support and advice during this effort. Nat, especially, extended kind and insightful assistance during some crucial weekend meetings that kept my part of the National Model afloat. Dave Andersen also asked the right questions at a crucial time.

Anne Chay and Kelsey Thompson kept the computer programs and flow diagrams in order and cheerfully endured frequent changes in datasets and model documentation. Mark Tangard typed and retyped this mammoth production with fantastic precision and dedication. I'll never forget his conquest of computer text editing, downtimes, and impossible deadlines.

Finally, thanks to the MIT Athletic Department, whose squash courts did as much as anyone to improve my psyche during those long winter months.

CONTENTS

CHAPTER I.	INTRODUCTION AND SUMMARY	15
	A. Purpose	15
	B. Summary	21
CHAPTER II.	A SYSTEMS APPROACH TO FINANCIAL MODELING	27
	A. An Introduction to System Dynamics	27
	B. Distinguishing Features of the Financial Model	35
	1. Disequilibrium in Financial Modeling	36
	2. Micro Decisions in a Macro Model	45
	C. Conclusions	54
CHAPTER III.	DESCRIPTION OF THE FINANCIAL SECTOR	59
	A. The Financial Sector as Part of the National Model	59
	1. Financial Structure and Macroeconomic Behavior	60
	2. Monetary Interconnections	61
	3. Transmission of Monetary Controls	64
	4. Historical Developments in Financial Activity	67
	B. Financial Institutions	68
	1. Overview	68
	2. The Savings Investor	71
	3. The Bank	75
	4. The Corporate Lender	81
	5. The Mortgage Lender	85
	C. Financial Functions	88
	1. Overview	88
	2. Primary Lending	92
	3. Return on Loans	107
	4. Investment in Government Securities	113
	5. Liabilities of Lending Institutions	121
	6. Bank Reserves and Currency	125

CHAPTER IV.	SIMULATIONS OF THE FINANCIAL SECTOR	133
	A. Introduction	133
	1. Purpose of Simulation	133
	2. Format of the Simulations	135
	3. Description of the Test Generator	137
	B. Simulations of the Bank	142
	1. The Bank--Step in Loan Demand	143
	2. The Bank and Savings Investor--Step in Loan Demand	160
	3. The Bank and Savings Investor--Cyclical Loan Demand	179
	4. The Bank and Savings Investor--Noise in Loan Demand	185
	C. Other Simulations	192
	1. The Mortgage Lender and Savings Investor-- Step in Loan Demand	193
	2. The Mortgage Lender, Bank, and Savings Investor--Open-Market Sale by the Monetary Authority	206
	3. The Full Financial Sector--Noise in Demand for Bank Loans	224
	D. Conclusions	234
	APPENDIX IV-1. Rerun Conditions Used to Simulate the Financial Sector Model	238
	APPENDIX IV-2. Equilibrium Conditions for the Financial Sector--Mortgage Lender plus Savings Investor	241
CHAPTER V.	TIME-SERIES TEST OF THE FINANCIAL SECTOR	247
	A. Introduction	247
	B. Procedure	248
	1. Output Variables	248
	2. Data-Based Input Variables	254
	3. Assumptions about Other Inputs	259
	4. Statistical Measures of Fit	266

C. Results	271
1. Time-Series Test of the Basic Model	271
2. Time-Series Test with Slower Turnover in Savings Deposits	291
D. Conclusions	298
APPENDIX V-1. Rerun Conditions for Time-Series Test	300
CHAPTER VI. LOOSE ENDS AND ISSUES	301
A. Structural Loose Ends	301
1. The Treatment of Common Stock	302
2. Aggregation in the Financial Sector	309
3. The Acquisition of Non-Money Factors of Production	311
4. The Computation Interval	312
B. Financial Issues and the National Model	314
1. The Importance of Money	315
2. Monetary Policy	317
3. Fragile Financial Structures	319
4. The Inflation Component of Interest Rates	321
5. The Term Structure of Interest Rates	323
APPENDICES	
APPENDIX 1. DESCRIPTION OF EQUATIONS FOR THE FINANCIAL SECTOR OF THE SYSTEM DYNAMICS NATIONAL MODEL	325
A. Introduction	325
B. Primary Lending	329
C. Return on Loans Outstanding	353
D. Investment in Government Securities-- Treasury Bills	367
E. Investment in Government Securities-- Government Bonds	384
F. Liabilities--Savings Deposits	397
G. Liabilities--Equity	411
H. Bank Reserves and Currency	421
I. Temporary Equations	436
J. Flow Diagrams for the Financial Sector	445

APPENDIX 2.	TEST GENERATORS AND COUPLING EQUATIONS FOR THE NATIONAL MODEL	453
	A. Test Generator for Borrowing Sectors	453
	B. Test Generator for Monetary Authority and Treasury	467
	C. Coupling Equations	482
	D. Flow Diagrams for Test Generator and Coupling Equations	489
APPENDIX 3.	THE FINANCIAL SECTOR MODEL (N201)	493
	A. Equations	493
	B. Definitions	509
APPENDIX 4.	BIBLIOGRAPHY	521

LIST OF TABLES

Table III-1:	Savings Investor Balance Sheet	73
Table III-2:	Bank Balance Sheet	80
Table III-3:	Long-term Liabilities of Households and Business Firms, Year End 1973	83
Table III-4:	Corporate Lender Balance Sheet	85
Table III-5:	Mortgage Lender Balance Sheet	88
Table IV-1:	Comparative Balance Sheets of the Bank-- First Simulation	157
Table IV-2:	Comparative Balance Sheets of the Bank-- Second Simulation	163
Table IV-3:	Comparative Balance Sheets of the Savings Investor--Second Simulation	165
Table IV-4:	Comparative Balance Sheet of the Mortgage Lender--Fifth Simulation	199
Table IV-5:	Comparative Balance Sheets of the Savings Investor--Fifth Simulation	202
Table IV-6:	Comparative Balance Sheets of the Savings Investor--Sixth Simulation	214
Table IV-7:	Comparative Balance Sheets of the Bank-- Sixth Simulation	222
Table IV-8:	Comparative Balance Sheets of the Mortgage Lender--Sixth Simulation	223
Table V-1:	Outputs of the Financial Sector Used in Time-Series Tests	250
Table V-2:	Time-Series Inputs Used to Test the Financial Sector	255
Table V-3:	Assumptions About Selected Inputs to the Financial Sector	260
Table V-4:	Statistical Results of Time-Series Test	272
Table V-5:	Comparison of R^2 for Two Time-Series Tests, with Alternative Values for the Average Life of Savings Deposits	298

LIST OF FIGURES

Figure I-1:	Basic Sectors of the National Model	17
Figure II-1:	The Feedback Loop Structure	29
Figure II-2:	A Positive Feedback Loop and Portfolio Management	30
Figure II-3:	The Combination of Positive and Negative Feedback Loops	31
Figure II-4:	Partial DYNAMO Flow Diagram of Long-Term Bond Acquisition	33
Figure II-5:	A Simple Model of Bank Lending (Case #1)	49
Figure II-6:	A Simple Model of Bank Lending (Case #2)	51
Figure III-1:	Money Flows in the National Model	63
Figure III-2:	The Financial Sector as a Filter that Influences Monetary Control over Borrowing and Savings	66
Figure III-3:	The Flow of Private Savings into Financial Assets	70
Figure III-4:	Coupling Between Private Savers and the Savings Investor	74
Figure III-5:	Negative Feedback Loop and Fractional Reserve Banking	77
Figure III-6:	Reserve Classifications in the Banking System	78
Figure III-7:	Functional Organization of the Financial Sector	90
Figure III-8:	Timing of Credit Requests and Extensions	98
Figure III-9:	Feedback Loops Relating Liquid Assets and Loan Extension Rate	102
Figure III-10:	Negative Feedback Loops Relating Bank Lending and Borrowed Reserves	106
Figure III-11:	Structure of the Return on Loans	108
Figure III-12:	Negative Feedback Loop Relating Loan Demand and Interest Rates	110
Figure III-13:	Negative Feedback Loop Relating Profitability and Interest Rates	111
Figure III-14:	Negative Feedback Loop Relating Interest Rate Spread and Interest Rates	113
Figure III-15:	Negative Feedback Loop Relating Bond Purchases and Liquidity	118
Figure III-16:	Negative Feedback Loop Relating Bond Purchases and Current Relative Returns	119
Figure III-17:	Negative Feedback Loop Relating Desire Transactions in the Bill Market and the Return on Treasury Bills	120
Figure III-18:	Three Negative Feedback Loops Influencing the Return on Savings Deposits	124

Figure III-19:	Conserved Flows Between Owned Reserves and Currency in the Public	126
Figure IV-1:	Major Feedback Loops Between Financial Sector and Financial Test Generator	139
Figure IV-2:	Possible Behavior of Loan and Backlog Variables in the Test Generator in Response to a Step in Desired Loans	140
Figure IV-3:	Bank Lending Variables in Response to Step in Loan Demand--First Simulation	145
Figure IV-4:	Return on Bank Loans in Response to Step in Loan Demand--First Simulation	149
Figure IV-5:	Bank-Held Securities in Response to Step in Loan Demand--First Simulation	152
Figure IV-6:	Bank Reserves in Response to Step in Loan Demand--First Simulation	154
Figure IV-7:	Bank Assets During 1972-1975	159
Figure IV-8:	Bank Balance Sheets Variable in Response to Step in Loan Demand--Second Simulation	162
Figure IV-9:	Bank Lending Variables in Response to Step in Loan Demand--Second Simulation	166
Figure IV-10:	Return on Bank Loans in Response to Step in Loan Demand--Second Simulation	168
Figure IV-11:	Bank Savings Deposits in Response to Step in Loan Demand--Second Simulation	172
Figure IV-12:	Bank-Held Securities in Response to Step in Loan Demand--Second Simulation	175
Figure IV-13:	Savings Investor Assets in Response to Step in Loan Demand--Second Simulation	177
Figure IV-14:	Bank Assets in Response to Cyclical Loan Demand--Third Simulation	181
Figure IV-15:	Interest Rates in Response to Cyclical Loan Demand--Third Simulation	184
Figure IV-16:	Bank Assets in Response to Noise in Loan Demand--Fourth Simulation	187
Figure IV-17:	Interest Rates in Response to Noise in Loan Demand--Fourth Simulation	188
Figure IV-18:	Reference-Cycle Patterns of Commercial Paper Rate and Monetary Growth Rate	190
Figure IV-19:	Relationship From Model Between Return on Treasury Bills and Change in Money Supply	191
Figure-IV-20:	Balance Sheet Variables of the Mortgage Lender in Response to Step in Loan Demand--Fifth Simulation	195
Figure IV-21:	Balance Sheet Variables of the Savings Investor in Response to Step in Loan Demand--Fifth Simulation	200
Figure IV-22:	Interest Rates in Response to Step in Loan Demand--Fifth Simulation	203
Figure IV-23:	Annual Change in Savings Account Balances and Direct Investments of Households	207

Figure IV-24:	Assets of the Savings Investor in Response to Open Market Sale by the Monetary Authority--Sixth Simulation	211
Figure IV-25:	Returns on Assets of the Savings Investor in Response to Open Market Sale by the Monetary Authority--Sixth Simulation	215
Figure IV-26:	Major Influences on Savings Deposit Return in Response to Open Market Sale by the Monetary Authority--Sixth Simulation	218
Figure IV-27:	Bank Lending Variables in Response to Open Market Sale by the Monetary Authority--Sixth Simulation	220
Figure IV-28:	Loans Outstanding in Response to Noise in Demand for Bank Loans--Seventh Simulation	226
Figure IV-29:	Annual Change in Three Categories of Primary Credit, 1961-1975	228
Figure IV-30:	Government Securities in Response to Noise in Demand for Bank Loans--Seventh Simulation	230
Figure IV-31:	Annual Change in Treasury Bills Held by Banks and Households, 1961-1975	231
Figure IV-32:	Interest Rates in Response to Noise in Demand for Bank Loans--Seventh Simulation	233
Figure V-1:	The Savings Structure for Time-Series Testing	261
Figure V-2:	Comparison of Model-Based Time-Series with Data-Based Time-Series	268
Figure V-3:	Two Comparisons of Time-Series Data	270
Figure V-4:	Time-Series Comparisons of Outstanding Primary Credit	273
Figure V-5:	Time-Series Comparisons of Short-Term Lending	275
Figure V-6:	Time-Series Comparison of Long-Term Lending to Business	276
Figure V-7:	Time-Series Comparison of Mortgage Lending	278
Figure V-8:	Time-Series Comparison of Return on Short-Term Loans	280
Figure V-9:	Time-Series Comparison of Return on Long-Term Corporate Loans	283
Figure V-10:	Time-Series Comparison of Return on Mortgage Loans	285
Figure V-11:	Time-Series Comparison of Return on Treasury Bills	287
Figure V-12:	Time-Series Comparison of Return on Government Bonds	290
Figure V-13:	Time-Series Comparison of Long-Term Lending to Business, with Slower Turnover in Savings Deposits	293
Figure V-14:	Time-Series Comparison of Mortgage Lending, with Slower Turnover in Savings Deposits	295
Figure V-15:	Time-Series Comparison of Return on Mortgage Loans, with Slower Turnover in Savings deposits	296

CHAPTER I. INTRODUCTION AND SUMMARY

This study describes the structure and development of a dynamic, macroeconomic model of financial processes. The purpose and context of the model is prescribed by a larger modeling effort, of which the financial structure constitutes an important component. System dynamics has guided the development and testing process, so the purpose and essential features of the model distinguish it in many respects from other financial studies. Apart from models of finance in the individual firm (see Lyneis 1974 for references), system dynamics has not been applied in any detailed way to finance at a macroeconomic level. The study described here, therefore, constitutes a first step which, it is hoped, will lead to valuable insights in finance theory and policy.

A. Purpose

Though developed and tested separately, the model must be viewed as part of the System Dynamics National Modeling Project. The level of aggregation and selection of variables relate to the purposes of the larger model, which is intended to clarify the causes of socio-economic behavior and to guide public policy. The rest of this section, therefore, outlines the organization of the National Model.*1*

The National Model treats all major aspects of the socio-economic system as internal variables to be generated by the

*1*Much of this description of the National Model is taken from Forrester et al. 1976, pp. 11-17.

interplay of mutual influences within the Model structure. The Model contains seven major sectors (see Figure I-1) and generates the flows of goods, orders, money, and information that tie the sectors together.

By reaching from national monetary and fiscal policy down to ordering and accounting details within an individual production sector, the Model will bridge between the concepts of macro- and micro-structure in the economy. Because behavior of the economy develops from deep within its structure, the Model should be able to exhibit the major behavior modes of the economy, and provide important insights and information about causes of socio-economic behavior.

A standard production sector will be replicated to form a major part of the Model. With appropriate parameter values, the standard sector can be used to represent a variety of production and distribution activities--consumer durable goods, consumer soft goods, capital equipment, building construction, agriculture, resources, energy, services, transportation, secondary manufacturing, knowledge generation, self-provided family services, military operations, and government service. Such generality focuses attention on the fundamental nature of production of goods and services and simplifies both construction and explanation of the model.

Within each production sector are inventories of many factors of production, including labor and various output of other sectors. For each factor, an ordering function creates an order backlog for the factor in response to desired production rate, desired factor intensity, marginal productivity of the factor, price of the product, growth

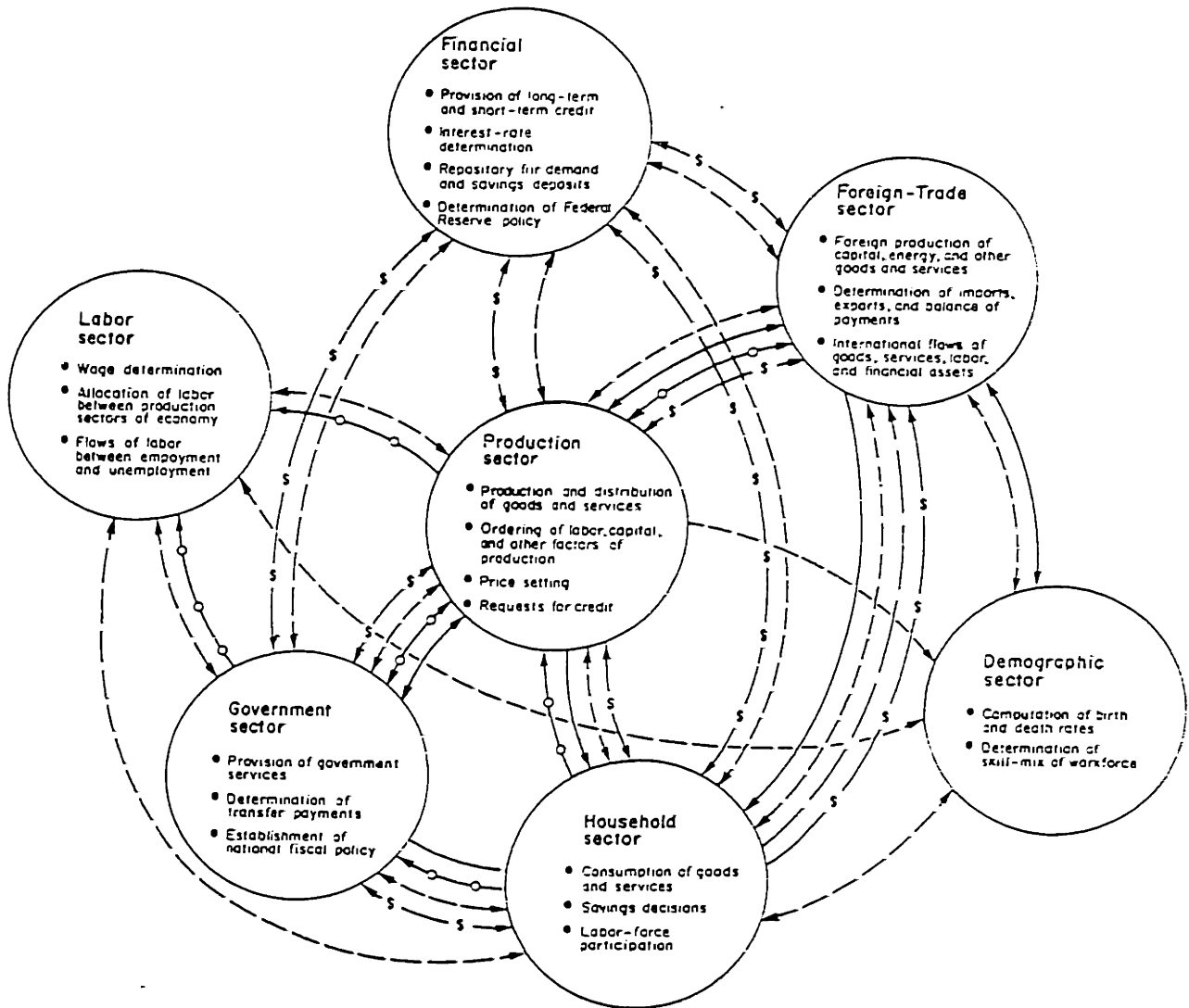


Figure I-1. Basic Sectors of the National Model

expectations, product inventory, and backlog, profitability, interest rate, financial pressures, and delivery delay of the factor. By comparison to other large-scale models, the ordering function in the System Dynamics Model is more influential than the production function. Much of the depth of dynamic behavior of the Model grows out of this feature.

The structure of a standard production sector is essentially the structure of a single firm in the economy. As with a firm, the sector has an accounting subsector that pays for each factor of production, generates accounts receivable and payable, maintains balance-sheet variables, computes profitability, and borrows money. The structure should generate the full range of behavior that arises from interactions between the physical variables and the money and information variables. By carrying the Model to such detail, it should communicate directly with the real sector where a wealth of information is available for establishing the needed parameter values.

A production sector will generate product price in accordance with conditions within the sector and between the sector and its customers. For testing price and wage controls, coefficients can be set to inhibit price changes. The sector will distribute output among its customer sectors. Market clearing, or the balance between supply and demand, is struck not by price alone but also on the basis of delivery delay reflecting availability, rationing, and allocation. As we shall see, the Financial Sector draws several analogies from these pricing and

production processes.

People in the production sectors are divided into two categories--labor and professional. For each category, a mobility network defines the channels of movement between sectors in response to differentials in wages, availability, and need. This labor-mobility network allocates the workforce between employment and unemployment and among different productive sectors of the economy. The labor sector also establishes wage levels for each production sector.

The demographic sector generates population in the Model by controlling the flows of births, deaths, immigration, and aging. Age categories divide people into their different roles in the economy from childhood through retirement. The sector also divides people between the labor and professional streams in response to wages, salaries, demands of the productive sectors, capacity of the educational system, and economic background.

The household sectors are distinguished by economic category--labor, professional, unemployed, retired, and welfare. Each household sector receives income, saves, borrows, purchases a variety of goods and services, and holds assets. Consumption demands respond to price, availability of inputs, and the marginal utilities of various goods and services at different levels of income. The household sectors also determine workforce participation--the fraction of the population actively seeking work--in response to historical tradition, demand for labor, and standard of living.

The government sector of the National Model will generate

government services, tax rates, government expenditures and transfer payments, and sales of government securities to finance the national debt. Government services will be generated through use of a standard production sector whose inputs are labor, capital, buildings, energy, and other factors of production. An additional replication of the standard production sector may be used to represent military services.

The National Model will simulate the behavior of a single domestic economy. Once the Model is developed, either the whole Model, or parts of it, can be replicated to represent an aggregate trading partner (or multiple trading partners) of the domestic economy. For example, standard production sectors could be replicated to represent an aggregate foreign manufacturing sector and an aggregate foreign resource sector. The foreign-trade sector will consist of one or more foreign producers and a set of coupling equations linking the foreign and domestic economies. The coupling equations of the foreign-trade sector will generate exchange rates, balance of payments, and flows of imports and exports.

In the context of the complete National Model, the Financial Sector links directly with the production, household, government, and foreign-trade sectors. Although Figure I-1 includes Federal Reserve policy as a function of the Financial Sector, that function has been developed separately (see Behrens 1975) and does not lie within the boundary of the Financial Sector model. With the completion of separate sector development and testing, the Financial Sector will be merged gradually with the other parts of the National Model.

B. Summary

This section summarizes the contents of the remaining five chapters of the study. Supporting material, in the form of detailed descriptions of model equations, is provided in the appendices.

Chapter II introduces the systems approach to financial modeling. The first section provides the basic elements of a system dynamics model, which is built around feedback loops that underlie real activities. Examples of causal-loop diagrams and flow-chart conventions provide the reader with the background necessary to study the proposed model.

More significant than the formal methodological features is the conceptual approach to modeling financial processes. Because we are interested in disequilibrium behavior in the economy, the model contains structures that generate this behavior endogenously. For this purpose, several elements appear that do not enter other financial models in the same way. For example, money is conserved, flowing explicitly through the system and accumulating in system levels; interest rating are represented as dynamically adjusting level variables; accumulations reflect specific security categories; and the model represents credit availability explicitly by containing a "backlog" of loan requests that are not always realized when desired through the price-clearance mechanisms.

By portraying the micro-decision structures of banks and other financial institutions, the model generates macro-level behavior. A comparison of two small models of bank lending in Chapter II serves to

exemplify the principle of representing explicitly only those information flows and variables that underlie decisions in the real system. Throughout the chapter, comparisons with the literature and other models*2* are drawn.

Chapter III describes in some detail the institutions and functions that appear in the Financial Sector model. The chapter first establishes the "management" versus "money-desk" perspective of the sector as part of the National Model and identifies the important role of the sector as the source of new money in the economy and the filter through which official monetary policy affects real economic activity.

The Financial Sector as defined here channels the flow of savings from household and business sectors to those who need short-term and long-term funds. The institutions that effect this transfer consist of portfolio managers (trust and pension funds), commercial banks, and non-bank lending institutions. In the model of financial activity, a "Savings Investor" serves as the aggregate portfolio manager of all private savings. That is, instead of households directly putting their savings into the time or savings deposits of banks and non-bank lenders, or into government securities, equities, etc., each household and business sector accumulates an undifferentiated pool of savings which the Savings Investor then allocates among different kinds of deposits and securities. Commercial banks are aggregated into one "Bank," which

*2*For example, the MIT - Pennsylvania University - Social Science Research Council Model (MPS) and the Data Resources, Inc. (DRI) model.

receives deposits (including savings allocated by the Savings Investor) and extends short-term loans. Non-bank lenders are represented in the model by two institutions, the "Corporate Lender," which extends long-term credit to business firms, and the "Mortgage Lender," which extends residential mortgage credit to households.

As Chapter III demonstrates, many functions are common to the three lending institutions (the Bank, the Corporate Lender, and the Mortgage Lender) and to all four private financial institutions (the three lenders plus the Savings Investor). These functions encompass primary lending, investment in government securities, the setting of interest rates, and the management of bank reserves.

Chapter IV performs a set of seven simulations of the Financial Sector, driven by simple test inputs such as steps, sine waves, and noise in loan demand. The first test examines asset management (the manipulation of loan and security portfolios) by isolating the Bank from the rest of the sector and stepping up desired loans by 10%. The simulation is designed mainly to relate the internal structure to model behavior. The basic asset patterns in this artificial test configuration seem consistent, however, with observed patterns.

The next three simulations combine the Bank and Savings Investor, wherein the Bank can exercise both liability management (mainly "selling" deposits through interest rate adjustments) and asset management under a variety of test inputs. Model output in these tests compares well with observed phasing and amplitude relationships for

different types of assets and interest rates.

The remaining simulations combine other subsets of the Financial Sector. A test of the Mortgage Lender and Savings Investor, for example, reveals important differences in loan adjustments and influences on the savings deposit yield. Combining these two institutions with the Bank shows how these differences lead to realistic asset shifts in response to changing interest rates. For example, a "credit crunch" is simulated as a sizable open-market sale by the Monetary Authority. In response to this initial shock, the sector generates "disintermediation" (where savers shift funds from fiduciaries to direct investments) and a shift in deposits from mortgage lenders to the commercial banking system. Both phenomena have been observed in recent years.

The last test imposes noise in loan demand on the entire financial system to explore phasing and amplitude differences among asset categories and interest rates. In general the results, which are compared with recent data, support the internal structure of the sector. However, as is the case throughout the chapter on dynamic tests, some inconsistencies between model and reality are reported and should be investigated in the next phase of model development.

Chapter V describes time-series tests of the Financial Sector, wherein real-world data for the period 1960-75 are put into the model and selected variables from the model are compared with their actual counterparts. Although the test reveals some problems that should be studied further, the statistical and qualitative fit is fairly good in

most cases and lends credence to the model.

Chapter VI takes up some of the loose ends that emerged during the development and testing process and suggests some avenues for future research. The incomplete or weaker elements in the Financial Sector include the lack of explicit equity markets and excessive sensitivity of model simulations to the size of the computation interval. Structural modifications are proposed to deal with both of these cases.

The second part of Chapter VI identifies some issues for which the Financial Sector, combined with the rest of the National Model, is especially well-suited. These issues include the contribution of monetary factors to economic instability and inflation, the appropriate targets for official monetary policy, the vulnerability of the financial system to changing modes of economic behavior, and the inflation component and term structure of interest rates. By developing and testing the Financial Sector of the national economy, this study provides a new point of departure for exploring these and other significant economic issues.



CHAPTER II. A SYSTEMS APPROACH TO FINANCIAL MODELING

This chapter introduces the system dynamics methodology. The first section presents the basic components of a system dynamics model. The second section considers, in more detail, some of the features that distinguish a system dynamics model of financial activity from other aggregate financial models. The discussion focuses on the specification of structure and should help the reader to understand the model described in Chapter III.

A. An Introduction to System Dynamics

System dynamics is a simulation approach to modeling that applies the principles of cybernetics to social and physical systems. The basic component of a system dynamics model is the information feedback loop, a sequence of causal influences that leads back to its own starting point in a closed circuit. The feedback loop contains two essential components, levels (stocks) and rates (flows). Levels are the state variables, or accumulations, that characterize the system at any point in time. Model behavior arises from the variation in the quantity in each level over time. Rates are the system's action or policy variables that effect change in the levels. Rates represent information flows and flows of people, money, goods, orders, and other conserved quantities. Since the rates acting on a level summarize all the factors that change that level, they are generally complex expressions. Often one or more components of a rate are sufficiently important to warrant individual attention. These auxiliary variables are separated

algebraically from the rate equations.

Figure II-1 displays the basic feedback loop structure, using the symbols of DYNAMO flow-charting to portray the two essential components. The figure shows a rate that is linked in an information feedback loop to a system level. The rate variable constitutes a decision that relies on information contained in the system state. While the decision produces action, such as a flow of money or people, and thereby changes the quantity in the level, the link between decision (rate) and state (level) represents a rule, or policy, that governs the decision. A typical system policy in the Financial Model, for example, relates the purchase of Treasury bills (contained in a system level) to the discrepancy between desired and actual levels of bills. A system dynamics model, in fact, constitutes a set of states and decisions combined according to the modeler's perception of real operating policy rules. The modeler tries to develop confidence in his policy structure by studying the behavior it generates and relating the behavior to observed reality. As the modeling process continues, one tries to identify the decision rules that have an important dynamic impact and, thereby, to discover those policies that effectively improve behavior.

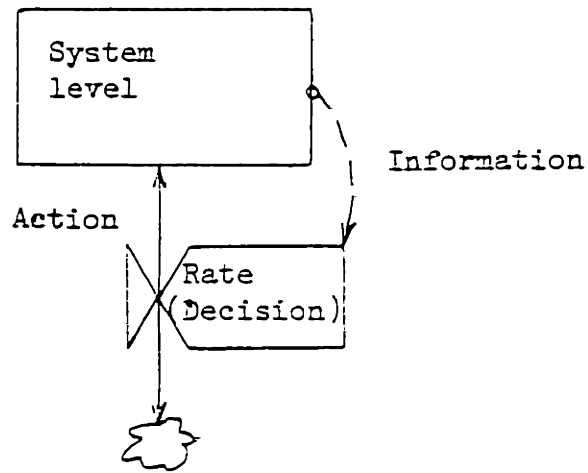


Figure II-1. The Feedback-Loop Structure

The direction of causality linking two model variables, as well as the polarity of complete feedback loops, may be described in a causal-loop diagram. Figure II-2 exhibits a simple diagram of one of the feedback loops that appears in this study. Each arrow in the figure indicates the direction of causality; for example, the accumulation of bonds augments the flow of interest payments to the individual or institutional investor. The four variables are linked in a positive loop, wherein a change in one element sets in motion a chain of events around the loop that eventually produces a reinforcing influence on that element. The accumulation of securities by a savings institution, for example, produces interest income that can enlarge the security holding. This loop in isolation generates self-sustaining growth.

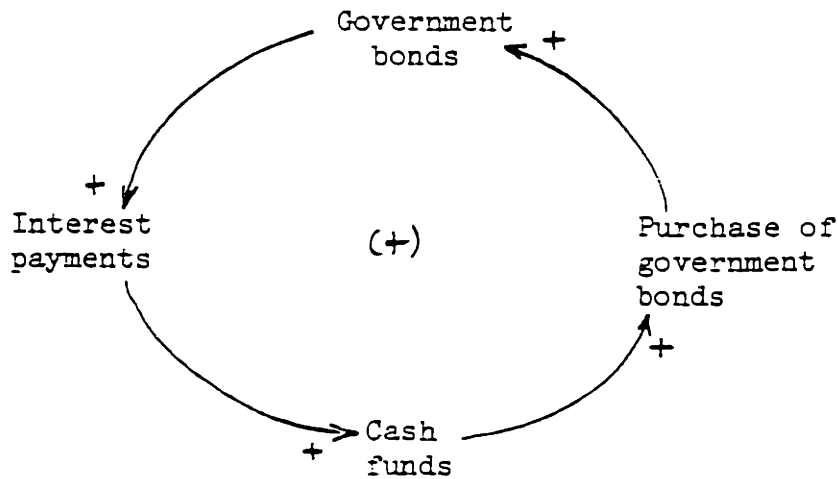


Figure II-2. A Positive Feedback Loop in Portfolio Management

A second type of loop generates negative feedback. In negative feedback loops, change in one element propagates around the loop to produce counteracting pressures in the same element. For example, two variables in the positive loop shown in Figure II-2 are also linked in a negative loop. Figure II-3 adds a link between security purchases and cash to show that, while higher reserves of cash and other liquid assets permit or encourage additional purchases, the purchase transactions deplete the pool of cash. The purchase-cash loop is self-corrective, rather than self-sustaining.

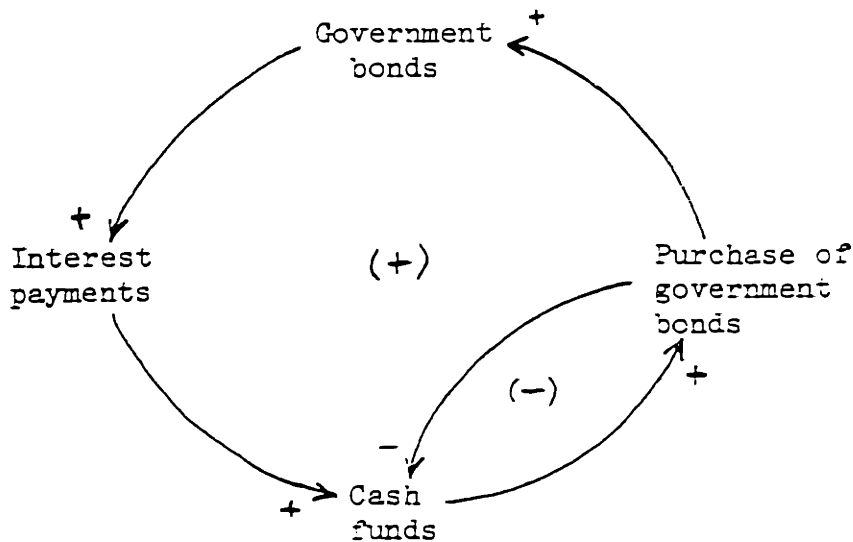


Figure II-3. The Combination of Positive and Negative Feedback Loops

Feedback loops differ not only in their polarity, positive or negative, but also in the delay by which responses are propagated around the loop. Delays may exert an important impact on the direction, timing, and magnitude of the influence of one system element on another. Suppose, for example, that in the system described in Figure II-3, interest accrues continuously but, in fact, is paid only annually or when the security matures (as with discounted bonds). In this case, purchases deplete cash immediately while interest payments and maturities replenish cash after a delay. If bond purchases are growing, the cash outflow will exceed the inflow and the level of cash and other liquid assets will decline. The declining level of cash will restrain further investment in bonds and could also influence plans and expenditures elsewhere in the system.

Causal-loop diagrams, such as those portrayed in the previous

two figures, provide an organizing framework for a model, but they do not yield the information required to express a set of relationships in the form of equations. The model described in this study uses the DYNAMO compiler and, therefore, adopts the conventions of DYNAMO flow diagrams to specify the variables and the links between them required for simulation. Figure II-4 exhibits a DYNAMO flow diagram for the two feedback loops portrayed in Figure II-3. The figure contains variables that appear in the larger model described in Appendix 1, although the format of the diagram is simplified for clarity. The conventional DYNAMO symbols portray levels (rectangles), rates (valve symbols), and auxiliaries (circles). Solid lines reflect physical flows such as money or securities, while dotted lines portray information flows or some functional dependence. Variables defined elsewhere appear in parentheses (such as return on government bonds RGB). The remaining term (average life of government bonds ALGB) appears as a constant.

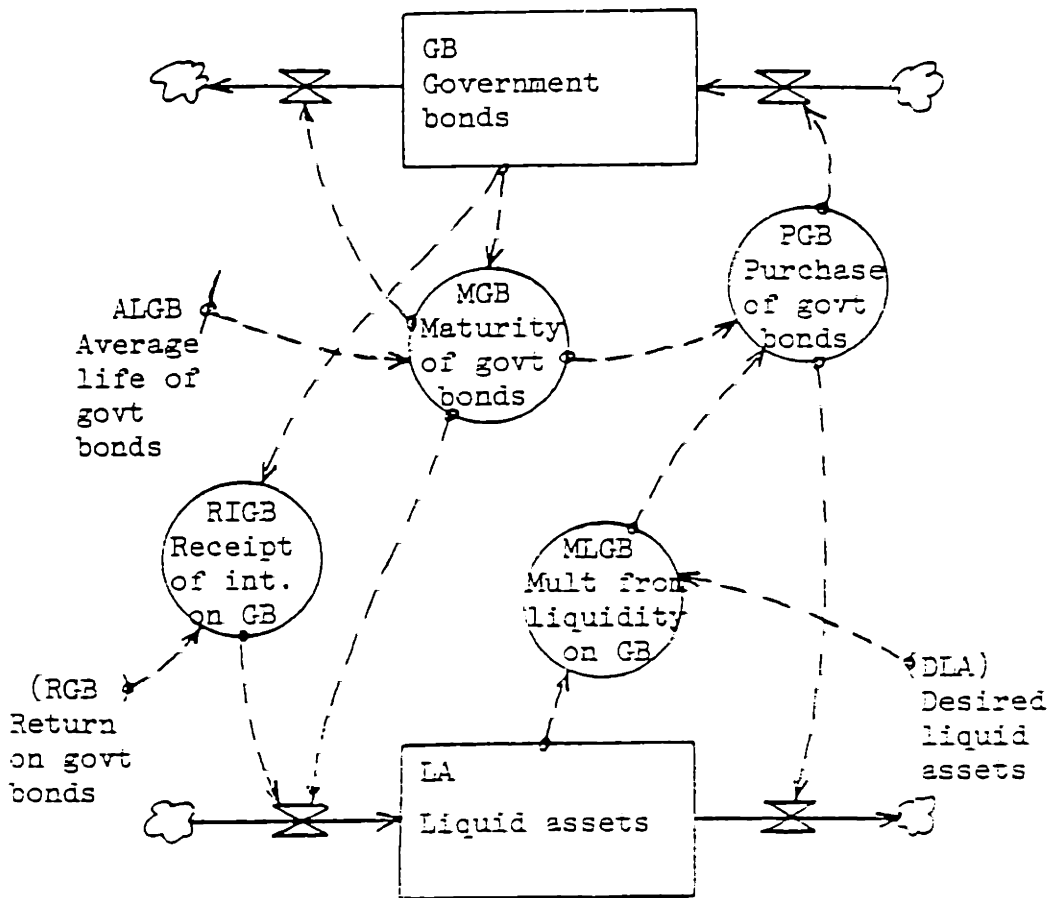


Figure II-4. Partial DYNAMO Flow Diagram of Long-Term Bond Acquisition

Government bonds GB is a level variable that accumulates the difference between the purchase of government bonds PGB and maturities of government bonds MGB. Liquid assets LA is a level that contains cash funds as well as other near-cash securities. The liquid assets pool grows with interest on bonds as well as maturities and declines with new bond purchases. The receipt of interest on government bonds RIGB

expands with the accumulation of bonds. As liquid assets LA begin to exceed desired liquid assets DLA, the rate of bond purchases can expand above the volume necessary to replace maturing bonds. Concurrently, augmented bond purchases deplete cash funds (part of liquid assets) and, thereby, restrain the capacity for making additional purchases. The influence of relative liquidity on bond purchases is expressed through the multiplier from liquidity on government bonds MLGB.*1*

Specification of the system dynamics model described in this study constitutes a causal theory, at a level of aggregation consistent with the purposes of the National Model described in Chapter I. The study focuses on developing a theoretical structure rather than on deriving empirical relationships, although qualitative comparisons between model simulations and real-world behavior are described in Chapter IV, and an attempt to fit time-series data appears in Chapter V. As part of the theoretical exploration, computer simulation permits one to test the model for internal consistency, sensitivity to parameter changes, the impact of nonlinearities, and the modes of disequilibrium behavior. This structural approach to financial modeling should become

*1*Detailed equation descriptions appear in Appendix 1. Here the basic functional relationships (without the DYNAMO time subscripts) are listed:

$$\begin{aligned}d/dt(GB) &= PGB - MGB \\d/dt(LA) &= MGB + RIGB - PGB \\PGB &= MGB * MLGB \\MLGB &= f(LA/DLA), \text{ where } f \text{ indicates an increasing, nonlinear} \\&\quad \text{functional relationship} \\MGB &= GB / ALGB\end{aligned}$$

clearer in the next section, which explores specific aspects of the proposed model.

B. Distinguishing Features of the Financial Model

The rate-level principle described in Section A guides the development of a system dynamics model. The modeler tries to identify the important system levels and considers the feedbacks between levels and the rates of flow that influence the levels. For example, the inclusion of liquidity pools for each sector forces the modeler to explore the effects of asset purchases on liquidity and the possible constraints of inadequate liquidity on the purchase of assets. The link between level (liquidity) and rate (asset purchase) forces the modeler to observe the basic physical principle of conservation. A conserved flow model assures that physical quantities, such as money, move within distinct channels and enter or disappear from the system only through explicit processes. Like all physical accumulations, therefore, the level of liquidity in our example cannot fall below zero. Well before this extreme is reached, in fact, the declining level of liquidity begins to restrain the flows that deplete it. Assets cannot be acquired at the desired rate. The constraints emanating from this point, in turn, affect the flow of liquidity and its accumulation elsewhere in the economic system. In this way, the impact of declining liquidity in one place filters through the economy, affecting individual decisions and overall system behavior.

1. Disequilibrium in Financial Modeling

In a review article on "monetary economics," Stanley Fischer writes that the most significant change in monetary theory over the last 25 years is the shift from comparative static analysis to explicitly dynamic analysis (Fischer 1975, p. 157). The newer econometric models, for example, incorporate lag structures that permit dynamic simulations to test the sensitivity of system response to exogenous inputs and changes in parameter values.

The system dynamics model of financial processes is in keeping with the trend toward dynamic, disequilibrium models. In fact, dynamic, state-variable models are well-suited for exploring the nature of disequilibrium, wherein the system states (levels) are changing over time. Disequilibrium behavior is captured in a system dynamic model through the representation of level variables that conserve quantities such as money, bonds, and loan requests in their own channels and serve to uncouple rates of flow that might otherwise, by assumption, be represented in equilibrium.*2*

In contrast, many econometric models, including those containing lag structures, assume instantaneous market-clearance mechanisms or other equilibrium relationships that prevent the analysis

*2*Economic models without the integration processes that produce dynamic behavior are often inadequate for describing the disequilibrium characteristics of economic activity. Samuelson's classic multiplier-accelerator model, for example, attempts to explain disequilibrium behavior (business cycles) while retaining basic equilibrium concepts. The consequences of this failure to accumulate essential physical quantities are treated in Low (1976).

of disequilibrium or of policies that might mitigate unwanted economic behavior. For example, most financial models assume that desired and actual money stocks are equal, an assumption that Cagan (1972, p. 120) criticizes. Other models fail to recognize the appreciable lags in adjusting portfolio transactions or interest rates that arise from information and transaction costs (Bosworth and Duesenberry 1974, p. 53), or from institutional, psychological, and social forces (Forrester 1961, pp. 406-411).

While economists have begun to apply disequilibrium analysis to prices, economic models have yet to represent successfully the dynamic adjustment of both price and quantity. Fischer writes, "The outstanding problem in macroeconomic disequilibrium theory is the working out of joint price and quantity determination." (Fischer 1975, p. 161). The model presented in this study attempts to work out asset prices (or interest rates) and quantities by tracking separately the two distinct, but dynamically interacting concepts. In the model, both interest rates and security holdings are represented as level variables. To highlight the importance of integration and conservation in system dynamics models, the discussion that follows will focus on these two levels, as well as on liquidity and the accumulation of loan requests. The inclusion of these four variables as levels in the model may permit a more complete analysis of disequilibrium behavior than has been attempted in the past.

In the National Model, money flows throughout the system and

accumulates in levels of liquidity for each sector.*3* Monetary flows, thereby, are separated from the flows of products or orders and from information relating to prices and real purchasing power. The separate flow of money has two important consequences. First, we know that official monetary policy operates on the capacity of banks to create deposits, as well as interest rates in the securities markets. Therefore, the cash reserves of the banking system, as well as the money pools of other credit institutions and borrowing sectors, are represented in the model in order to trace the impact of official monetary decisions on spending behavior.

Secondly, the distinction between actual money pools, or the more broadly-defined pool of liquid assets, and desired levels affects asset purchases, as was shown in the previous section. In the model, the purchase of securities or the extension of credit reduces the cash reserves of banking institutions and produces pressures to replenish liquidity by selling securities, restraining lending, or attracting

*3*Real spending decisions are based, in part, on "liquidity," a broader concept than what we usually call "money" (currency plus demand deposits). In the National Model, therefore, money plus near-money assets (for the financial institutions, this includes Treasury bills) constitutes the conserved quantity, represented in a level of "liquid assets." In each financial institution, for example, money is calculated algebraically as the difference between the level of liquid assets and levels containing near-money assets (e.g., Treasury bills). While the amount of money calculated in this fashion influences asset transactions (e.g., the purchase of Treasury bills) and, therefore, is controlled in the model, the amount of money itself is not represented directly as a level variable and, therefore, is not technically a conserved quantity. (See Chapter III and Appendix 1 for details.)

savings deposits. These adjustments take time to accomplish and can be constrained, or otherwise influenced, by official ceilings on interest rates, or by more general efforts to tighten or relax credit conditions.

The treatment of money in the major economic models differs from the above description. In accordance with standard Keynesian theory, the demand for money responds to changes in income (to capture the transactions motive) and to variations in actual and expected interest rates (which indicate the opportunity cost of holding money as opposed to other assets). The MPS and DRI models, therefore, both contain equations that specify the demand for demand deposits as functions of interest rates (including, in the MPS model, the change in the Federal Reserve's discount rate as a signal or proxy for expected changes in other interest rates). The demand deposit equations in both models also contain some indication of income and wealth.

Yet neither the MPS nor DRI models, in their underlying structural development or in the regression equations themselves, express money as a conserved quantity. The equations for demand deposits, for example, relate money mainly to interest rates but do not indicate whether or not the demand is realized or what happens if it's not. In other words, money does not accumulate the flows of credit, interest payments, expenditures, or security transactions that directly determine the money stocks of various interacting sectors of the economy. Yet, intersectoral monetary flows, with their resulting accumulations, seem to be an important focus of monetary and fiscal policy. Moreover, the extension of bank credit, which creates demand

deposits, is uncoupled in these models from the quantity of money. Thus, the feedbacks between credit extension and real spending, as well as the official policies designed to influence these channels, are obscured or ignored.

In the system dynamics model, on the other hand, the extension of bank credit constitutes a flow that directly augments the money stock of borrowing sectors. While alternative interest rates may influence a sector's asset transactions and, therefore, total money balances, the impact of interest rates on money levels is indirect. Finally, we have seen previously that money balances both are affected by asset transactions and, in turn, influence future transactions through the operation of explicit feedback loops.

Interest rates are also represented in the system dynamics model as levels. The level, in this case, does not accumulate flows of tangible quantities, such as money and other liquid assets, but represents a dynamic process wherein interest yield changes in response to demand and supply in different markets. In large markets with homogeneous assets, such as government securities, the response is rapid. But in the case of negotiated loans that make up the bulk of primary credit transactions, interest rates adjust over an appreciable period of time. The adjustment times reflect delays and imperfections in obtaining information about market conditions; competitive factors that restrain banks, for example, from moving far out-of-line with the competition; and institutional-social factors that introduce caution and delayed decision-making within business or other bureaucratic

organizations. The process of integration, reflected in the interest rate levels, portrays this dynamic adjustment.

Moreover, changes in yield represent an imbalance in demand and supply. Suppose a financial market moves from supply-demand equilibrium to disequilibrium and then back into balance. During that transition, the interest-rate level will integrate the effect of imbalance and will end up at a new equilibrium that might or might not equal the beginning value. The rate-level format permits the yield to "float" without reference to an initial value and yet still reflect relative supply and demand.*4*

A third important level variable in the model is the accumulation of securities within the Bank and other financial institutions. In reality, holdings of bonds, bills, CD's, etc., influence the total volume of securities exchanged, the government's refinancing needs, and, through relative supply and demand, interest rates. The model assumes that investors maintain their holdings by replacing maturing securities or those sold in secondary markets, unless various pressures encourage different behavior. The stock of securities, therefore, directly influences market demand and, thereby, interest rates.

*4*Equilibrium in a state-determined system is characterized by unchanging system levels (the time derivatives of all levels = 0). At issue here is the capacity of interest rates to be pushed freely by pressures emanating from other parts of the system, not that substantially higher or lower interest rates might be consistent with a new supply/demand equilibrium.

In contrast, the MPS, Brookings, and other large-scale models determine interest rates on the basis of term structure equations, which specify yields for various security categories as functions of a particular (short-term) rate (and other factors such as changes in the rate of inflation).^{*5*} Most models rely heavily on exogenously-determined rates (e.g., the Federal Reserve's discount rate in the MPS model) to derive the crucial short-term yield. And few models contain the stock of securities at all in their interest-rate equations. Benjamin Friedman, on the other hand, criticizes the term structure approach because it does not take into account the volume of long-term securities in the determination of long-term interest rates (B. Friedman, February 1974).

The system dynamics model described later reflects available quantities of securities in each market. Each type of security is confined to an identifiable channel and cannot disappear from the system except through some explicit process. Supply and demand for each security, and thereby interest rates, depend on this endogenous conservation of asset flows rather than on exogenously-determined interest rates or other non-systemic influences. This separation of securities into distinct markets, however, does not preclude the opportunity to arbitrage between security classes and maturities in

^{*5*}While the MPS model explicitly uses the term structure approach in relating corporate bond rates to short-term (commercial paper) rates, the DRI model does not directly specify long rates as functions of short rates. However, the equations (and estimated coefficients) end up looking rather similar.

response to changes in interest rates. Indeed, an important input to the transactions decision in the model is the relationship between the yield on each security relative to (risk-adjusted) returns available on other assets.

A fourth important level in the proposed financial model is the backlog of loan requests. In the procurement of nonfinancial factors by a firm or productive sector, a flow of orders accumulates in a backlog that is worked down over varying periods of time, according to the nature of the factor. The backlog (vacancies) for labor, for example, may average only a few weeks, while orders for capital will remain in backlog for a considerably longer period. Even in equilibrium, a backlog exists, reduced by shipments and replenished with new orders. In disequilibrium, orders and shipments do not balance and the net difference accumulates in backlog.*6*

Although money is not commonly considered a factor of production, its procurement through the extension of credit logically fits the procurement pattern of other factor inputs. Orders for credit respond to a variety of pressures that emanate largely from within each ordering firm or sector. During the process of negotiating loans and lines of credit, lending institutions perceive a volume of loan requests that will be required in the near future. Since there is no guarantee,

*6*Most economic models do not contain order backlogs and, therefore, miss the effect of the conservation of orders on investment patterns and system stability. Mass cites some of the relevant literature and discusses the important dynamic effects of backlogs on business behavior (Mass 1975, especially Chapter 3).

however, that liquidity will be adequate to meet loan demand, the flow of loan requests will not always equal the extension of short- or long-term credit. The net difference must be conserved in a backlog level or explicitly canceled out of the level in order for loan requests not to be lost unaccountably from the system.

The principle of conservation requires that "orders" accumulate even though data on unfilled loan requests is not generally available.*7* The existence of a backlog, moreover, provides the information lenders need to adjust their portfolios over the near future and determines the relative capacity of investing institutions to extend credit. A model that contains an accumulation of outstanding loan requirements permits the explicit treatment of availability and credit rationing which, together with interest rates, equates ex post (flow) demand and supply.

The intervening levels in an economic structure uncouple flows such as orders and money and permit explicit disequilibrium analysis. In many economic models, on the other hand, flow rates depend on other flow rates. For example, in the DRI model, the inflow of investible funds to mortgage lenders is a function of current disposable income (see Eckstein et al. 1974, pp. 599-600). Current income appears in many models as a proxy for capacity to invest or spend, but the causal

*7*The Federal Reserve started recently to collect data on "commitments," a portion of which could be considered firm requirements subject, of course, to cancellation; but this data is imprecise as to the type and firmness of the commitments.

linkage between income flows and spending requires structure, such as accumulated income in the form of money pools and wealth, that is usually missing. To cite the examples of structure that have been discussed in this section, liquidity levels uncouple income flows from asset purchases; accumulated security holdings uncouple purchases from maturities; and the backlog of loan requests uncouple the need for credit from the capacity of banks and fiduciaries to make loans.

2. Micro Decisions in a Macro Model

The model described in this study attempts to represent real decision processes explicitly, in a structure whose component parts can be recognized by bankers and investors. Loan extensions in the model, for example, are directly and causally dependent on influences that bankers supposedly consider, including alternative yields on competitive assets, liquidity ratios, and pressures exerted by the central bank authorities. While the equations reflect processes that occur at this micro-level, the model structure generates macro-economic behavior.

In contrast to this approach many financial models contain quantitative relationships that are not intuitively meaningful, where abstraction may imply, but does not express underlying behavioral and causal assumptions. Benjamin Friedman writes: "The analytical frameworks which economists use to investigate various economic phenomena often bear little resemblance to market participants' conceptions of the processes in which they play some role."

(B. Friedman, June 1975, p. 1).^{*8*}

An approach that explicitly portrays the micro-level operating processes has at least three advantages. First, such a model can be communicated relatively easily to operators and policy-makers, who can recognize the structure as pertaining directly to what they do. Second, it is often easier to obtain a consensus on the explicit structural components of the model when they constitute recognizable, direct causal links rather than abstract relationships that may hold little intuitive meaning. Finally, models that reveal real-life causal links tend to improve policy analysis, in which the effects of policy intervention on behavior can be traced to explicit activities rather than to abstract, statistical relationships.

A simple illustration may help to clarify the difference between models that portray actual decisions and models that abstract beyond the recognizable processes. Figures II-5 and II-6 portray

^{*8*}His statement introduces the discussion of long-term interest rate determination that was cited previously. Consideration of the reasons for adopting such analytical frameworks goes beyond this treatment of the system dynamics approach to model specification. Some argue, however, that formal data rather than theory or direct observation, too often determine structure. One critic of econometric methods, for example, writes, "I define an econometric model as one whose structure is dictated primarily by the data, and only secondarily by theoretical considerations." (Black 1974, p. 1).

alternative dynamic models of bank lending.*9* Both models represent the accumulation of deposits through the extension of loans by the aggregate banking system.*10* In both examples, the demand for loans is assumed to encourage banks to lend up to the limit imposed by the central bank's reserve requirements. At any time, the banking system can support a volume of total deposits equal to total reserves R divided

*9*The two models are illustrative only, and do not portray directly the larger model described in this study. But the structures discussed here are simple and seem suitable for distinguishing between the "operating level" approach to modeling and more abstract approaches.

*10*Introductory textbooks commonly distinguish between a single bank, which attracts deposits so as to make more loans or investments, and the banking system as a whole, which creates deposits by making loans. The creation of deposits by the aggregate system may be considered a macro-economic phenomenon, while attracting deposits by an individual bank is considered a micro-economic phenomenon.

by the required reserve ratio RRR--i.e., maximum demand deposits $MDD = R/RRR$.^{*11*} If banks have no desire or need for reserves not used to back deposits (excess reserves ER), then equilibrium exists when $DD = R/RRR$.

^{*11*}Suppose total bank assets equal reserves (R) plus earning assets (E) and that total liabilities consist of demand deposits (DD); then, $DD = R + E$, or

$$DD/R = 1 + E/R.$$

According to the central bank, banks must hold reserves equal to some fraction, the required reserve ratio RRR, of total deposits. If the banks are fully extended, then $RRR = R/DD$, or, by substitution,

$$1/RRR = 1 + E/R.$$

Multiplying through by R and substituting DD for R + E gives

$$(1/RRR)R = DD = MDD.$$

The term $1/RRR$ may be called the "bank money multiplier" (Shapiro et al. 1968, p. 9) and indicates the multiple by which a change in reserves R will yield an ultimate change in demand deposits DD.

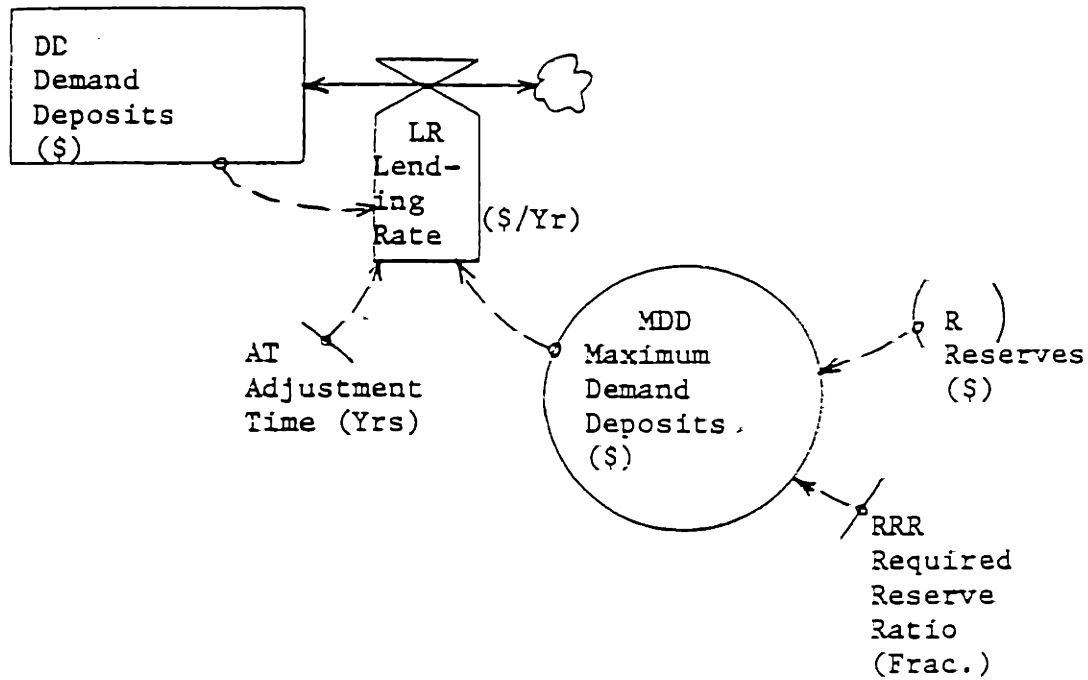


Figure II-5. A Simple Model of Bank Lending (Case # 1)

Should reserves R be increased by ΔR , then demand deposits will rise by an amount equal to $\Delta R / RRR$. The change from one equilibrium to another, however, does not occur instantaneously. Instead, the net lending rate LR moves up in response to the addition in reserves and causes deposits to rise toward their new maximum level. In the first model, lending rate LR is formulated so as to adjust demand

deposits over a specified adjustment time AT (3 months); that is,

$$LR = (MDD - DD)/AT.*12*$$

The second model of bank lending also adjusts deposits in response to changes in reserves (or reserve requirements), but contains different formulations. As shown in Figure II-6, the level of demand deposits DD, together with the required reserve ratio RRR, determines the volume of required reserves RR. Required reserves RR, together with reserves R, determines the amount of excess reserves ER which the banking system can lend. As in the first model, we assume that desired excess reserves DER equal zero and that loan demand is sufficient to assure that any positive amount of excess reserves will be lent out. If reserves R step up, excess reserves ER, which equals reserves R minus required reserves RR, increases at the same time, and lending starts to rise. Lending now reflects the adjustment of the discrepancy between excess reserves ER and desired excess reserves DER, over the time to adjust reserves TAR; that is, $LR = (ER - DER)/TAR$.

*12*Expressed as a differential equation,

$$(d/dt)DD = LR = (MDD - DD)/AT = (R/RRR)/AT - (1/AT)*DD.$$

Solving for DD,

$$DD = R/RRR - [(R/RRR) - DD_0]e^{-t/AT}$$

where DD_0 is the initial value of DD and AT is the system time constant. This simple system describes a goal-seeking, or negative feedback loop, where MDD (= R/RRR) is the system goal toward which DD adjusts.

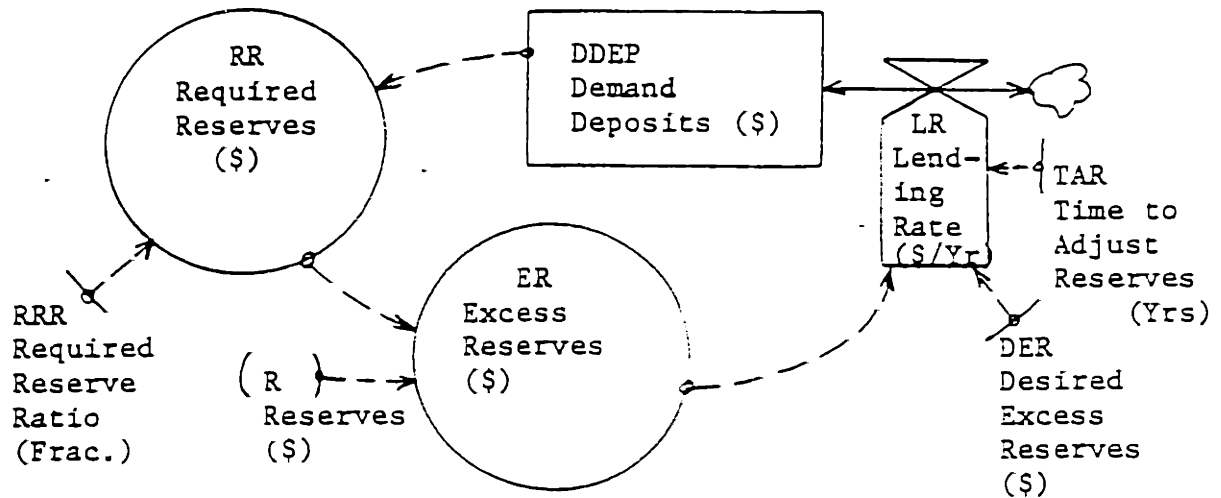


Figure II-6. A Simple Model of Bank Lending (Case # 2)

The time constants in the two cases (AT and TAR) have distinctly different meanings. The adjustment time AT in Figure II-5 is a parameter that refers to a system-wide adjustment and could be estimated only from observation of the entire system over some period of time, possibly through the use of statistical techniques. The parameter would reflect all the factors that influence bank lending and, therefore, could change over time as different factors play a more or less important role. The time to adjust reserves TAR, on the other hand, has operational meaning to a banker, even though banks do not fully control the creation of deposits. The value of TAR, which is considerably shorter than the system adjustment time AT, might be selected by asking bankers how long they normally like to keep

nonearning reserves in excess of official or operating requirements. Other factors that may influence lending (e.g., relative returns or measures of bank liquidity) may enter the model separately without changing the meaning of the equations or parameters associated with adjusting excess reserves.

The individual in a large system can act only on the basis of information available to him. While the final system-determined equilibrium (e.g., maximum demand deposits MDD in the first example) is not information usually accessible to the individual banker when he makes a lending decision, desired and actual excess reserves are known and have operational meaning. A model that portrays individual rational decision processes may or may not move toward a system-wide optimum, as the goal for any individual unit is not necessarily the same as the goal for the system.

The simple model discussed above, as well as the full financial model described later, attempts to develop structure on the grounds of economic theory, direct experience, observation and intuition, verbal information, and the principles of integration and feedback introduced in Section II.A. The structure is what counts. If a concept enters into real decision-making, it is represented in the

structure, whether or not statistical data is available, and regardless of nonlinearities that might pose estimation problems for statistical modelers.*13*

In addition to enhancing the possibilities for communication and consensus, causal structures that portray micro-level decisions help to identify the points of the system in which policy intervention can affect system behavior. For example, the first of the two bank lending models introduced earlier contains no direct causal link between appropriate information (e.g., loanable cash reserves) and bank decisions. Therefore, changes in policy, that is, in rules by which actual decisions are made, cannot be explored in the model simulations or introduced as real policy alternatives. The second model, on the other hand, explicitly contains excess reserves which constitute a control variable that bankers observe and influence directly. By intervening in a causal model one can explore mechanisms that influence system behavior and one can begin to understand how the policy intervention propagates through the system.

*13*Nonlinearities, in fact, may be necessary in a structure that attempts to represent real-life physical constraints. For example, the accumulation of money and other liquid assets, which was discussed previously, appears to impose a nonlinear impact on spending, since it is literally impossible to pay out funds that do not exist. The nonlinearity begins to exert an impact when the system strays beyond "normal" ranges of behavior. A case in point is the Great Depression, when liquidity in certain sectors of the economy (such as agriculture) virtually dried up. The National Model is designed to explore changes in historical conditions, future social and economic constraints, and alternative policies that could well force the system into the nonlinear ranges that produce unaccustomed modes of behavior.

The large-scale macroeconomic models, in contrast, usually rely on statistical correlation to support causal hypotheses. Drawing policy conclusions from statistical correlation models, however, can be hazardous. In the late 1960s, monetarist economists attempted to support, with statistical regressions, a causal link running from the rate of change in the money supply to business activity. Tobin showed, however, that it is perfectly possible to construct an economic model in which money has no causal influence on business and yet generates the same lead-lag relationships that have been observed historically (Tobin 1969). Intervening to influence a supposed causal link that is weak or nonexistent in reality will fail to have the desired impact and could produce unwanted consequences.

C. Conclusions

This chapter has described how integrations and lag structures portray dynamic, disequilibrium behavior. In some ways contemporary economics is moving in a similar direction, but there are important countercurrents. Comparative statics, for example, still characterizes many "dynamic" models, wherein all economic actors are assumed to optimize their positions and, thereby, establish an equilibrium during successive, arbitrarily defined, periods. Simultaneous equation solutions suit this form of analysis.

More extreme than comparative statics analysis is the theory of "rational expectations," pioneered by Muth (1961) and since developed by Sargeant (1972) and others. Stated simply, the theory asserts that

prices and interest rates reflect all known information instantaneously; that known information includes instantaneously formed expectations about policy actions or other "outside" shocks to the system; and that "expectations, since they are informed predictions of future events, are essentially the same as the predictions of the relevant economic theory" (Muth 1961, p. 316). In a rational expectations world, immediate price adjustment means, in the extreme, that public policy actions produce change only in prices and not in transactions. For example, if the Federal Reserve takes action to increase the money supply by buying securities, the economy will react by adjusting instantaneously the expected rate of inflation and, therefore, will cause interest rates to rise rather than fall. Only if there were lags in the formation of prices and expectations would such an action generate lower interest rates and, thereby, real changes in output. But, according to the proponents of rational expectations, these lags seldom exist and cannot be depended on to produce successful economic policy.

The system dynamics model described in this study differs radically from a rational expectations model. Here there are differential lags in perceiving and acting on information that imply memory and the conservation of both information and real flows that is ignored in other models. Whereas Muth writes, "Information is scarce, and the economic system generally does not waste it" (Muth 1961, p. 316), a system dynamics modeler asserts that information is excessive, imperfect, and internally inconsistent, leading to delayed reactions and market "clearance" based not only on price but also on

availability. To portray this world, a model requires the disequilibrium structures described earlier.

Moreover, in a world of imperfect and excessive information, decisions can no longer be optimal. For an optimal decision requires a set of criteria, such as the reaction patterns of all market participants, that is simply not known to any individual--much as the system goal in the small banking model described earlier is not an input to the decisions of individual bankers. Instead of optimizing alternatives, the individual more often "satisfices" by seeking minimally satisfactory alternatives. March and Simon write:

Most human decision-making, whether individual or organizational, is concerned with the discovery and selection of satisfactory alternatives; only in exceptional cases is it concerned with the discovery and selection of optimal alternatives.... To optimize requires processes several orders of magnitude more complex than those required to satisfice. An example is the difference between searching the haystack to find the sharpest needle in it and searching the haystack to find a needle sharp enough to sew with. (March and Simon 1958, p. 141).

An example of satisficing in the model described later is the manner in which the return on loans is determined by the lending institutions. The lender tries to reduce various conflicting pressures, such as deviations from acceptable profitability and interest rate spreads; he does not try simply to maximize profit over some short period of time. This type of behavior, though not characteristic of the traditional concept of "economic man" in the comparative statics or rational expectations theories, may still be described as rational. Simon writes that most real economic decisions are made by a rational,

choosing organism of limited knowledge and ability. "This organism's simplifications of the real world for the purposes of choice introduce discrepancies between the simplified model and the reality; and these discrepancies, in turn, serve to explain many of the phenomena of organizational behavior." (Simon 1955, p. 114).

As a fully-contained theory of behavior, the model described in this study becomes a vehicle for revealing both the short-term and long-term dynamic implications of alternative policies. For example, simulation tests of the Financial Sector of the National Model, together with Monetary Authority and borrowing sectors, will permit the exploration of different monetary policies on short-term business cycles. One benefit of this testing procedure could be to distinguish the short-term effect of officially-induced changes in interest rates on inventory management from the longer-term impact on capital investment.*14* Other tests of the Financial Sector, alone or in combination with other parts of the National Model, will be discussed in later chapters.

*14*Mass explores the causes of short-term and long-term business cycles in (Mass 1975), and suggests the need for future research on the dynamic impact of monetary actions on different types of economic instability.



CHAPTER III. DESCRIPTION OF THE FINANCIAL SECTOR

This chapter describes the Financial Sector model and outlines the functions and structure of each subsector. The description attempts to clarify important links within the Financial Sector and between the sector and its environment. References to the literature on banking and finance serve to relate the work to other studies in finance. In addition to this verbal treatment of the model, Appendix 1 provides an equation-by-equation description.

Section (A) relates the Financial Sector model to the overall purposes of the National Model, thereby suggesting the degree of aggregation required of the Financial Sector. Section (B) describes the institutions that are represented by the sector, namely a generalized "Savings Investor" that collects and allocates private savings, and three aggregate lending institutions that extend short-term credit to business and household sectors (the Bank), long-term credit to business (the "Corporate Lender"), and residential mortgage credit (the Mortgage Lender). Section (C) considers the functions that, in large part, are common to the four institutional categories.

A. The Financial Sector as Part of the National Model

Unlike most system dynamics projects, the study of financial processes contained here has substance only within a larger framework, namely the National Model described in Chapter 1. As part of a bigger project, the Financial Sector model must contain enough detail to permit the exploration of issues that will be treated by the overall National

Model. These issues relate to the modes of macroeconomic behavior, the monetary interconnections between operating sectors of the national economy, the transmission of monetary controls, and long-term historical developments.

1. Financial Structure and Macroeconomic Behavior

In most respects, the purpose of a system dynamics model is defined in terms of dynamic behavior. The modeler decides to focus on certain modes of behavior, such as short-term oscillations or long-term growth, and structures his model to include only those variables, linkages, and time constants that produce the behavior of interest. Therefore, a model designed to analyze the short-term business cycle would exclude slowly-changing demographic factors; while a model that deals with long-term economic growth would ignore quickly-varying phenomena such as prices and inventories.

The behavior modes of interest in the National Model range from the three- to seven-year inventory-employment cycle to the long-term economic growth cycle.*1* Structures whose time constants give rise to very quick adjustments (less than two or three months) would not be expected to contribute to fluctuations with a periodicity exceeding two years. The structure of the Financial Sector, therefore, excludes or simplifies the representation of very quickly changing

*1*See Forrester 1974 for more details on the modes of interest and the reasons for using one model to study such a wide range of dynamic issues.

elements that are unnecessary with respect to the behavior modes of interest. For example, Bank borrowing from the Monetary Authority is modeled as an instantaneously adjusting variable. Borrowed reserves could be represented properly by a level that increases with the extension of loans by the Monetary Authority and declines as these loans mature. But the relevant time constant, which defines the average life of a loan from the Federal Reserve, rarely exceeds a week and is, therefore, far too short to affect three- to seven-year fluctuations.

In specifying a suitable time span of interest we can distinguish between the "money desk view" of financial activities, that focuses on daily adjustments in Federal funds and other money-market instruments (see, for example, DePamphilis 1974), and the broader view of a bank's management, that looks beyond the daily or weekly positions to assess bank strategy over the next three to twelve months (as in Hodgman 1963). Given the purposes of the National Model, the broader, longer-range focus is the more relevant for modeling financial activity. We are interested, therefore, in the lending institution's response to required loans and other factors over several months or longer, rather than in how a bank might adjust daily reserve requirements.

2. Monetary Interconnections

The National Model contains consumer and producing sectors connected by the markets for labor, raw materials, goods, and money. The purpose of disaggregating the model into many sectors and markets is to provide a realistic framework for analyzing economic instability and

long-term growth. Moreover, the National Model should permit an in-depth study of inflation, which has accompanied growth in all of the industrialized economies. Tobin has observed that the interrelationships among different sectors of the economy are important for understanding inflation (Tobin 1972).^{*2*} Our own preliminary dynamic tests of interacting production sectors of the National Model (see Forrester et al. 1975) also suggest the importance of interactions among sectors to overall dynamic behavior. Financial markets comprise one important channel through which different non-financial sectors interact.

Each sector in the model contains a level (stock) of liquid assets that consists of money plus near-money substitutes. Directly affecting these pools of liquidity are monetary flows. As shown in Figure III-1^{*3*}, money moves among production sectors in exchange for

^{*2*}According to Tobin, if demand is high for products of one sector and low for products of another, the high-demand sector will tend to bid up both its product prices and prices for its factor inputs. At the same time, the low-demand sector may well be forced to maintain or increase its prices due to rising factor cost and declining profitability. Such interactions among sectors can cause an inflation that can be characterized as simultaneously demand-pull and cost-push, but in different sectors of the economy.

^{*3*}Figure III-1 shows money in each sector. As described later, money (equal to currency plus demand deposits) is calculated for each non-bank financial institution as the algebraic difference between the level of total liquid assets and the level of non-money liquid assets (e.g., Treasury bills). The contrast between money and the broader concept of liquid assets will be handled in a similar fashion in the production and household sectors. Nevertheless, the figure shows only the money portion of each sector's broadly-defined liquidity.

product sales (factor purchases); between household and production sectors in payment for consumer products and labor services; and between the government and other sectors to account for transfer payments, taxes and the purchase of goods and services. Money flows are separated from the flows of products and orders, and from information relating to prices or purchasing power.

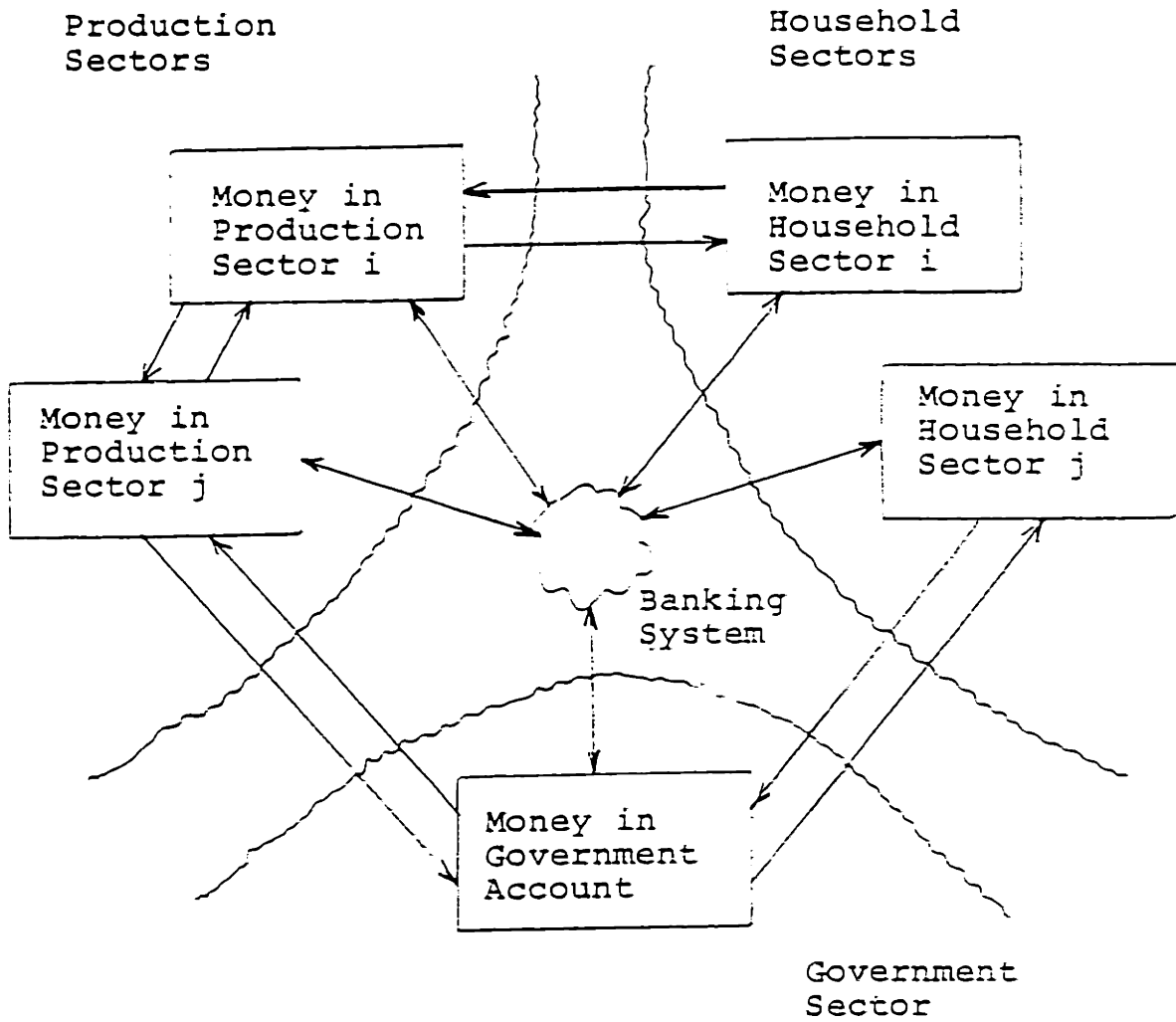


Figure III-1. Money Flows in the National Model

The explicit treatment of money flows permits one to examine the impact of money and close substitutes on decisions of different sectors to spend or save. Under normal conditions, liquidity remains at desired levels and has no significant impact on spending. Conditions of monetary constraint, however, will affect prices and interest rates, the capacity to meet current payment obligations, and the assumption of future commitments.

The total supply of money can be reduced or expanded by the activities of the banking system, broadly defined to include both commercial banks and the Monetary Authority. Thus, Figure III-1 shows the banking system as a cloud-shaped source or sink, where money originates or disappears from the economy.

3. Transmission of Monetary Controls

In addition to treating the relative impact of money flows among different sectors, the National Model will explore monetary controls that influence overall economic activity. Monetary controls generally do not affect directly one's decisions to spend or save, but work through the established financial institutions. Economists disagree about the links between monetary policy and economic activity and about the advisability of trying to adjust quickly to variations in interest rates, unemployment or inflation. Some are more inclined to "fine-tune" the economy to continuously changing conditions, while others favor slowly changing policy rules, such as maintaining a steady growth rate in money supply. One argument against fine-tuning is that

the lags between policy and economic behavior are fairly long and variable and may cause monetary decisions to have maximum impact at the wrong times (Friedman 1968). Another argument cites the instability in financial markets that results from frequent changes in Federal Reserve decisions (McCracken 1975).

Questions relating to the effects of official monetary actions can be examined with the aid of the Financial Sector model. As shown earlier, the Monetary Authority in the model operates in the government securities market to influence bank reserves and interest rates. The short-term effect on bank lending capacity varies and is determined by the Bank's liquidity position. The Bank may be able to attenuate the direct impact of monetary controls, however, by selling deposits (CD's and other savings deposits) to other investors (represented by the Savings Investor) and thereby continuing to extend credit in the face of tight money policies. Moreover, when Bank credit is restrained, potential borrowers may turn to non-bank credit institutions (the Corporate Lender or Mortgage Lender) which, in turn, can bid for private savings, expand their lending, and thereby diminish the effect of official monetary control.

Figure III-2 shows the position of the Financial Sector as a filter through which the monetary authorities attempt to control the rest of the economy. To influence the extension of credit to primary borrowers, the monetary authority must interact with institutions of the Financial Sector in the securities markets or through regulations affecting bank reserves. In response to the monetary control functions,

the sector may try to influence the demand for funds and overall savings by adjusting interest rates and the availability of credit.

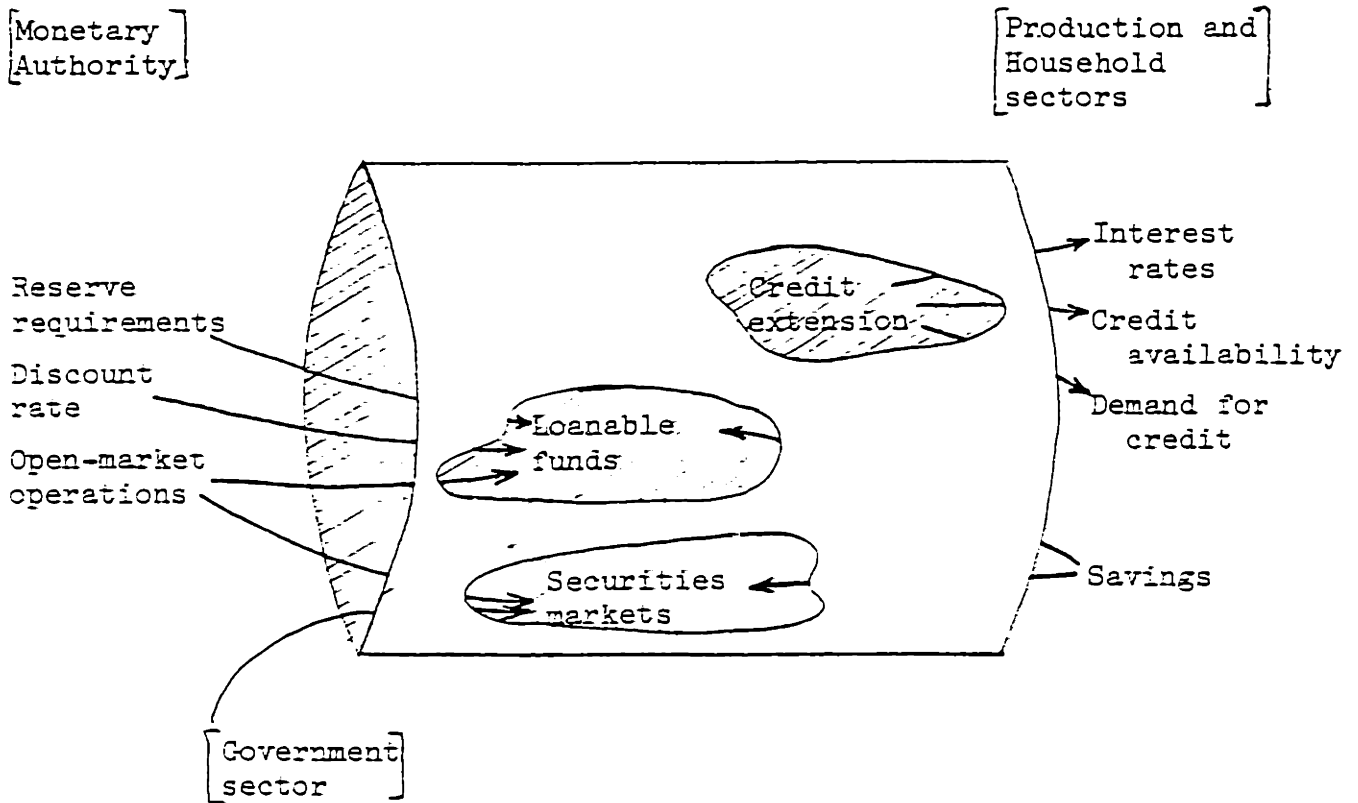


Figure III-2. The Financial Sector as a Filter that Influences Monetary Control over Borrowing and Savings

4. Historical Developments in Financial Activity

In addition to representing the financial functions of current institutions, the model should also exhibit the broad sweep of historical developments in financial activity since the mid-1800s. Important changes have occurred since then. In banking, for example, the establishment of the Federal Deposit Insurance Corporation in 1933 put an end to sudden massive withdrawals from banks resulting from public lack of confidence. But runs on the banking system contributed to financial panics in the past and produced extreme constraints on the banks' capacity to meet withdrawals. Therefore, the structure of the Bank contains enough detail to exhibit the effect of these extreme conditions.*4*

In the realm of financial intermediaries, major developments include the rise in government debt that began with the First World War and the rapid expansion in installment credit and mortgage financing that followed World War II. A dramatic example, relating mainly to the expanding residential construction industry, the growth in savings and loan associations, from \$5.5 billion in loans in 1945, to almost \$300 billion in 1975. The Financial Sector model should capture these historical developments by revealing, for example, the growth in

*4*An example of the structure that would have an impact only in times of crisis is the dependence of current deposit withdrawals on the Bank's reserve position. In normal times, desired withdrawals are realized. But in a crisis, depleting reserves cause banks to fail and affect the aggregate banking system's capacity to accommodate deposit withdrawals.

construction lending by the mortgage lending institutions to the household sectors of the economy.

B. Financial Institutions

1. Overview

The Financial Sector allocates and controls the flow of savings from household and business sectors to those who need short-term and long-term funds. The institutions that effect this transfer consist of four types:

- (1) Portfolio managers (trusts and pension funds)
- (2) Commercial banks
- (3) Non-bank lending institutions
- (4) Monetary Authority

In the model of financial activity, a "Savings Investor" serves as the aggregate portfolio manager of all private savings. That is, instead of households directly putting their savings into the time or savings deposits of banks and non-bank lenders, or into government securities, equities, etc., each household and business sector accumulates an undifferentiated pool of savings which the Savings Investor then allocates among different kinds of savings deposits, Treasury bills, government bonds, or equities. Commercial banks are aggregated into one "Bank," which receives deposits (including savings allocated by the Savings Investor) and extends short-term loans. Non-bank lenders are represented in the model by two institutions, the "Corporate Lender," which extends long-term credit to business firms, and the "Mortgage Lender," which extends residential mortgage credit to

households. The Monetary Authority performs the control functions of the Federal Reserve and is described elsewhere (Behrens 1975). As Section (C) will demonstrate, many functions are common to the three lending institutions (the Bank, the Corporate Lender, and the Mortgage Lender) and to all four private financial institutions (the three lenders plus the Savings Investor). Before describing the common functions, however, this section will consider the four institutions represented in the model and how they interrelate.

Figure III-3 exhibits a schematic overview of the manner in which funds in the model are transferred from savers to borrowers. Each household and business sector adds excess funds to a pool of private savings. These savings are collected by the Savings Investor and then distributed among a wide variety of financial assets, including two kinds of government securities and three types of "savings deposits." Common stock also appears as an asset of the Savings Investor, although in the model described in this study, the purchase and valuation of common stock are not treated. For now, only contractual, interest-bearing assets are created in the Financial Sector model.

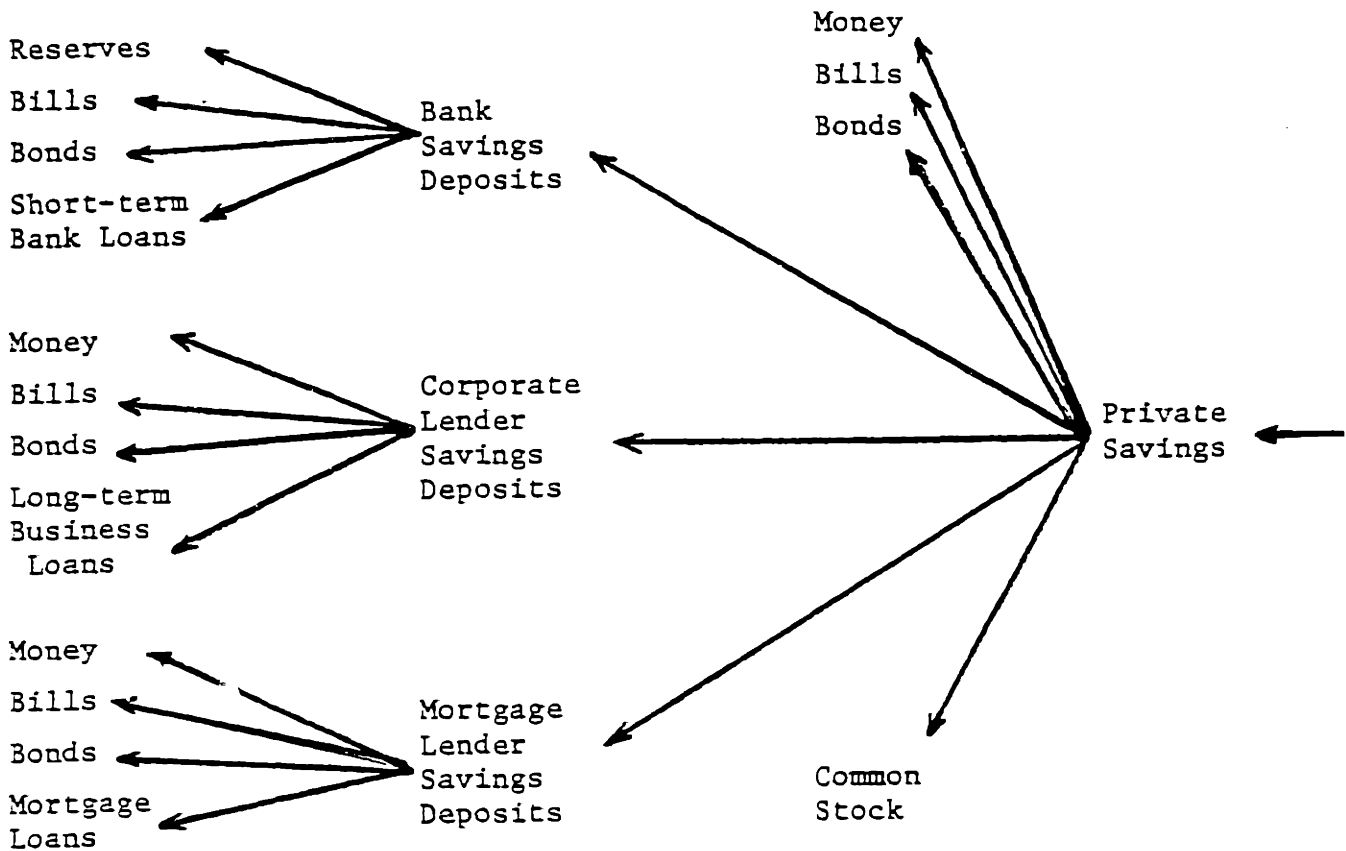


Figure III-3. The Flow of Private Savings into Financial Assets

The "savings deposit" assets of the Savings Investor constitute liabilities of the three lending institutions. The flow of funds into these deposit accounts provides resources for making loans and for purchasing government securities. Each lender can hold its assets in the form of cash reserves, yield-bearing government securities, or loans of various types.

In addition to interacting directly with borrowers, the four financial institutions in the model also interact with each other and

with the Monetary Authority and Treasury in the government securities markets. The Monetary Authority conducts open-market operations in these markets and, thereby, affects the amount of Bank reserves. The Treasury, of course, finances its deficits by selling securities to the other market participants. As we shall see later, a market allocation mechanism in the model generates flows of Treasury bills and bonds from one seller (the Treasury) to five purchasers (including the Monetary Authority), in accordance with each institution's portion of total desired purchases. Thus the Bank, for example, competes with other financial investors for the available bills and bonds. Secondary transactions, which permit the sale of securities before they mature, may occur within each aggregate institution but do not appear explicitly in the model.

2. The Savings Investor

Although the Savings Investor in the model most closely resembles bank trust departments and others who manage individual and business portfolios, it does not really represent real-life institutions. Rather, the Savings Investor serves as an allocation mechanism that transfers private savings into the hands of established lending institutions (through the acquisition of deposit liabilities), into the government (through the purchase of government securities), or into equity ownership (not dealt with further in the current version of the model). In reality, many different parties perform these functions. Individuals, for example, normally invest directly in the yield-bearing

deposits of fiduciary institutions; corporations buy most of the certificates of deposit that constitute a portion of the Bank's "savings deposits" in the model; and both individuals and corporations invest directly in Treasury bills and government bonds. Instead of making their own allocation decisions, however, the household and business sectors of the National Model relegate these decisions to the Savings Investor by simply depositing excess funds in "savings." The assets of a typical sector, therefore, would include money (for transactions purposes), savings, receivables, and various physical assets.*5*

In the balance sheet of the Savings Investor, shown in Table III-1, the assets consist of money plus a range of government securities, savings deposits, and equities.*6* The liabilities consist entirely of savings deposits that accumulate in each of the household and business sectors of the National Model.

*5*Note that the allocation of all private savings by one "savings investor" implies a common array of preferences among firms and households for different types of securities, maturities, and risks. Given the standardized equation format of the Financial Sector, however, a "household Savings Investor" could be separated from a "business Savings Investor" if one wanted to distinguish between their different preference functions.

*6*As noted before, the current version of the Financial Sector model does not treat the issuance and valuation of common stock. For now, therefore, common stock appears as an asset of the Savings Investor only at a constant nominal value (see Appendix 1, Equation 134).

Table III-1
SAVINGS INVESTOR BALANCE SHEET

<u>Assets</u>	<u>Liabilities</u>
Money	Total Savings
Treasury bills	
Government bonds	
Savings deposits in Bank	
Savings deposits in Corporate Lender	
Savings deposits in Mortgage Lender	
Common stock	

Each household and business sector contains a level of savings, which, in addition to money and receivables, constitutes the only financial asset on the sector's books. The level grows when new savings are deposited or when earnings accrue on the assets of the Savings Investor. Figure III-4 gives a simplified portrayal, in the form of a DYNAMO flow diagram, of the links between the Savings Investor component of the Financial Sector and the production and household sectors. The diagram shows that an increase in savings ISAV adds to each sector's level of savings SAV. At the same time, money flows out of the sector's money pool and increases the amount of cash funds held by the Savings Investor. Subsequent investments by the Savings Investor affect the composition of its assets but have no effect on the amount of savings held by each production or household sector.

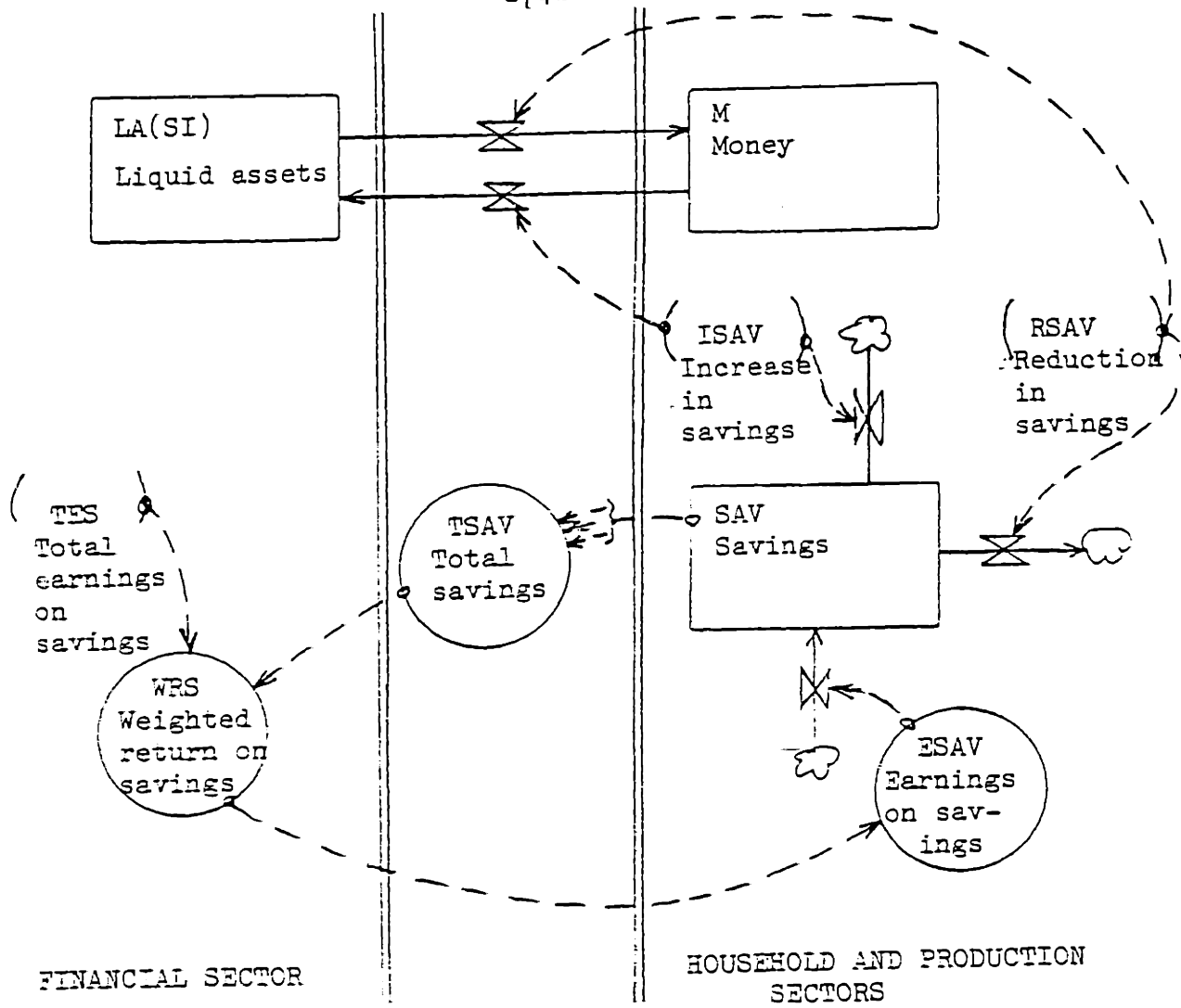


Figure III-4. Coupling between Private Savers and the Savings Investor

Earnings on savings deposits or other assets held by the Savings Investor serve to increase the Savings Investor's total assets. At the same time, these earnings are summed and then divided by the amount of total savings T_{SAV} to derive a weighted return on savings WRS. This measure of total return (in fraction per year) is applied to each sector's level of savings to determine a flow of earnings on savings E_{SAV} (in dollars per year). Thus, the interface between private savers and the Financial Sector assures that total savings and total assets of

the Savings Investor remain in balance.

3. The Bank

Over 75% of the stock of money in this country (currency plus demand deposits) consists of demand deposits at commercial banks. Over 90% of all payments are made by means of checks drawn on these deposits (Shapiro et al. 1968, p. 121). The money supply, therefore, is determined largely by the manner in which commercial banks create and contract demand deposits.

The process of deposit creation is described in most introductory texts on economics and banking. Deposits grow when currency or gold is placed with a bank, or when a bank makes a loan. Deposits decline when currency is withdrawn, or when bank loans are retired. Most banks must hold, in reserve, an amount in cash or deposits at the Federal Reserve equal to a specified fraction of demand deposits. This fraction, or required reserve ratio, is determined by the monetary authorities and changes from time to time in response to various economic conditions.*7*

The extension of bank credit is restrained by the fractional

*7*See Behrens 1975, Chapter 5, for a discussion of the determinants of the required reserve ratio. Note that the Bank in the financial model most closely resembles member banks of the Federal Reserve system, which imposes reserve requirements and acts as lender of last resort to member banks that fail temporarily to meet deposit withdrawals. Most of the nation's banks, accounting for the vast majority of demand deposits, are members of the Federal Reserve System. The remaining non-member banks must comply with reserve requirements imposed by state banking laws.

reserve ratio: new loans, and thereby deposits, can be created only when banks have reserves that are not required to protect deposits; and a fraction of every expansion in outstanding deposits must be transferred to the required reserve account. Excess reserve balances available for lending, therefore, shrink as credit expands. Demand deposits and excess reserves, therefore, are linked in a negative feedback loop, shown in Figure III-5, in which a deviation between desired and actual excess reserves produces pressures tending to close the gap. As we saw earlier, the value of the system time constant determines how much time elapses before a new equilibrium is attained.

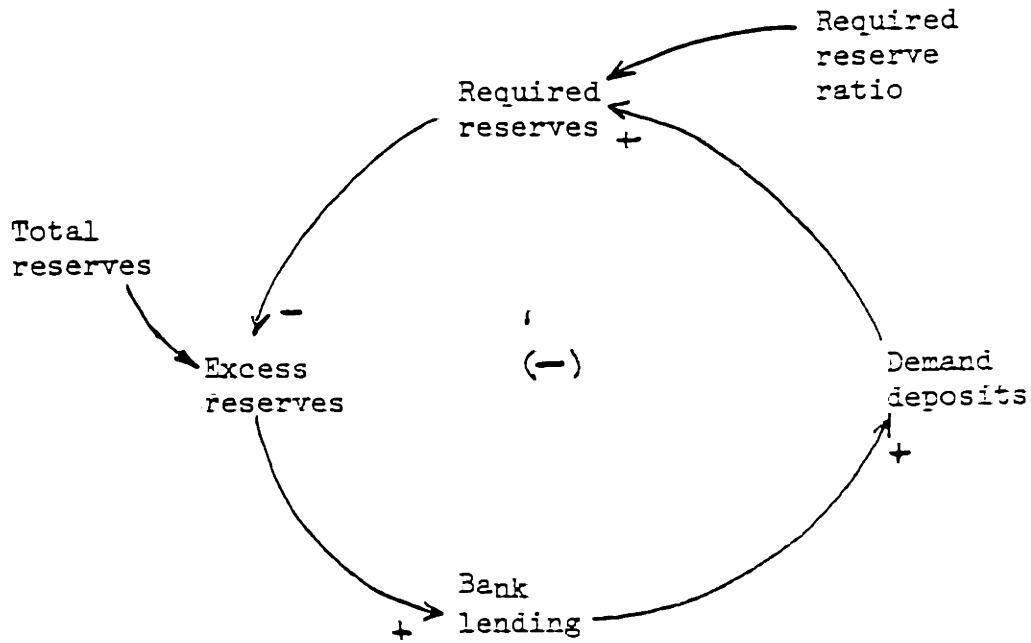


Figure III-5. Negative Feedback Loop in Fractional Reserve Banking

As Figure III-6 shows, reserves of the banking system can be classified in different ways. In terms of source, total reserves are either owned by the bank or borrowed from the Federal Reserve. In terms of application, reserves are either required (as a proportion of outstanding deposits) or excess (not required to offset deposits, and thereby available for lending). Borrowed reserves may be less than excess reserves for the aggregate system, as in Banking System A, thus yielding "free" reserves (equal to owned excess reserves); or total

borrowed reserves may exceed excess reserves, thereby yielding negative free reserves.*8*

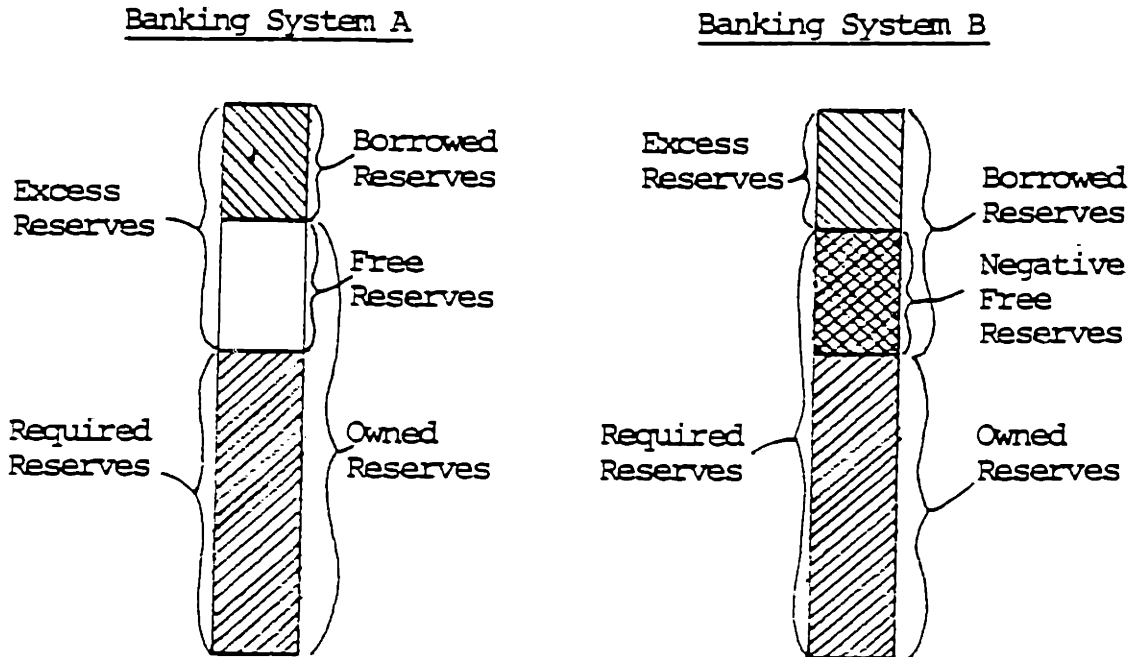


Figure III-6. Reserve Classifications in the Banking System

The balance sheet of the Bank in Table III-2 shows that certain commercial banking activities are not pursued explicitly by the Bank in the model. Installment credit, for example, is not treated as a

*8*Since 1960, Federal Reserve member banks in the aggregate have held positive free reserves at year-end for 8 years and negative free reserves for 8 years.

separate category of funds, but is considered part of "short-term" loans. Moreover, even though commercial banks can engage in mortgage lending, the model is organized functionally so that the Bank makes only short-term loans, while the Mortgage Lender extends all of the residential mortgage credit, and the Corporate Lender makes mortgage loans to business firms. Municipal bonds do not appear explicitly; they are subsumed in the category of long-term government bonds, even though local obligations, unlike Treasury securities, do not constitute one homogeneous aggregate.*9* Finally, federal funds and inter-bank loans, which are important sources of liquidity, do not appear in the balance sheet, because they are netted out in the aggregation of all banks into one institution.

*9*The National Model could contain an explicit municipal sector (separate from the federal government) which would be built around the standard production sector and would seek long-term funds in the credit or securities markets. An expansion of the financial model to accommodate this possibility is discussed in Chapter VI.

Table III-2
BANK BALANCE SHEET

<u>Assets</u>	<u>Liabilities</u>
Reserves	Deposits
- Owned	- Demand
- Borrowed	- Time
Securities	Equity capital
- Treasury bills	Borrowed reserves
- Government bonds	
Primary loans (short-term)	
- Sector 1	
.	
.	
.	
- Sector "n"	

The items on the Bank's balance sheet, as well as their layout in Table III-2, provide an impression of how the model and the rest of this chapter are organized. Reserves are either owned or borrowed, as shown in Figure III-6. Treasury bills and bonds (including municipal bonds) comprise the widely traded securities available to the Bank. They can be reduced so as to raise loanable funds, or increased in times of slack loan demand. Primary loans may be classified according to the "n" different borrowing sectors and differ from security holdings by the nature and structure of the lending relationship. Later sections of this chapter will treat each of these broad asset categories.

Most of the Bank's liabilities consist of demand and time deposits. The Bank can influence the deposit mix and, thereby, the level of required reserves, by varying the rate it pays on time deposits (including CD's) and thereby encouraging their expansion or reduction.

In addition, shareholders of the Bank own equity, which expands or contracts through adjustments in the flow of dividend payments. Finally, the Bank can borrow reserves from the Federal Reserve, offset by the same account on the asset side.

4. The Corporate Lender

We have already seen that the Bank in the model extends only short-term credit, even though most commercial banks also engage in real-estate loans, mortgages and other types of long-term lending. The two non-bank lenders in the model also constitute somewhat artificial entities in that they each bring together many different types of investors and engage in a fairly narrow range of lending activities. Table III-3 exhibits the types and sources of long-term private capital that existed at the end of 1973.*10* Each of the four columns in the table is represented by one of the four financial institutions. Residential mortgages, for example, are held by the Mortgage Lender and include the mortgage holdings of commercial banks as well as the assets of institutions, such as savings and loan companies, that engage almost exclusively in mortgage credit. Installment credit is subsumed in Bank lending, and equity eventually will be held by the Savings Investor.

The Corporate Lender draws together a broad array of real-life investors. The bulk of the Corporate Lender's assets consist of corporate bonds, held directly by individual investors as well as by

*10*Government bond holdings, which are spread among the four financial institutions in the model, do not appear in the table.

insurance companies and pension funds.*11* Most of the corporate bonds held by households are negotiable bonds that are traded actively in secondary markets, while much of the insurance companies' long-term holdings consist of privately-placed credits. We may assume that secondary trades take place within the aggregate Corporate Lender, even though they do not occur explicitly in the model. For convenience, primary loans of the Corporate Lender also include commercial mortgage credit extended to finance buildings, shopping centers, and so forth--debts that, in part, are backed by the general credit of the borrowing corporation or by a real-estate project's earning power. Therefore, some of the assets actually held by savings banks and savings and loan associations are subsumed in the Corporate Lender.

*11*As shown earlier, all household savings accumulate in a pool that is allocated by the Savings Investor among an array of portfolio alternatives. One such alternative is the "savings deposits" of the Corporate Lender, which, in turn, invests in corporate bonds.

Table III-3
LONG-TERM LIABILITIES OF HOUSEHOLDS AND BUSINESS FIRMS,
YEAR-END 1973 (a)
(\$ billions)

Assets of:	Long-Term Household Liabilities		Long-Term Business Liabilities	
	Residential Mortgages	Installment Credit	Debt (c)	Equity (e)
Households	12.4	--	66.9	744.4
Business	--	11.9	--	--
Commercial Banks	74.9	69.5	44.9	0.7
Mutual Savings Banks	61.1	1.4	25.2	4.0
Savings & Loan Associations	210.7	1.6	21.5	--
Insurance Cos.	40.4	--	134.7	45.5
Pension Funds (d)	9.4	--	79.2	107.8
Finance Cos.	12.5	43.4	--	--
Others (b)	8.8	19.6	14.2	40.7
	-----	-----	-----	-----
	430.2	147.4	386.6	943.1
Financial Institutions in Model	Mortgage Lender	Bank	Corporate Lender	Savings Investor

(a) Excludes assets of Federal, state, and local governments, foreign holders, or government-sponsored credit agencies.

(b) Includes credit unions, real estate investment trusts, security brokers and dealers, open-end investment companies.

(c) Includes Corporate and foreign bonds and commercial mortgages. Foreign bonds = \$16.6 billion (4% of total).

(d) Includes private pension and state and local retirement funds.

(e) Common stocks at market value.

SOURCE: Statistical Abstract of the United States (U.S. Department of Commerce, 1974).

The balance sheet of the Corporate Lender in some respects resembles the Bank's balance sheet. Yield-bearing assets include government securities and primary loans, while the only other asset is money. Liabilities include yield-bearing "savings deposits," but not demand deposits. Equity capital, a much smaller component of total liabilities, consists of accumulated earnings that have not been paid out in the form of dividends. Although some long-term lending institutions, especially insurance companies, can borrow short-term funds from commercial banks, the Corporate Lender (as well as the Mortgage Lender) does not have this option in the model. This simplification seems justified in view of the relatively small amount of short-term credit that lending institutions actually require to accommodate their own customers' loan demand.*12*

*12*The most important instances of short-term borrowing by financial institutions seem to be accommodated implicitly elsewhere in the National Model. Each production sector carries receivables on past sales that have not yet been paid. Thus each production sector is also a financial lender and can be said to include the activities of financial institutions that are established in reality to facilitate the sales of certain kinds of products. For example, the consumer durables sector implicitly would include the financial arm of the automobile industry, represented by such companies as the General Motors Acceptance Corporation. The consumer durables sector, in turn, borrows short-term funds from the Bank in order to finance these activities. In like manner, the establishment of real-estate investment trusts, whose recent difficulties have endangered many banks in this country, could be subsumed in the construction or building sector of the model, financing the sales of the sector which, in turn, relies on the Bank for short-term credit.

Table III-4
CORPORATE LENDER BALANCE SHEET

<u>Assets</u>	<u>Liabilities</u>
Money	Savings deposits
Treasury bills	Equity capital
Government bonds	
Primary loans (long-term)	
- Sector 1	
.	
.	
- Sector "n"	

5. The Mortgage Lender

Since World War II the mortgage market has absorbed more private savings, than all of the corporate, US government, and municipal bond markets combined. Most of this expansion has occurred in home mortgages which currently exceed the value of outstanding federal, state, and local long-term bonds. Residential mortgages now total about \$500 billion, while all types of mortgages total well over \$600 billion. In addition to sheer size, several factors justify a separate mortgage lending institution in the financial model. One significant consideration is the long average maturity of mortgage loans,*13* which, together with the construction activities they finance, appears to

*13*The average term to maturity on first residential mortgages is about 25 years (see Brigham and Bartell 1970, p. 292), but refinancings cause mortgage portfolios to roll over in considerably less time. (An average lifetime of 12 years is assumed for mortgage loans in the model.)

contribute to long-term swings in economic activity.*14* Another factor is the sluggish adjustment in interest rates that mortgage lenders are allowed or are willing to pay for deposits, which, during times of tight money, can result in a significant drain on funds necessary to meet the demand for mortgage credit. Thus, a "credit crunch" can penalize the construction industry more severely than other sectors of the economy. This last consideration will be taken up in Chapter IV.

The main suppliers of mortgage finance are savings and loan associations, life insurance companies, mutual savings banks, and commercial banks. Like short-term bank credit, mortgage loans are individually negotiated and usually do not trade in secondary markets. While home mortgages rely in large part on the property as security, much of the smaller volume of commercial and industrial mortgages relies more on the viability of the borrower and, in the model, are considered part of long-term business debt to the Corporate Lender rather than household debt to the Mortgage Lender.

Savings and loan associations, which account for over half of the outstanding residential mortgages, have been restrained since 1966 by a ceiling on what they can pay in interest on deposits. Therefore,

*14*Like investment in long-lived industrial capital, investment in residential housing probably contributes to longer economic cycles than the acquisition of other household durables. These considerations are analogous to the impact of the different life spans of productive factors on economic cycles. See Mass (1975) for details. Maisel also suggests that residential construction and its financing through mortgage loans contributes to economic instability, although his analysis does not focus on the periodicity of the resulting fluctuations (Maisel 1963).

during periods of high loan demand, or rising nominal interest rates, savings and loan's cannot raise as much in deposits as might otherwise like, and have been forced to rely mainly on loan repayments and the growth in savings through interest accumulation to finance rising loan demand and to offset the competition for deposits from other lending institutions. In addition, savings and loan banks can borrow from the National Home Loan Bank system (NHLB). These advances, much like Federal Reserve Bank loans but of a longer maturity, have, at times, added significantly to loanable funds. In 1969, for example, NHLB advances climbed to a record \$4 billion, about equal to the unusually low gain in savings deposits (USL 1973, p. 116). Under most conditions, however, these loans constitute a small portion of total funds. In the model, provision is made for officially-imposed ceilings on deposit rates, but the facility to borrow from government agencies has been left for the future.

Table III-5 gives the balance sheet of the Mortgage Lender. Like the Corporate Lender, the Mortgage Lender holds money as well as securities. Liabilities consist of yield-bearing deposits and equity, both held by the Savings Investor. Interest paid on deposits, relative to rates available on other types of savings deposits and government securities, affect the willingness of savers (through the Savings Investor) to hold deposits which, together with loan repayments, constitute the main source of lending capacity.

Table III-5
MORTGAGE LENDER BALANCE SHEET

<u>Assets</u>	<u>Liabilities</u>
Money	Savings deposits
Treasury bills	Equity capital
Government bonds	
Primary loans (long-term)	
- Sector 1	
.	
.	
- Sector "n"	

C. Financial Functions

1. Overview

Despite differences among financial institutions, their lending decisions and asset allocation respond to similar pressures and in most cases can be modeled identically. Both commercial banks and non-bank lenders, for example, are established primarily to make negotiated loans to individual customers. To accommodate primary lending activities, these institutions also hold government bonds, Treasury bills, and other widely-traded secondary assets for security and liquidity. Moreover, the various kinds of fiduciaries set interest rates and manage cash reserves in a similar fashion. Because of the functional similarities, the Financial Sector can be thought of as a set of functions, as well as a set of different institutions.

Figure III-7 portrays the functional organization of the sector. Each institution extends primary credit, manages an investment portfolio of securities, sets interest rates on loans and deposits, and

manages a cash position. These common functions are bounded by the inside circle and are interconnected. For example, relative interest rates affect the allocation and volume of securities, while primary lending is influenced by the availability of liquid assets (including Treasury bills). Within the larger sector boundary, but outside of the boundary of any one institution, lie the government securities markets, which allocate securities according to relative supply and demand.

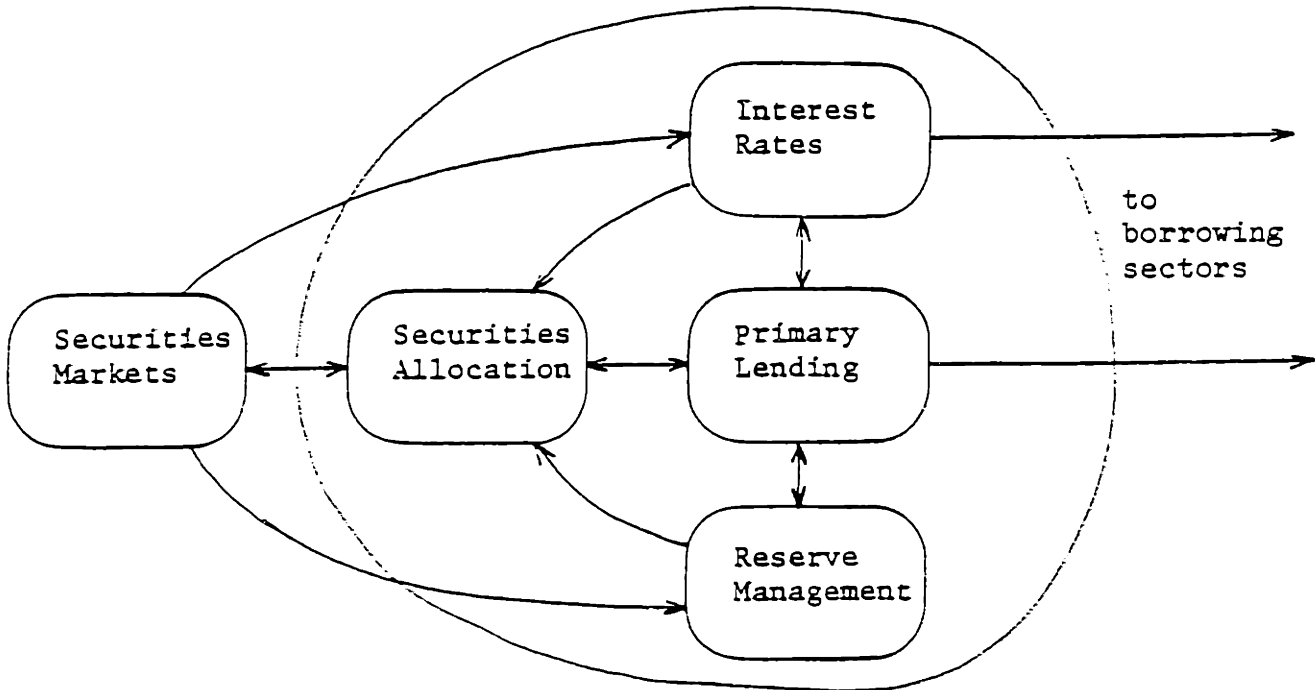


Figure III-7. Functional Organization of the Financial Sector

The sector model uses the DYNAMO III compiler in order to facilitate the representation of activities that are repeated in several parts of the model. As explained elsewhere (Pugh-Roberts 1976), the DYNAMO III compiler can accommodate arrays of equations. Therefore, one equation can be written to represent a relationship common to more than one institution or asset type. One of the equations, for example,

defines a variable called "liquid assets" LA, which has a subscript "FI" standing for "financial institution." The "FI" indicates that one equation for liquid assets actually represents four distinct quantities. As can be seen in Appendix 1, the use of subscripts is somewhat complicated by the fact that some equations are common to all four financial institutions and, therefore, have the "FI" subscript; some equations are common to the three lenders ("L"); some are common to only non-bank lenders ("NBL"), and so forth. The subscript that appears with a variable indicates which subset of the four financial institutions contains that variable.

The equations are written so that one could use the same model to simulate the Bank alone, the Bank in connection with one other lender, or any other combination of financial institutions. The equations would remain the same, but the parameters might differ if, for example, one wanted to combine all long-term lending into one (rather than two) entities.

Equations that are common to the three lenders generate primary lending, the return on loans, transactions in government securities, and the management of deposit and equity liabilities. Other structures apply to all four institutions (e.g., government securities transactions and certain liquidity flows), or to only a single institution. The most important of the non-general formulations determine the management of Bank reserves, which have different characteristics from the cash reserves of other fiduciary institutions. Finally, a block of coupling equations expresses the monetary flows

among financial entities and links the entire sector with other sectors of the model. Coupling equations lie outside of the Financial Sector boundary and are usually unique to the particular configuration of the National Model into which the sector is merged.

The equations of the model are described individually in Appendix 1. The purpose of this section, therefore, is to give an overview of the formulations that clarifies the functions and major links within the Financial Sector. The equations are written in blocks that, for the most part, carry common subscripts and describe particular functions. The rest of this chapter is organized along the same pattern, except that the description of government security transactions (Treasury bills and bonds) pertains to two blocks of equations.

2. Primary Lending

Primary loans may be defined as credits that are usually negotiated with each borrower and reflect an assessment of each borrower's current and expected financial condition. Primary loans of banks are usually not traded in secondary markets, and, therefore, represent relatively illiquid investments. Primary loans of the Corporate Lender or Mortgage Lender include long-term claims that also are not generally sold before maturity or, if traded in established secondary markets, are held within the boundaries of aggregate lending institutions. Most of the following discussion will focus on the Bank, although the same structure applies to the other two lenders.

Most studies of banking represent the extension of primary

credit as a portfolio selection problem tempered by the special relationship that exists between a bank and its customers. At one extreme is the single-period portfolio selection model, which emphasizes the similarities between commercial banking and optimal portfolio management. In this view, bank loans, like any other financial asset, adjust instantaneously or within a short period to relative return, risk, and liquidity. Tobin expresses the portfolio selection view of banking most forcefully. A bank, he writes, is like any other financial intermediary, in that it attempts to maximize short-term profit by equating marginal returns with marginal costs. "However short the period, it is only returns over the period immediately ahead that are relevant to portfolio selection." (Tobin 1959, Chapter 3, p. 2). Elsewhere, he writes, "The distinction between commercial banks and other financial intermediaries has been too sharply drawn. The differences are of degree, not of kind." (Tobin 1963, p. 418).

At the other extreme is the view that banking institutions exist because of their special relationship with customers and, therefore, must respond to long-term considerations more than to short-term marginal returns. Hodgman most strongly states this position: "Commercial banking is essentially a service industry. The loan and investment policies of commercial bankers are strategically subordinated to the customer service aspect of banking and cannot be understood apart from this aspect." (Hodgman 1963, Preface). As a pure portfolio manager, a banker in Tobin's model would seek or reject lending opportunities on the basis of marginal risk and return,

regardless of customer relationships. Hodgman, on the other hand, asserts that the deposit relationship is crucial for long-term profitability and that loans to non-depositors, at the same rate of return, are considerably more costly from a long-term point of view than loans to depositors. He writes, "In the long run the individual bank's capacity to lend and invest depends upon its depositors." (p. 25). Therefore, "A bank's most important customers are its depositors, not its borrowers." (p. 166).

Most recent banking studies combine the short-term portfolio balance approach and the long-term primacy of customer relationships. The MPS model, for example assumes that banks attempt to maximize short-term profit by choosing an optimum investment portfolio (which does not include bank credits), but that the optimum portfolio is based on expected levels (and variance) of outstanding loans and deposits (Modigliani et al. 1970, pp. 181-185). Bosworth and Duesenberry express the primacy of customer loans in an equation for excess loan demand, which combines the two driving forces in banking--business loan demand and Federal Reserve open-market policy. In their model, banks adjust security holdings, when possible, to meet loan demand. "To put it shortly--and with some lack of precision--when the Federal Reserve provides banks with sufficient reserves to accommodate business loan demand passively, the rest of the market is insulated. When Federal Reserve policy does not provide enough reserves, the excess loan demand is passed to the rest of the market through bank sales of securities or bank issues of additional short-term liabilities." (Bosworth-Duesenberry

1973, p. 68).^{*15*}

The Financial Sector model also distinguishes between customer loan demand and securities investment. Like banks in the Bosworth-Duesenberry study, the aggregate Bank manipulates investments in response to changes in loan demand and stays relatively clear of the securities markets when liquidity is easily forthcoming from the Federal Reserve.

Primary credit extension is governed by four direct influences:

- (1) Loan demand
- (2) Liquidity
- (3) Relative returns
- (4) Borrowed funds

Unlike most financial models, the impact of loan demand is exerted through a "backlog of loan requests," as well as through asset prices (interest rates). The nature and implications of this backlog level can be explained most clearly by comparing the procurement of credit by each borrowing sector in the National Model with the procurement of other factor inputs. That is, whether obtaining labor services, capital equipment, or money, the purchasing sector formulates a need, places orders, and eventually receives the input in accordance

^{*15*}In a model that bases asset choice entirely on interest rates, Silber fails to reveal substitutability between government securities and the rest of a bank's portfolio (Silber 1970, p. 39), a result that is consistent with the separation of primary lending from other portfolio investments. Goldfeld arrives at a similar finding. (Goldfeld 1966, pp. 57-59).

with the supplying sector's capacity to meet demand.

The lending equations resemble the formulation for shipments in the standard production sector. That is, the demand for loans, like the demand for factors of production, is represented by a backlog level that accumulates orders (loan requests). The backlog determines an indicated shipping (loan extension) rate which, together with the sector's product inventory, generates an actual shipping (loan extension) rate. The backlog of loan requests divided by the loan extension rate defines a loan extension delay which, when transmitted to each ordering sector, determines the flow of loans to each sector.

The notion of lending against a backlog of loan requests logically suits the process of loan negotiation and credit extension. But the concept is unconventional and will be clarified here. Bank loans or long-term credit extended by the various thrift institutions can be divided into two categories--project loans, and loans extended under previously-negotiated commitments (such as lines of credit). Project loans are extended to finance particular, identifiable projects. They constitute virtually all of the credit held by mortgage lending institutions and other long-term lenders, and perhaps 30% to 40% of the loans granted by commercial banks. Loans granted under existing commitments are used when needed and help to meet short-term requirements not identified with particular projects. These loans account for the remaining portion of bank credits.

Project loans clearly fit the format of lending against a backlog. In anticipation of a construction project or similar

investment, a firm will plan the related financial needs and negotiate the financing over some months. During the negotiating process, credit "orders" become visible to the lending institution as an accumulated backlog, representing a financing need which the lender would like to accommodate if possible. Based on the backlog of loan requests, the lender determines an indicated or desired lending rate, which may be modified by relative liquidity, returns, or borrowed funds. In the case of bank loans granted under previously-arranged commitments, the backlog represents requests for lines of credit and less formal commitments that the borrower intends to utilize over the coming year. The credit extension delay encompasses the time to arrange for new or renewed commitments, as well as the shorter time that passes before the commitment is utilized.

The credit extension process involves several sequential steps, shown schematically in Figure III-8. For both project loans and commitment loans, the borrower plans his future financial needs by estimating the amount and timing of future costs and revenues. Then the borrower and lender enter into discussions about the cost and availability of credit, discussions that evolve into formal negotiations. During this phase, the lending institution reviews the borrower's financial condition and, for current customers, any changes that have occurred since the last loan or line of credit was extended. Given the lender's liquidity and interest rate, a loan or commitment is

granted and money is transferred either immediately or after a fairly short time.*16*

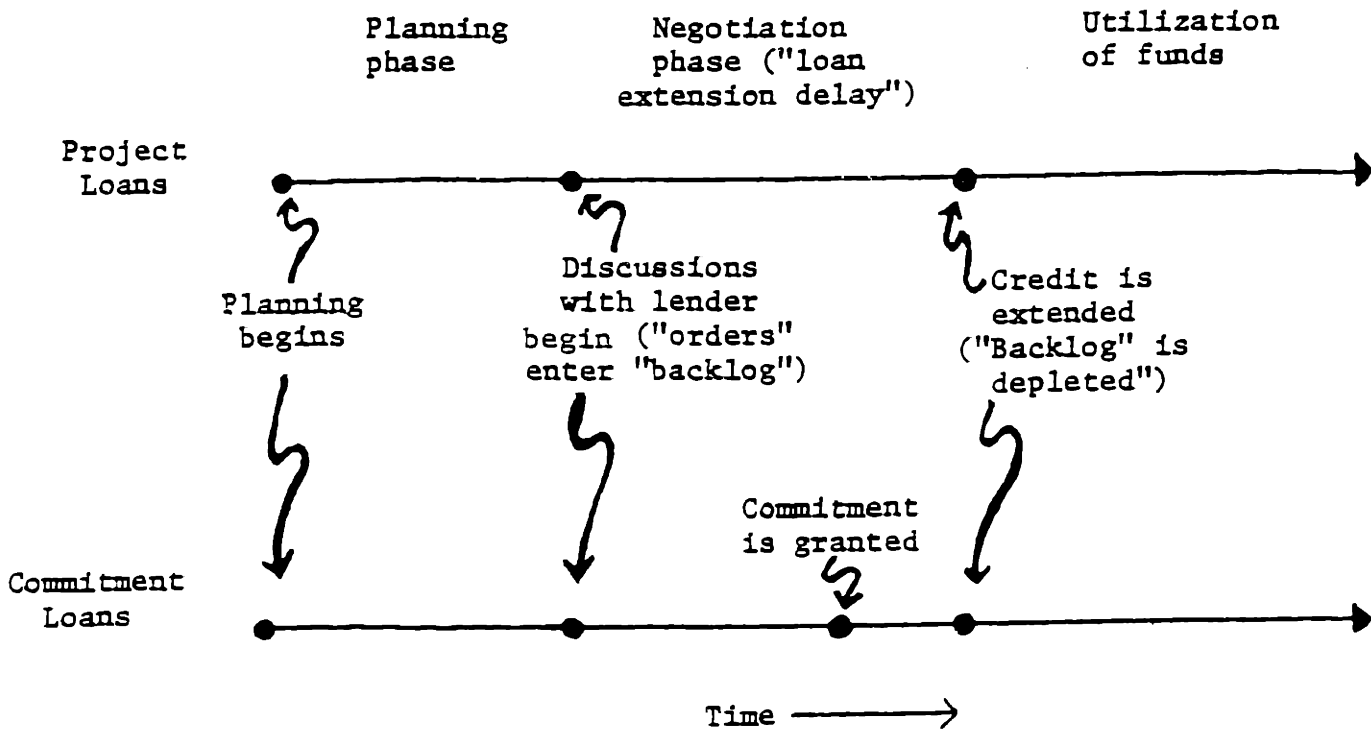


Figure III-8. Timing of Credit Requests and Extensions

*16*For any one bank, an annual commitment may remain unutilized for a good part of the year, as the borrower may have only seasonal requirements and may also distribute his usage of credit lines among several different banks. In the model, however, all banks are aggregated into one entity, and regular seasonal patterns are ignored. Thus, for the aggregate Bank, the negotiation process involves commitments that the borrower actually intends to use, and they are generally "taken down" (the money passes from lender to borrower) soon after the commitment has been arranged.

As an information input to the supplier of funds, the "backlog" of loan requests represents commitments that the Bank or other lenders must try to satisfy in the near future. If demand rises, for example, the Bank will wish to increase its lending rate in order to maintain its normal accommodation of credit requests and, thereby, to maintain a "normal loan extension delay." Thus, the desired or indicated loan extension rate ILER equals the backlog of loan requests BLR, divided by the normal loan extension delay NLED:

$$\text{ILER} = \text{BLR}/\text{NLED}.$$

The normal loan extension delay may be compared with the actual loan extension delay, which is defined as the backlog of loan requests BLR divided by the loan extension rate LER:

$$\text{LED} = \text{BLR}/\text{LER}.$$

As backlog grows, the loan extension delay initially increases, thereby indicating the reduced availability of credit relative to demand. This indicator of reduced credit capacity, if not quickly restored by expanded lending, eventually causes potential borrowers to reduce their credit demands. As an indicator of market supply and demand, the loan extension delay also affects the determination of interest rates. A higher delay, for example, indicates tighter credit conditions and causes lenders to increase the return on loans. The higher cost of credit eventually may cause borrowers to reduce their loan requests.

The relation of primary lending in the model to a backlog of loan requests makes explicit the notion of credit availability or

"rationing" that is treated in much of the banking literature. The loan extension delay in the model indicates the relative availability of credit to current and prospective borrowers. Implied by this delay is a whole range of non-price features that make up what Hester calls the "loan offer function." (Hester 1967). These features, which vary as relative credit capacity expands or contracts, include the size of loan, repayment schedules, maturity, guarantees, types of collateral, dividend and working capital restrictions, and other restrictive covenants.

There are several theories of credit rationing. In the simplest sense, rationing in any market occurs when price (interest rate) fails to equilibrate supply and demand. As shown further on, the model generates a dynamically adjusting return on loans. One of the influences on the desired return is the condition of the credit markets, indicated by the relative loan extension delay. During the period of adjustment in interest rates, the Bank could exhibit "dynamic rationing" (Jaffee 1971, p. 15), where, for example, interest rates fail to rise fast enough to stifle excess demand. However, interest rates in the model are also influenced by factors other than relative demand, so that it is possible for interest rates to remain constant for awhile, even when the relative loan extension delay would suggest the existence of excess demand. (See the description of interest rates in Appendix 1.)

Liquidity, as well as demand, influences lending capacity. Liquid assets consist of directly-loanable funds or securities that can be liquidated easily. For the three lending institutions, liquid assets consist of cash reserves plus Treasury bills (with an average maturity

of six months). Although reserves for the Bank, and money in the case of non-bank lenders, constitute the pool of directly-loanable funds, the important lending decisions focus on the broader concept of liquidity. The composition of liquidity is handled in the investment accounts, as we shall see further on.

To some observers, liquidity management is the essence of banking. Crosse and Hempel observe, "It is the task of bank management to measure immediate and prospective demands and to anticipate them, to the extent possible, by providing an adequate reservoir of liquidity instruments." (Crosse and Hempel 1973, p. 143). This reservoir of liquidity may be considered an inventory out of which demand may be satisfied. "Cash and other assets readily convertible into cash represent 'inventories,' the carrying cost of these 'inventories' is the surrender of earnings power, and various penalties are incurred for insufficient 'inventories.'"*17* (Porter 1961, p. 326).

Figure III-9 exhibits the relationship between lending and liquid asset "inventories." The inside negative loop portrays the direct effect of loan extensions on liquid assets. When the loan extension rate rises, for example because a growing backlog of loan requests expands the indicated loan extension rate, liquid assets decline. The decline in liquidity, relative to desired liquid assets, restrains further lending. As with depleting inventories in production

*17*Duesenberry also draws an analogue between the liquid assets of banks and the inventories of other business firms (Duesenberry 1963, p. 13).

sectors, therefore, the "physics" of shipping goods or credit out of a declining inventory level requires a constraining link between the liquid assets level and the lending rate. When liquidity is excessive, on the other hand, lending terms may be eased, banks will be more inclined to lend to non-depositors or to other less established customers, and lending will rise above the rate usually elicited by outstanding credit demand.

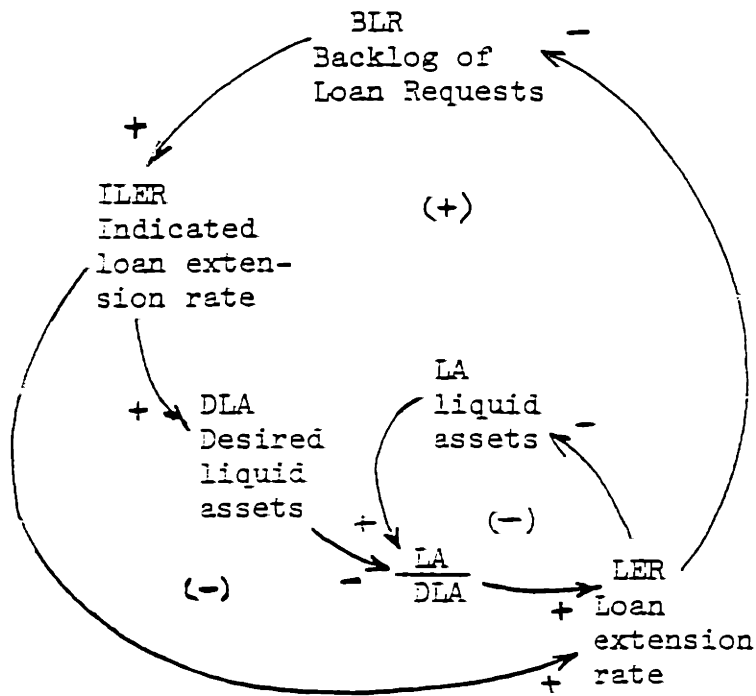


Figure III- 9. Feedback Loops Relating Liquid Assets and Loan Extension Rate

The outside (negative) loop reveals the direct link between loan demand and lending that has already been described. For example, as demand, in the form of backlog, rises, the indicated and actual loan extension rates rise, thereby reducing the backlog of loan requests. The positive loop in the upper part of the figure reduces the full

impact of demand on lending, however, because, as the indicated loan extension rate grows, the pool of desired liquid assets also expands. As desired liquidity grows relative to actual levels, lending is curtailed in order to rebuild the liquid assets inventory. This restrictive influence on lending, however, is not enough to prevent a higher rate of loan extensions, for the direct impact of backlog on lending (outer loop) always exceeds the indirect impact (through desired liquid assets). But as lending expands, the liquidity pool declines, which, if no other forces are present to replenish liquid assets, eventually will suppress loan extensions. Through these and other channels, lenders attempt to maintain an adequate inventory "buffer," by adjusting the level of liquid assets to a desired amount equivalent to several months' worth of indicated loan extensions.

The third influence on credit extension is the relative return on loans. Usually, relative returns does not constitute a strong influence on lending, since over the short term, at any rate, credit extension responds primarily to loan demand even at the expense of a short-term marginal disadvantage. Lenders generally adjust their rates fairly slowly, partly so as not to jeopardize customer relationships. Political, social, or other "non-economic" pressures can also prevent lenders from raising their rates rapidly, in which case the relationship

of loan yields to more freely-adjusting returns can have a significant impact on lending.*18*

To calculate relative returns on loans RRL in the model, the lending institution relates "effective" returns on loans outstanding ERLO to an average return on assets ARA. The effective return equals the current return, less the default fraction on outstanding loans. The impact of defaults is considered in more detail later on. The average return, or reference point in the comparison, equals a weighted return on all assets available to the lender. The comparison is adjusted by a "risk and cost premium on loans" RCPL which accounts for the spread in returns required to compensate for non-default risks (such as the risk of realizing capital losses through changes in interest rates) and administrative costs (such as credit checking or collecting on small installment loans). A similar relative return calculation influences all asset purchases in the Financial Sector and is shown below. When the ratio equals one, relative returns have a neutral impact on lending (or purchases of other assets). When the ratio exceeds one, lending expands; and when the ratio falls below one, lending is contracted.

$$RRL = (ERLO - RCPL)/ARA.$$

*18*Some observers have blamed the inflation of the early 1970s, in part, on the political restraints that prevented banks from raising the prime rate as fast as loan demand warranted. The artificially low rates thereby encouraged borrowing and inflationary spending (Rose 1976, p. 175). In the model, the setting of the return on loans outstanding RLO (see Equation 24) incorporate the possibility of a ceiling rate, which could be imposed in simulations of the National Model to explore the importance of artificially-constrained rates on inflation.

Defaults on loans exert both short-term and long-term effects. In the short term, a higher default fraction causes the effective return to decline, thereby reducing the attractiveness of loans relative to other assets. Moreover, a high incidence of failures causes bank liquidity to decline, thereby restraining further lending. At these times of illiquidity, banks become increasingly dependent on the government, mainly the Federal Reserve, to bail them out of an otherwise dangerous situation.*19*

Over the longer term, defaults encourage greater caution among bankers and usually result in higher credit standards. This is a long-term impact, because the memory of extensive business failures, such as those of the Great Depression, lingers long after normal conditions return. Defaults, as well as other criteria for creditworthiness, such as debt-equity ratios, differ from sector to sector. Therefore, the determination of creditworthiness, or of what constitutes a justifiable loan request, resides within each sector. In other words, even though the designation "creditworthy" involves attitudes of the lender, it also entails conditions of each borrower and, thereby, is established outside of the boundary of the Financial

*19*Two recent examples that led the Federal Reserve to rescue major parts of the banking system were the collapse of the Penn Central Railroad in 1970 (entertainingly described in Smith 1972), and the failure, two years later, of the Franklin National Bank. Minsky writes that banks have come to expect the Federal Reserve to save them from the effects of business failures and, therefore, have been more willing to take significant credit risks. The entire financial system becomes increasingly fragile as a result (Minsky 1975).

Sector described in this study.

Lending is also influenced by the level of outstanding borrowed funds (borrowed reserves in the case of the Bank). When borrowed reserves approach or exceed the maximum amount deemed acceptable by the Monetary Authority, the Bank becomes subject to increasing pressure on further lending.*20* When, as a result, lending is reduced, the process of money creation through the extension of credit is restrained. This means that the total money supply eventually is brought back to a lower level than would otherwise prevail. A reduced money supply requires fewer protective reserves, thereby limiting the Bank's need for borrowed funds. The negative feedback loop just described appears in Figure III-10.

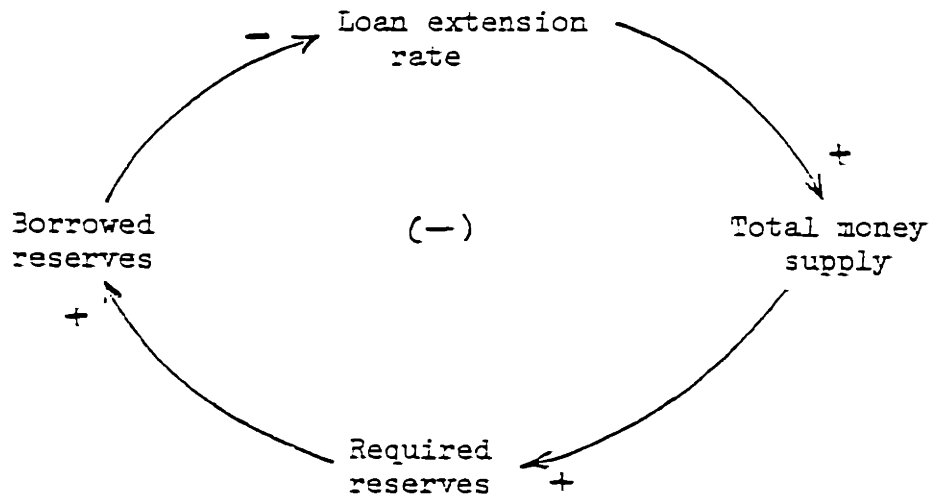


Figure III-10. Negative Feedback Loop Relating Bank Lending and Borrowed Reserves

*20*The other two lending institutions in the model cannot borrow, like the Bank, from an official "lender of last resort"; so the influence of excessive borrowing applies only to the Bank.

3. Return on Loans

As we saw in the previous section on primary lending, the lending institutions provide two basic signals about credit market conditions to potential borrowers: the loan extension delay (indicating the availability of credit) and the return on loans (indicating the price of credit). The first signal has already been described. To generate interest rates, the aggregate lending institution adjusts its current return to a desired, or indicated, level over a period of several months. In this fashion, the return on loans adjusts over time, rather than instantaneously, to market conditions and other influences. The adjustment time (= 0.3 years in test runs of the model) reflects delays in perceiving and reacting to market trends, the tendency of credit institutions not to get far out of line with the competition when setting rates, and the inclination of lenders to protect customer relationships even at the expense of having to ration credit. The structure of each lending institution's return on loans is displayed in Figure III-11, which shows the goal-seeking nature of interest rates in the model, as well as the factors that influence the desired interest rate goal.

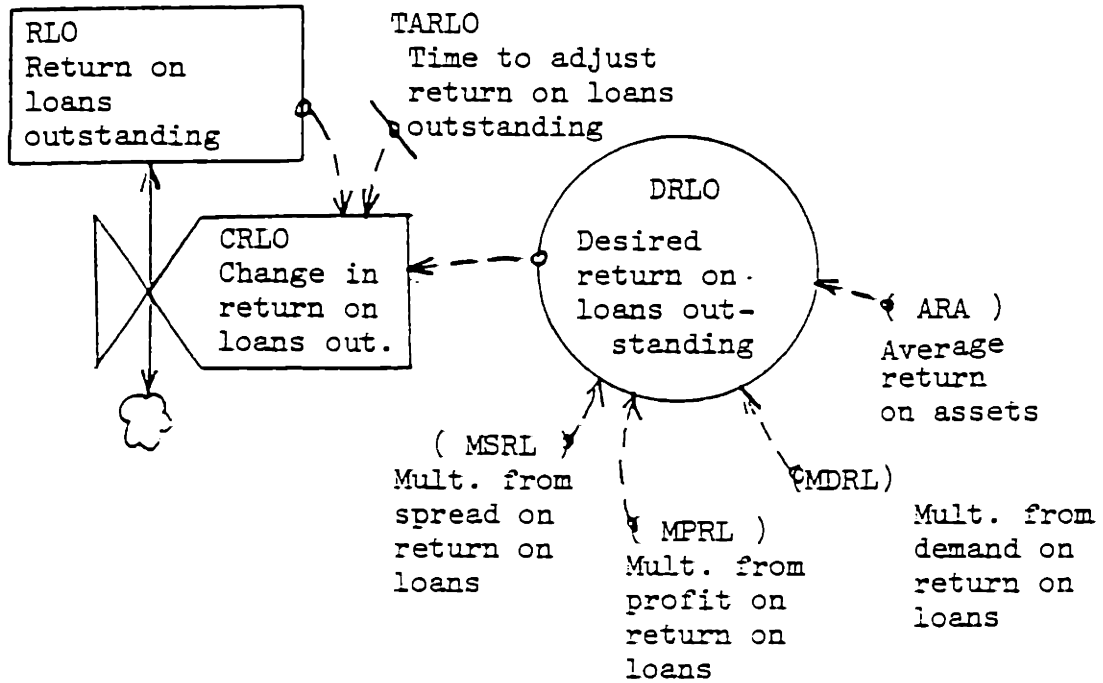


Figure III-11. Structure of the Return on Loans

The desired return on loans reflects four basic influences:

- (1) average return on assets
- (2) relative loan extension delay (an indicator of excess demand)
- (3) relative profitability
- (4) current spread between loan rate and deposit rate

The average return on assets represents an arithmetic mean of the current returns available to lenders, including the opportunity cost of foregoing the yields available on government securities in order to make loans. If the other influences, such as loan demand, are neutral, the desired rate equals the average return, plus the acceptable risk and

cost premium on loans and the (perceived) default fraction on loans*21*

The other influences expose the return on loans to negative feedback pressures. Relative loan demand in primary credit markets, for example, is reflected in the loan extension delay, a variable that declines when supply is tight relative to demand, and rises with surplus liquidity. When the loan extension delay is relatively high, desired, and therefore actual, interest rates tend to rise; while a short delay has the opposite effect. Higher interest rates tend to discourage loan demand, which lies outside the Financial Sector boundary, thereby bringing down the backlog of loan requests and reducing the loan extension delay (which is a function of backlog). As shown in Figure III-12, these changes mitigate the upward pressure of interest rates.

*21*As we saw previously, the risk and cost premium on loans expresses the spread between loans and the average return required to compensate for certain kinds of risk and administrative costs. Both the risk and cost premiums, as well as the default fractions, are constants in the current model testing.

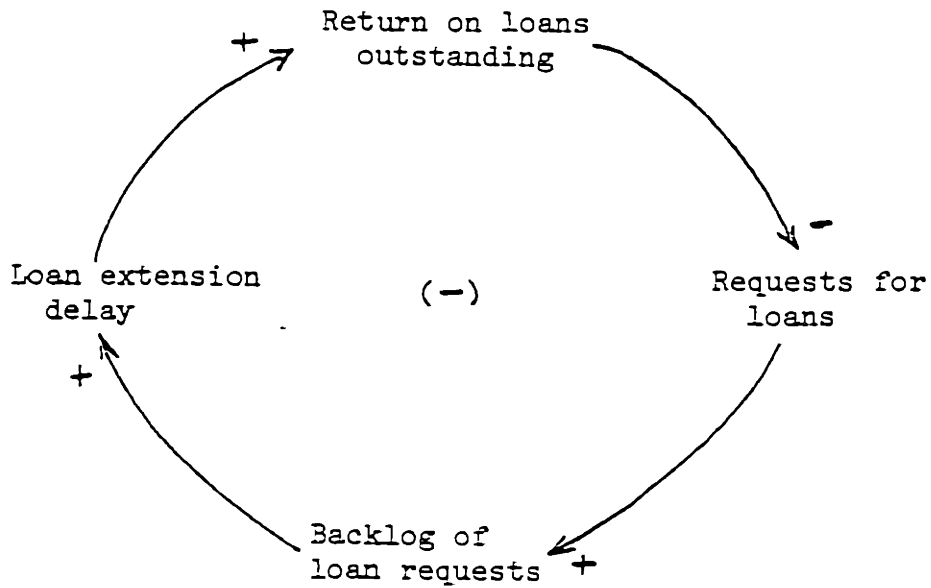


Figure III-12. Negative Feedback Loop Relating Loan Demand and Interest Rates

The third influence on primary interest rates is relative profitability. In the model, the ratio of current profits to total assets is compared with an acceptable ratio. As profitability declines, the return on loans moves up, as shown by the loop in Figure III-13. As profitability exceeds acceptable levels, lenders are willing to let rates fall (or rise less rapidly), so as to maintain or augment market share. The pressure from profitability on interest rates is a good example of satisficing, versus optimizing, economic alternatives, a distinction that was drawn in Chapter II. A pure profit maximizing model would probably not include the notion of a satisfactory (as contrasted with maximum) return nor permit downward pressure on interest rates in response to "excessive" profitability.

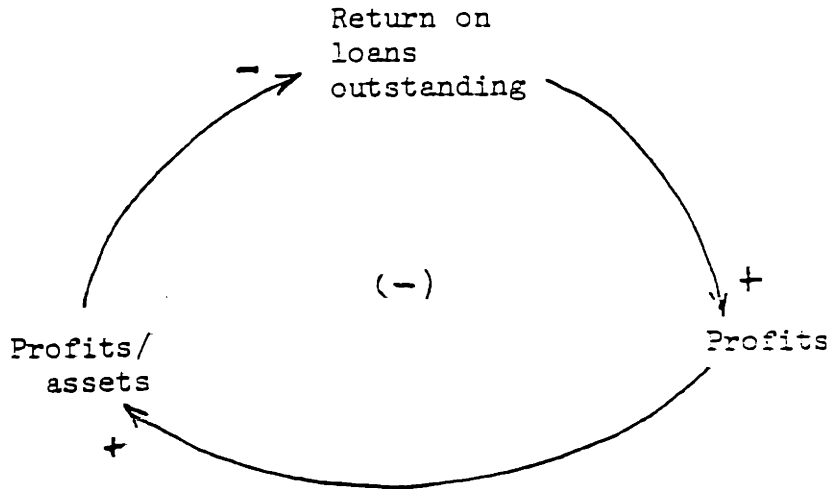


Figure III-13. Negative Feedback Loop Relating Profitability and Interest Rates

The influence of a higher interest rate on profits is not necessarily immediate, since interest payments on loans already booked are usually based on past returns and not the current return. For the Bank, the delay in the impact of higher returns on the aggregate flow of profits is not substantial, because Bank loans are short-term (with an average life of one year), and because a large portion of commercial bank loans carry floating rates that adjust to current market conditions. For the Mortgage Lender, however, a higher interest rate will have little immediate impact on earnings because of the long

turnover in mortgage loans (12 years in the model) and the fact that a mortgages rarely carry floating rates.*22*

If we combine this delayed impact on revenues with unrestrained adjustment of interest rates on savings deposits, which banks use to attract liquidity, profits can be squeezed during times of rising rates. As we shall see in the section on liability management, expanded loan demand not only causes loan rates to rise but also encourages lending institutions to raise the returns they pay on savings deposits, if they are permitted to do so, in order to attract funds. Savings deposits have a short "maturity" compared with long-term mortgage or business loans. Therefore, in the short run, the rising rate on deposits erodes profits, despite the higher marginal return on loans. In addition to relative profitability, therefore, lenders also look at the spread between asset returns and deposit rates, a current relationship that influences future profits. The negative feedback between returns and spread, shown in Figure III-14, helps to prevent wide swings in profits and is a commonly-used comparison in banking. When the cost of deposits is relatively high (the spread is low relative to the traditional relationship), pressure builds to raise the return on

*22*In simulations of the model, one can adjust the averaging time used in calculating the aggregate return on loans that governs interest payments. For example, an averaging time of 12 years for determining the payment of interest on mortgage loans implies that all outstanding mortgages carry yields that prevailed when the credit was originally extended. An averaging time of 6 years, which is employed in Chapter IV, assumes some floating rates (as well as a portion of interest in the form of initial, or front-end fees).

loans. A high spread, on the other hand, encourages lenders to reduce loan rates.

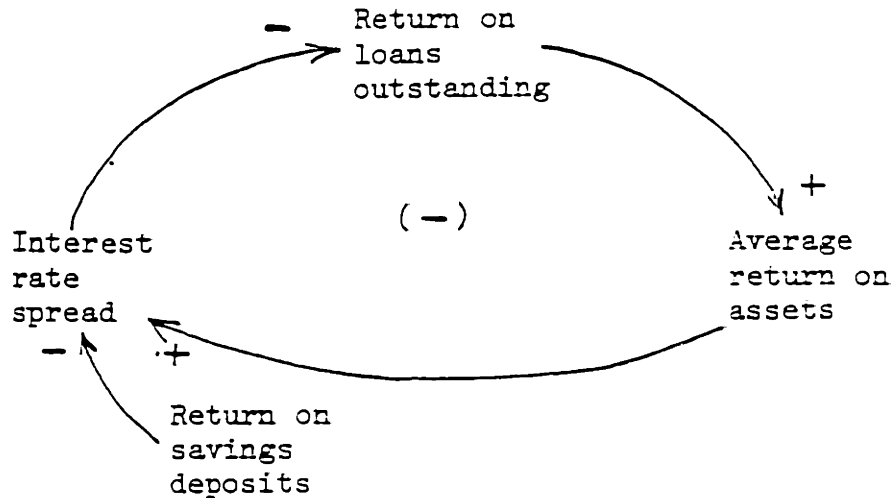


Figure III-14. Negative Feedback Loop Relating Interest Rate Spread and Interest Rates

4. Investment in Government Securities

Lending institutions, like other firms, can actively manipulate both sides of their balance sheets. Before the 1960s, the banking literature focused on "asset management." Banks were said to rely mainly on asset adjustments when managing liquidity, and were relatively passive to the flows occurring in deposit accounts (see, for example, Robinson 1962). This section describes asset management, while Section C.5 deals with the management of liabilities as a means of adjusting loanable funds.

The investment portfolios of the three lending institutions consist of "Treasury bills" and "government bonds." State and local

obligations are included in these categories, so that the bond portion of the portfolio is really not as homogeneous in reality as the name implies in the model. Treasury bill transactions permit lenders to adjust rapidly the composition of their liquid assets (defined as "cash funds" plus bills) and to respond, as well, to relative interest rates. Bond transactions reflect liquidity requirements as well as cash funds and relative returns.

Securities markets in the model serve to allocate transactions in each security among the different market participants. Each financial institution determines a desired purchase rate. If, for example, the Bank wants to maintain a constant stock of bills or bonds, its desired purchases just offset maturing issues. If one of the institutions wants to expand its holdings, desired purchases exceed the replacement volume. For each security, the different desired purchase rates are combined with the desired transactions of the Monetary Authority and Treasury. With Treasury bills, for example, total desired sales by the Treasury are compared with total desired purchases of the other market participants. Securities change hands according to each participant's portion of total desired purchases. If the two sides of the market are equal, each desired purchase rate is realized. If total desired purchases exceed desired sales, short-term demand goes unsatisfied.*23*

*23*The demand and supply for securities are expressed as flows (desired purchase and sale), while the demand and supply of primary loans are expressed as stocks (backlog of loan requests and "inventory" of

This formulation suggests a concept of desired transactions that differs from the usual notion of current demand and supply in the securities markets. Here, the Bank or some other market participant may desire a change in its security holding without necessarily transmitting this information to the securities broker. Thus, demand and supply refer to what an investor will want to transact over some extended period of time (weeks or months) rather than the amount he might tell his broker to buy or sell on some particular day. In the model, therefore, the securities markets do not necessarily match demand and supply at every instant in time.

Government securities are traded in active secondary markets. In the model, however, secondary sales, which could take place between the Bank, Savings Investor, and Mortgage Lender, do not occur. Instead, each lending category can change its security holdings by augmenting desired purchases, and thereby obtaining a larger share of the total volume supplied by the Treasury, or by refusing to replace securities as they mature. This format does not preclude secondary transactions that may occur within the three aggregate lending categories.*24*

An important determinant of each party's desired purchase of

liquid assets). Inventories and backlogs exist in the actual securities markets, but they involve such short delays that an allocation scheme based on relative flows seems appropriate for our purposes.

*24*An earlier version of the model contained explicit secondary transactions, but they entailed more complicated structure and had no significant impact on behavior that could not be produced with the current formulations.

Treasury bills is the discrepancy between the desired and actual cash funds portion of liquid assets. Every asset transaction involves a change in cash funds (excess reserves in the Bank, money in the case of other lenders). When the Mortgage Lender buys a bill, for example, its money stock declines and that of the Treasury increases. When the Bank buys a bill, the Bank credits the seller with a deposit and, thereby, reduces its excess reserve position by a fraction of the new deposits.

Just as the liquid asset pool constitutes an inventory to support lending, the excess reserves or cash component of liquid assets also may be viewed as an inventory required to carry out transactions on a continuous basis. The desired value of this loanable funds inventory is usually a few weeks' worth of loans. When the desired and actual volume of cash funds diverge, pressure builds to correct the imbalance. For example, if excess reserves in the Bank are high, the Bank's purchase of Treasury bills increases, thereby adjusting the composition of liquid assets in favor of bills. If reserves (or money for the others) are short, then the Bank's purchases fall below maturities; the stock of bills declines through maturities, and the funds "inventory" is replenished.*25*

*25*Excess reserves cannot decline below zero, as the Bank can borrow reserves from the Monetary Authority when necessary to meet requirements. Free reserves, of course, can be positive or negative, as was shown in Figure III-6. Many financial modelers emphasize the importance of desired excess or free reserves as a focus of Bank asset management (e.g., Tobin 1959, Meigs 1962, Goldfeld 1966). Whereas our model posits a simple transactions motive for holding excess reserves (or cash for the other institutions), many models causally relate free reserves to various

While Treasury bills provide short-term liquidity, bonds provide a resource that can be converted into more liquid assets, as well as attractive returns and safety from default when loan demand is slack. Hodgman calls this the "residual" function of securities investment (Hodgman 1963, p. 38). That is, given the extent of loan demand and required liquidity, the investment portfolio provides alternatives to holding low-yielding liquid assets. By distinguishing between short-term and long-term securities, the Financial Sector model permits shifts between the liquid (short-term) category and the residual (long-term) category, in response to liquidity needs, relative returns, and expected changes in interest rates. When loan demand is robust, bonds are sold to reconstitute the liquidity buffer. When credit markets are slack and relative liquidity builds up, lending institutions are inclined to accumulate bonds.

Investors in the model derive a desired bond purchase rate which, depending on market conditions, may or may not be realized. In equilibrium, bonds are replaced as fast as they mature. When liquidity is insufficient, however, desired purchases fall below the volume of maturities; bond holdings decline and liquid assets are replenished. The compensating negative loop, shown in Figure III-15, operates like the loop that relates liquidity to lending (see Figure III-9).

other influences. For example, Tobin suggests that desired free or excess reserves might be either positive or negative depending on the relationship between the discount rate and the bill rate (Tobin 1959, Chapter 9, pp. 9-18). As described here and in the section on reserve management, actual free or excess reserves in the model change mainly as the indirect, rather than direct, result of trying to balance off other influences.

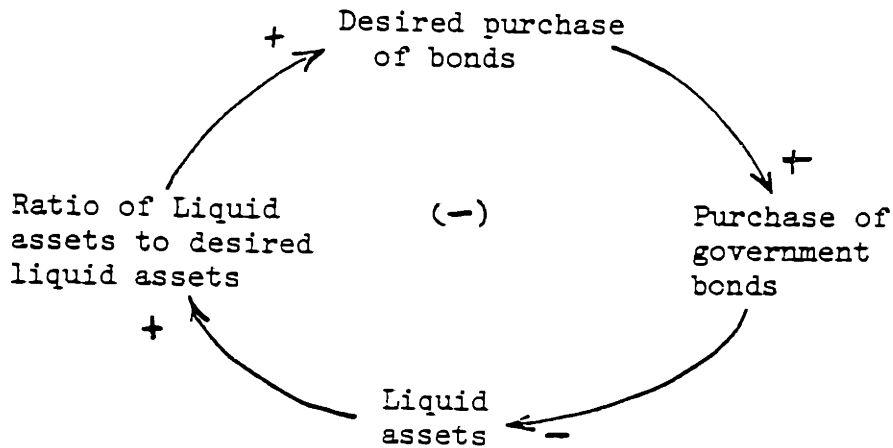


Figure III-15. Negative Feedback Loop Relating Bond Purchases and Liquidity

Although the investment portfolio is managed mainly to accommodate the primary lending function, relative returns have some direct impact on the balance between short-term and long-term securities in the securities portfolio. Crosse and Hempel write, "When the yield curve is sharply ascending, the temptation is strong for commercial banks to confuse the liquidity positions with their portfolios and to lengthen maturities in search of higher returns." (Crosse and Hempel 1973, p. 218). In the model, a yield that is high relative to other (risk-adjusted) yields available to the investor encourages purchases while a relatively low return discourages purchases. As we shall see below, these actions eventually reduce the yield spread. This negative feedback is shown in Figure III-16.

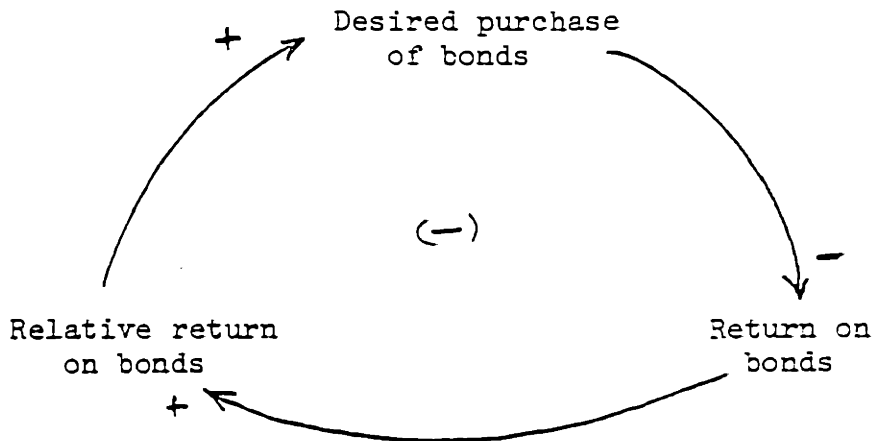


Figure III-16. Negative Feedback Loop Relating Bond Purchases and Current Relative Returns

In assessing the relative return on bonds, lenders compare the "effective" return, rather than the current return, to yields available on other assets. Based on past experience, investors form expectations about future rates. If the expected change in return is positive, for example, investors foresee higher rates and postpone the purchase of long-term securities in order to exploit the expected lower price. This expectations effect does not exert a direct impact on Treasury bill transactions; but given the other pressures on desired security holdings, a sale of bonds based on the anticipation of higher future bond yields frees up funds that, in part, go into Treasury bills.

The securities market not only allocates transactions, but also derives the total demand and supply necessary to determine interest rates. If the demand for Treasury bills, for instance, exceeds the supply, bill rates are pushed up, eventually serving to reduce the aggregate demand for bills. Figure III-17 portrays this negative loop.

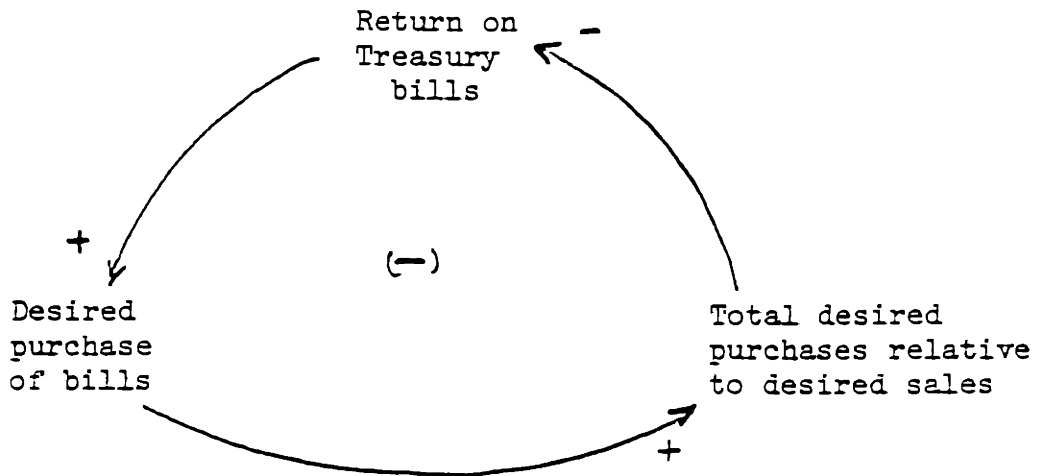


Figure III-17. Negative Feedback Loop Relating Desired Transactions in the Bill Market and the Return on Treasury Bills

Several recent studies emphasize the relative influence of supply and demand in the securities markets. For example, B. M. Friedman states that, in most models, long-term interest rates fail to reflect the way in which participants in the market for long-term securities adjust their actions to movements in short-term rates, the spread between long and short rates, and other determinants of portfolio behavior (B. M. Friedman 1974, p. 1). By treating demand and supply explicitly in each separate securities market, Friedman calculates an endogenous, jointly-determined yield for each security. Bosworth and Duesenberry also compute supply and demand for each of several security categories and relate the returns on securities to conditions in each market (Bosworth and Duesenberry 1973).

While the model described here determines interest rates on the basis of supply and demand in each securities market, many other financial models do not. The Brookings model, for example, permits the algebraic calculation of a short-term rate on the basis of the supply and demand for money and derives a long-term rate from a term structure equation. The MPS model yields a three-month bill rate but contains no explicit supply-demand equations for returns on other government securities. The dependence of long-term rates on short-term markets is based on the theory that the long-term bond rate reflects the average of expected short-term rates over the life of the bond, so that long- and short-term government securities can be considered perfect substitutes. This assumption is probably a useful first approximation of reality. "But once we embark on the task of giving a detailed treatment of the structure of the financial system, there is a strong case for building a model which starts from the beginning with a clearing of markets of particular types of securities." (Bosworth and Duesenberry 1973, p. 44).

5. Liabilities of Lending Institutions

The nature of banking, at least for the big money center institutions, has changed over the past 20 years. Because of rising interest rates and the growing sophistication that has permitted more transactions with smaller money pools, the volume of interest-free deposits and low-yield passbook savings has grown more slowly than the demand for credit. Whereas banks and other fiduciaries once merely gathered low-cost or no-cost deposits, "[t]oday, they must function like

supermarkets, haggling over the price of the money they acquire, attaching a small markup, and then reselling the product to the public." (Rose 1976, p. 174).

As a highly aggregated representation of financial activities, our model does not capture the diversity of liability instruments, such as Eurodollar deposits, certificates of deposit, overnight purchases of federal funds, and "repos" (securities sold under an agreement to repurchase within a day or so). Each lending institution in the model, however, has a "savings deposit" liability which lenders can attract or discourage by raising or lowering the rates they are willing to pay. The Bank adjusts its return on deposits in response to changes in market and other conditions. The long-term lenders adjust their rates more sluggishly. During periods of changing rates, most of the loans on the books of the Corporate Lender or Mortgage Lender have been acquired at an earlier time and at different rates. When rates are rising, therefore, the two institutions cannot quickly raise their portfolio yields in order to offset the higher rates they must pay to obtain funds. Moreover, long-term lenders are often constrained officially from paying competitive rates.

An individual bank can attract time deposits (mainly CD's) fairly quickly, and thereby augment its liquidity. For the banking system as a whole, however, attracting interest-bearing deposits simply encourages the conversion of demand deposits into time deposits. The resulting increase in liquidity for the aggregate, therefore, comes entirely from the lower reserve requirement on time deposits. For

example, if the required reserve ratio is 20% on demand deposits and 5% on time deposits, and if the banking system encourages depositors to convert \$1000 of demand deposits into time deposits, then excess reserves of the Bank will rise by \$150. The freeing of \$150 will permit an expansion of credit amounting to \$750 (assuming all of the new credit stays in demand deposit accounts). In the model, the Bank can encourage such a conversion by changing its return on deposits. If the Bank raises the return, for example, Bank "savings deposits" become relatively more attractive on a yield basis than other securities and encourage a change in the portfolio mix of the Savings Investor (which holds all of the lender's savings deposits).

Lenders control the return on savings deposits, to which the Savings Investor responds when allocating funds among deposits and other asset choices. The influences on this rate include relative liquidity, profitability, and relative interest rate spread. When liquidity declines, due to augmented credit demand, the lender raises the return on savings deposits. A higher return tends to attract savings, thereby permitting a higher rate of lending and a reduction in the loan extension delay. This negative loop is exhibited in Figure III-18. Profitability and relative spreads also exert negative feedback on the savings deposit yield. For example, a low spread between the rate on loans and the rate on deposits, as well as relatively low profitability, encourages a corrective reduction in the return on savings deposits so as to recoup profits.

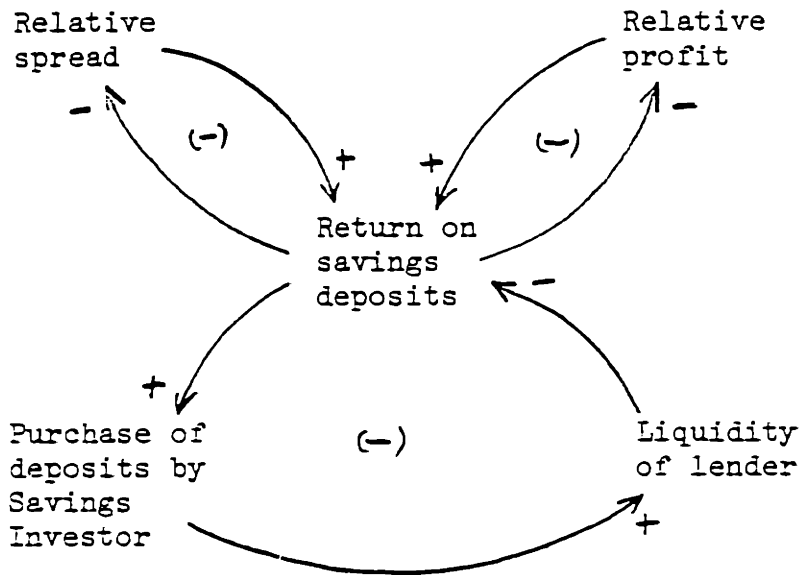


Figure III-18. Three Negative Feedback Loops Influencing the Return on Savings Deposits

In addition to defining the change in savings deposits and in associated returns, the block of equations for liabilities also permits "defaults" on savings deposits, which rise during conditions of extremely tight liquidity. Under normal conditions, of course, depositors are free to withdraw their funds at will.*26*

Finally, the liability equations determine the actual and desired level of equity. Current equity in a lending institution equals the difference between total assets and the non-equity liability accounts (e.g., savings deposits). Desired equity is based on an

*26*Because of Federal deposit insurance, "defaults" (including delayed payments) on savings deposits are largely a thing of the past. The possibility of defaults on deposits is accounted for, however, because of the National Model's long historical perspective.

acceptable ratio of equity to total assets. The actual level is adjusted to the desired amount by means of dividend payments, which are reduced when equity is low and expand when the equity account is high. Dividend payments are also influenced by the amount of cash on hand and the current level of profits.*27*

6. Bank Reserves and Currency

The sources and uses of Bank reserves involve a fair amount of detail in the model. Owned reserves of the Bank accumulate net currency deposits and the value of the Monetary Authority's operations in the securities markets. When deposits are converted into currency, owned reserves decline by the full value of the currency withdrawal. For simplicity, each production and household sector contains a money stock, with no distinction made between currency and demand deposits. To permit currency deposits and withdrawals from the banking system, however, a single stock of currency resides in the Financial Sector, representing the aggregate amount of currency held by the public. Conserved flows exist between the level of owned reserves in the Bank and the level of currency in the public. The two levels and the flow rates that affect them are shown in Figure III-19. At equilibrium, the levels remain constant, as the net value of open-market operations is zero, and currency withdrawals exactly offset currency deposits.

*27*As explained in Chapter VI, equity financing in the National Model could be handled through the dividend payment mechanism, in which case dividends would be controlled not only by pressures within the firm (as described here), but also by factors such as risk and return determined by investors.

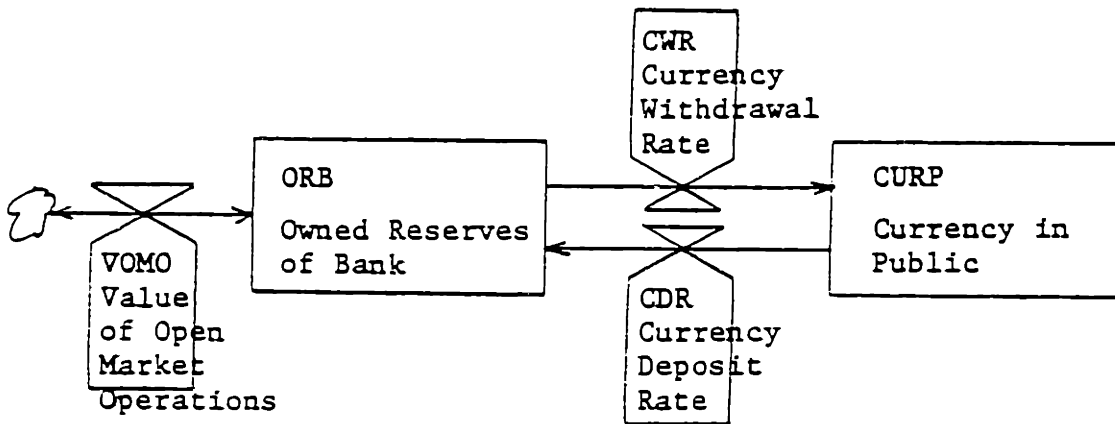


Figure III-19. Conserved Flows Between Owned Reserves and Currency in the Public

The public's desired ratio of currency to money (the sum of currency and deposits) can change over time,*28* and the process of credit extension can create deposits and thereby cause the actual composition of the aggregate money supply to diverge from the desired mix. In both cases, currency deposits and withdrawals no longer remain in balance. Under normal conditions, the two rates that connect the currency and reserve levels reflect only the public's desire to correct for any divergence between the desired and actual composition of the

*28*The desired ratio of currency to money is determined within the Financial Sector, but is held constant at the present stage of development. The ratio will reflect public confidence, mainly in terms of the Bank's past capacity to meet withdrawal demands.

money supply. Under conditions of stress, however, eroding public confidence can cause runs on the banking system which rapidly deplete bank reserves and bring about numerous bank failures. In the model, therefore, an extensive decline in owned reserves restrains currency withdrawals.

The other influence on owned bank reserves, the value of open-market operations, reflects the unique nature of the Monetary Authority's participation in securities markets. When a bank sells a security to a fiduciary institution, its owned reserves remain unchanged. But when a bank sells securities to the Federal Reserve,*29* the bank receives a deposit at the Federal Reserve and, therefore, an addition to owned reserves equal to the value of the security transaction. In like manner, a sale of bills by an individual savings institution to the Federal Reserve results in an increase in deposits at the Fed, which the investor transfers to the banking system when it deposits its check in a commercial bank.

The borrowed component of bank reserves is modeled as if the Bank can always borrow to meet current reserve requirements. That is,

*29*As stated earlier, secondary sales do not occur explicitly in the model. However, if the Monetary Authority wants to purchase more bills, its desired purchase rate rises. Because it now wants to purchase a larger share of the total volume supplied by the Treasury, the Monetary Authority accomplishes an additional purchase at the expense of other participants who obtain a smaller portion. The securities allocation scheme in the model, therefore, causes other participants to purchase less than they otherwise would and, therefore, produces an effect on bank reserves that is equivalent to a secondary sale by the Bank, Corporate Lender, or Mortgage Lender to the Monetary Authority.

whenever owned reserves fall below the required amount, borrowed reserves automatically make up the difference, so that excess reserves in the model ($=$ total reserves minus required reserves) can never be negative. In addition to the borrowing that meets net reserve requirements of the aggregate system, the model implies that there are always individual banks in the system that have to borrow from the Monetary Authority even when the system's net reserve position exceeds the required amount. Therefore, some debt to the Monetary Authority is always outstanding, although the amount is very small when excess reserves of the system are high and can be traded among banks in the Federal Funds market.*30*

Previous sections of this chapter have already shown that Bank lending and investment activities are curtailed as system borrowing from the Monetary Authority exceeds acceptable amounts. Although the model places no direct restriction on borrowing to meet requirements, therefore, it does impose constraints on the activities of the Bank that lead to a need to borrow. This procedure was described earlier and seems to reflect the current Federal Reserve policy described by DePamphilis:

*30*In the Federal Funds market, a bank with a tight cash position can purchase another bank's excess reserves for periods up to a week. Many banks, especially the large money center institutions, are reluctant to borrow from the Federal Reserve and, therefore, depend more often on the Funds market. The Federal Reserve also acts directly in the market by selling government securities in exchange for Federal Funds. Note that a long period of system borrowing does not necessarily mean that any individual bank is in debt for long.

The current policy is to accommodate the initial request for credit promptly. The bank is then placed under 'surveillance' and decisions are made as to the appropriateness of the bank's continued borrowing. If the borrowing for that bank is deemed appropriate, as a result of either the frequency of borrowings or the use of credit, then the Reserve bank engages in counseling activities with the bank. (DePamphilis 1974, p. 44).

Reserve borrowing, in reality, is a privilege that the Federal Reserve can deny. For example, a bank that tries to borrow in order to exploit the difference between the cost of borrowing and the returns it can obtain on investments may not be allowed to borrow from the Federal Reserve. In the model, however, the only direct motive for borrowing is to meet current requirements; and the profit maximizing motive, which the Federal Reserve can rebuff, does not appear. This treatment of borrowed reserves differs from other models, which relate borrowed reserves to borrowing costs (discount rate) and investment yields (usually a Treasury bill rate).^{*31*}

In the MPS model, the discount rate, and behind that the rate on Federal Funds, plays an important role as an indicator of short-term money market conditions. (See Modigliani et al. 1970, pp. 213-217.) In our model, the Federal Funds rate appears, but only as a function of other rates and not as a level that responds to conditions in a separate

^{*31*}Burger's equation, for example, contains a discount rate and the bill rate and implies that borrowing rises when the bill rate exceeds the cost (Burger 1971, p. 67). In the MPS^o model, free reserves (= excess reserves - borrowed reserves) is a function of the discount rate and the return on the investment portfolio, both of which are considered exogenous to the financial system.

funds market. The Funds rate reflects very short-term activities, and is an important input to the Federal Reserve's day-to-day decisions.*32* But, as Behrens shows (Behrens 1975), the National Model structure for monetary control focuses on the instruments that affect basic economic policy over months and years, and does not deal explicitly with day-to-day operations in the Funds market. Although the Federal Reserve runs its short-term trading with an eye on the Federal Funds rate, its longer-term goals relate to overall economic conditions which it attempts to influence through operations in the government securities markets, "counselling" or "moral suasion," and other policy instruments.

In terms of uses, bank reserves may be classified as required or excess. Required reserves simply reflect the required ratios on outstanding demand and time deposits. Excess reserves represent a residual that results from Bank lending and investing. Apart from trying to maintain adequate excess reserves as a part of the liquid

*32*The Federal Funds rate and the rate on Treasury bills vary in relation to each other over the very short term, but over the longer term the two rates are virtually equal. Between 1959 and 1969, the Funds rate averaged only five basis points (0.05%) over the bill rate (Boughton 1972, p. 53), the difference indicating the "non-price" costs of borrowing from the Federal Reserve (p. 45).

assets inventory, the Bank does not focus its attention on excess or free reserves.*33* However, reserves are directly affected by these activities.

*33*In the model, these two reserve concepts are related to rate differentials, lending activities, and the like, but they are not considered the direct focus of Bank decisions. This position conforms to Boughton's view that free reserves and excess reserves are not, from the perspective of a banker, demandable quantities (Boughton 1965, p. 344).



CHAPTER IV. SIMULATIONS OF THE FINANCIAL SECTOR

A. Introduction

1. Purpose of Simulation

This chapter employs computer simulation to explore the behavior of the Financial Sector model. Simulations of a system dynamics model have several purposes. First, one can trace behavior back to specific causal relationships in the model, and, thereby better understand the underlying model structure. More importantly, the model is supposed to represent reality. Simulations, therefore, should also reveal how well the model captures real processes.

Simulations should be used, first, to test the internal consistency of the model. When combined, do the structural components that may seem logical in isolation produce behavior that is consistent with the underlying assumptions? In the model described here, for example, the lending institution is designed to respond to rising loan requests by adjusting its security holdings and liabilities. One would suspect faulty structure if the lender responded to rising demand by lending less and augmenting its government securities. With cyclical adjustments in demand and supply, lending may indeed contract during a period of rising loan demand. But we should make sure, through intuition as well as empirical observation, that this behavior makes sense in light of the assumption underlying each component relationship in the model. As the testing process continues, the discovery of inconsistent results generally leads to improvements in the model.

Simulations also serve to test the correspondence of the model with observed experience. Qualitative conditions, such as extended growth in demand or cyclical fluctuations in business behavior, should give rise to recognizable financial behavior. For instance, the model should produce realistic phasing of changes in loans, GNP, and interest rates. The markets for long-term and short-term credit in the model should generate a recognizable term structure of interest rates. A general squeeze in credit conditions should prove more detrimental to long-term lenders, such as the Mortgage Lender in the model, than to short-term lenders, because an asymmetrical impact of tight monetary policy has been observed in reality. Apart from testing for qualitative behavior, one can assess the model's capacity to match past experience by comparing observed time-series data with time-series produced by the model. Time-series testing is taken up in Chapter V.

Finally, model simulations can be applied to the theories and policy conclusions that arise from other modeling efforts or from informal observation and intuition. With the aid of the Financial Sector, we should be able eventually to study numerous theoretical and policy issues. For example, how important is monetary policy in maintaining economic stability? How does inflation influence interest rates? Would floating interest rates on mortgage loans help to stabilize the housing market? Most of the interesting theoretical or policy questions cannot be dealt with, however, until the Financial Sector and other sectors of the National Model are linked together. The simulations in this chapter, therefore, will focus on the behavioral

implications of the underlying model structure and on qualitative comparisons with observed behavior.

2. Format of the Simulations

Although this study focuses on the Financial Sector, the sector cannot be simulated without some inputs from outside of the sector boundary. Certain explicit inputs, such as loan demand or desired government security sales, must be generated in some reasonable fashion in order to test the dynamic characteristics of the financial structure. While time-series data, which we shall examine in Chapter V, constitute one type of input, more artificial deterministic inputs, such as step or pure oscillatory patterns in loan demand, enable us to focus on the internal structure of financial activities. If we understand the sector's internal stability characteristics, for example, we shall understand better how financial structures contribute to the stability of overall economic activity.

The focus on internal financial structure has led to the development of a "test generator" that represents, in a highly simplified manner, the structure of the non-financial economy. The test generator is described in the next section of this chapter and in Appendix 2. The test equations provide the inputs that eventually will be supplied by the Monetary Authority, the Treasury, and the borrowing public, all of which directly interface with credit markets.

Since the Financial Sector is complicated, involving multiple replications of numerous financial functions, this chapter will describe

relatively simple tests first before activating all four financial institutions. The first test, therefore, involves only the Bank; the other financial institutions do not vary their asset transactions or interest rates. The next three simulations encompass the Bank and the Savings Investor. Subsequent tests treat mortgage lending in isolation, both long-term and short-term lenders together, and, finally, the entire array of financial activities.

Each test starts in equilibrium, a condition where none of the level variables can change without some outside disturbance.*1* "Disturbances" to the equilibrium condition consist of three types of test inputs--steps, pure oscillations, and random, autocorrelated noise. In the first test, for example, the Bank is subjected to a step in desired loans. This step causes the backlog of loan requests to rise, thereby producing expanded Bank loans, security transactions and other adjustments that lead, eventually, to a new equilibrium state. A step input in loan demand or in some other exogenous variable permits one to explore stability characteristics such as the damping of oscillations or the relative phasing of financial quantities as they change over time. Subsequent tests with oscillatory inputs permit an analysis of relative amplitude changes and the phasing or price and quantity adjustments. A noise input brings out the inherent periodicity of the system under

*1*The basic model program contains initial conditions and policy parameters that, when combined with the parameters based on real data, produce an equilibrium condition. Thus, the initial values of outstanding loans and securities in the Bank, though reasonably proportioned, do not reflect banks at a specific date.

study, as well as relative amplitude and phasing characteristics.

3. Description of the Test Generator

The test generator used in this chapter represents in simplified form other parts of the National Model. Nevertheless, the simulations still require over 40 test equations to operate credit extension and government securities markets. The test generator includes six physical levels, each of which affects decisions in the Financial Sector:

- (1) Backlog of loans
- (2) Loans outstanding
- (3) Money
- (4) Savings
- (5) Treasury bills in the Monetary Authority
- (6) Government bonds in the Monetary Authority.

Backlog and loan levels exist for each type of credit. Thus, when testing the Bank or the Bank with the Savings Investor, backlog and loan levels for the two types of long-term credit remain constant, and only the levels associated with Bank loans are allowed to vary. The major test inputs (step, pure oscillations, noise) apply to a desired level of loans. Comparison of desired and actual loan levels, together with a desired and actual backlog of loan requests, produces a correction term which, when added to replacements for maturities, generates loan requests. The basic "ordering" equation for loan requests, without subscripts, appears below:

$$\text{RLTG} = \text{MLTG} + \text{CLBTG}$$
$$\text{CLBTG} = (\text{DLTG} - \text{LOTG} + \text{DBTG} - \text{BLTG}) / \text{TCLBTG}$$

RLTG - REQUESTS FOR LOANS IN TEST GENERATOR (DOLLARS/YEAR)
MLTG - MATURITY OF LOANS IN TEST GENERATOR (DOLLARS/YEAR)
CLBTG - CORRECTION FOR LOANS AND BACKLOG IN TEST GENERATOR
(DOLLARS/YEAR)
DLTG - DESIRED LOANS IN TEST GENERATOR (DOLLARS)
LOTG - LOANS OUTSTANDING IN TEST GENERATOR (DOLLARS)
DBTG - DESIRED BACKLOG IN TEST GENERATOR (DOLLARS)
BLTG - BACKLOG OF LOANS IN TEST GENERATOR (DOLLARS)
TCLBTG - TIME TO ADJUST LOANS AND BACKLOG IN TEST GENERATOR
(YEARS)

Loans and backlog are embedded in the major feedback loops between lender and borrower. The extension of additional credit, for example, causes the backlog to decline and the loan level to rise which, in turn, reduces the flow of loan requests. At the same time, as requests for unrealized loans accumulate in backlog, say because the lending institution cannot obtain sufficient liquidity to meet demand, downward pressure on loan requests is generated. Figure IV-1 exhibits these negative feedback loops.*2*

*2*Note that other feedbacks, such as the depressive impact of higher loan extension delays and interest rates, are not embodied in the test generator, even though these price and availability feedbacks probably exist in reality and are active in the Production Sector of the National Model.

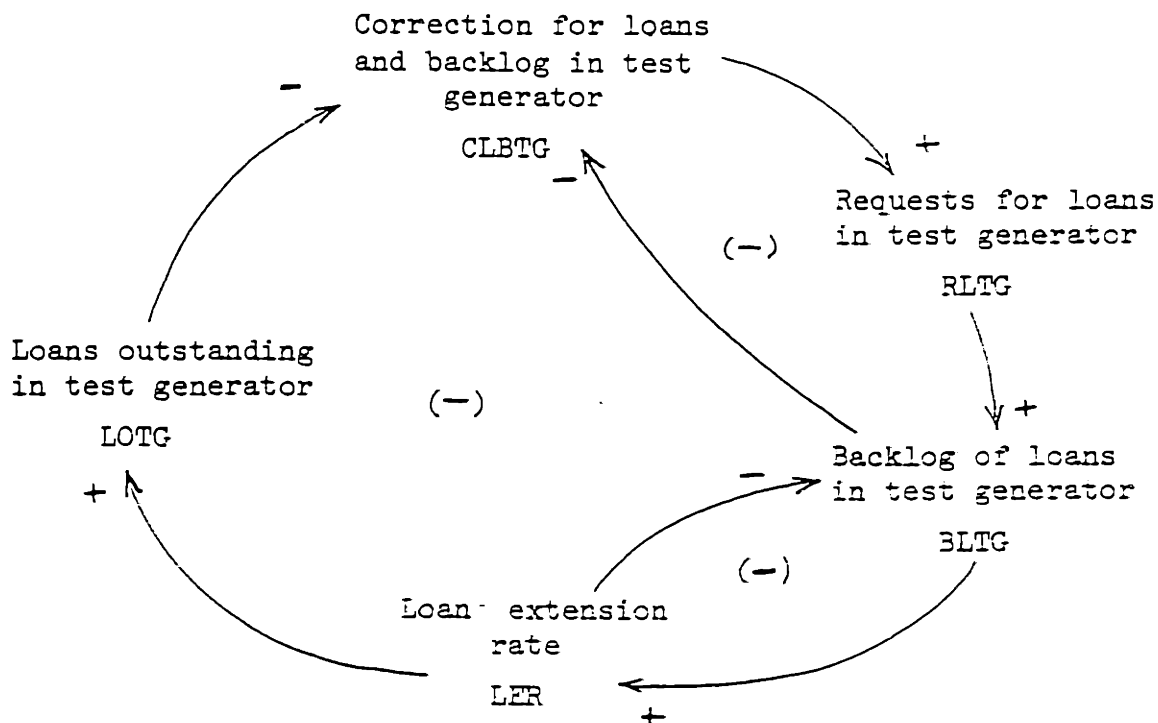


Figure IV-1. Major Feedback Loops between Financial Sector and Financial Test Generator

Assuming the lending institution can meet higher loan demand, loans and backlog will adjust to their desired levels and the correction term will approach zero. The backlog of loans, which first rises in response to higher loan requests, falls back to a new, higher level that is proportional to the higher flow of maturing loans. A step in desired loans in test generator DLTG, for example, could produce the behavior shown qualitatively in Figure IV-2.

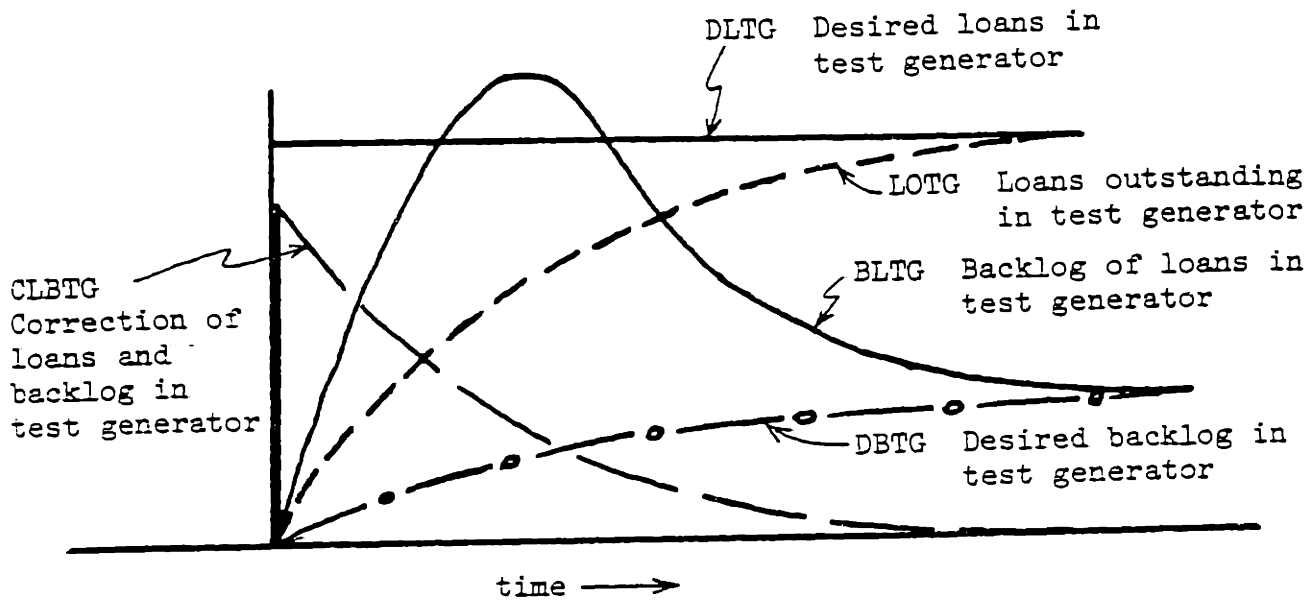


Figure IV-2. Possible Behavior of Loan and Backlog Variables in the Test Generator in Response to a Step in Desired Loans

The test generator contains one money level, which accumulates all the flows related to loan extensions and government security transactions. When the Bank makes a loan, money in the test generator rises (as does its demand deposit component) and excess reserves in the Bank decline. Therefore, a money level is required for the simulations so that the Bank can assess the level of liquidity. When other lenders extend credit or purchase securities from the Treasury, money in the test generator also rises; but total money, and therefore Bank reserves, are not affected, because an equal volume of funds flows out of the non-Bank lending institution.

In the National Model, each production and household sector contains a level of savings. Money set aside for savings directly

augments the money pool of the Savings Investor and, simultaneously, increases the quantity of savings. For the simulations described in this chapter, the savings level is held constant, so that one could eliminate the level variable in the test generator. But a level variable rather than a constant appears in the test generator in order to permit changes in savings for the time-series test described later. Information on savings is required by the Financial Sector in order to generate a weighted return on savings (equal to total earnings on assets held by the Savings Investor divided by total private savings). Eventually, this total return would enter into the savings decisions of household and business sectors.

The two remaining levels in the test generator accumulate the Monetary Authority's holdings of government securities. These levels are required to generate maturities and desired purchases, which eventually affect the value of open-market operations and Bank reserves. For most of the tests, the Monetary Authority holds constant levels of bills and bonds. To investigate the system's response to changing open-market operations, however, the level variables are required.

A final word should be said about the test generator's treatment of Treasury policy, which is reflected in the desired sales of bills and long-term bonds. An appropriate formulation for testing the Financial Sector entails a "neutral" policy on the part of the Treasury. One definition of neutral could be purely exogenous--that is, not responding to actions taken within the sector boundary. A constant desired transactions volume, for example, would be appropriate for tests

with a cyclical loan demand input. But for tests with a step input, a constant volume of desired sales would determine the new equilibrium level of government securities and interest rates, because, in equilibrium, total desired purchases of government securities must equal desired sales. The "policy" of holding desired sales constant, however, is hardly neutral with respect to the Financial Sector.

Tests that employ step inputs to the sector, therefore, do not assume constant desired sales rates by the Treasury, but instead, set desired sales equal to total maturities of the relevant security category. With this formulation, the internal structure of the sector being tested, rather than the (external) Treasury in the test generator, determines the new equilibrium values. Changes in related interest rates and asset holdings result from dynamics within the Financial Sector; the Treasury assumes an essentially passive role.

B. Simulations of the Bank

This section constitutes the main body of the simulation experiments. Bank lending in the model is based on structure that is replicated for all of the three lending institutions, so that simulations of the Bank will cast light on the behavior of the other lenders as well. Moreover, the Bank is unique in being able to create money and in the nature of its cash reserves, which differ from money used in other sectors. Finally, because these experiments with the Bank come first in the set of dynamic simulations, the description will contain more detail than subsequent tests of single or combined financial institutions.

1. The Bank--Step in Loan Demand

The first simulation of the Bank is somewhat rigged to produce a simple dynamic experiment. In response to a 10% step in desired loans, the Bank is prevented from raising deposit rates and, thereby, from attracting additional funds from the Savings Investor. The Bank's only source of liquidity, in addition to maturities on loans and securities and any additional income it can obtain from charging more on loans, is government bonds. As bonds are allowed to mature and are not replaced with new purchases, liquidity rises, thereby permitting additional loans. The Bank relies on asset management, in other words, rather than liability management, to meet its objectives.

In addition to holding both the level of savings deposits and the return on savings deposits constant, the first simulation also holds the yields on government securities constant, even though the Bank's attempt to sell off securities in the face of rising loan demand would cause these yields to rise. To produce simple behavior for the first test, therefore, we artificially hold all interest rates constant except the return on loans. We can examine, thereby, the major influences on lending, the return on loans, and security transactions in a clear and well-organized manner. In the next test, that combines the Bank with the Savings Investor, security yields and deposit rates are permitted to vary, with somewhat more complicated results. •

The first simulation is summarized in four figures, each one

showing a computerized plot of important financial variables over a 20-year period.*3* The following discussion is organized around these figures, which exhibit the behavior of Bank loan variables, interest rates, government securities, and reserves.

Figure IV-3 shows the major lending variables. After six months, desired loans (DLTG) step up by \$15 billion. As desired loans now exceed actual loans outstanding in test generator, requests for loans (not shown in the figure) also step up, and additional backlog of loan requests (not shown) accumulates. The indicated loan extension rate, which is proportional to backlog, rises sharply to a point about \$8 billion above the level that would satisfy the stepped-up loan demand.*4* The loan extension rate equals this indicated rate modified by the multipliers plotted in Figure IV-3, and therefore also rises sharply in response.

*3*Each computer simulation involves a set of parameter changes required to neutralize certain parts of the Financial Sector structure. For the first run, government security yields are prevented from changing by setting TFCR equal to 0; the Bank is prevented from changing the return on savings deposits, by setting TARSD equal to a large number (to approximate infinity); other switches, coefficients, and time constants are specified so that the Bank is isolated from non-Bank institutions. The step in desired loans in test generator SDLTG(1) equals \$15 billion and occurs at TSDL = 0.5. Also for each run I assumed a constant, rather than variable, default fraction on savings deposits (= 0.005). All of the parameter changes for the model simulations appear in tables at the end of this chapter.

*4*The new equilibrium loan extension rate, if desired loans are eventually realized, equals maturities, which in turn equals the initial value of loans (LOTG) plus the step in desired loans (SDLTG), divided by the normal payment time for loans NPTL, or $(148.5E9 + 15E9)/1 = 163.5E9$.

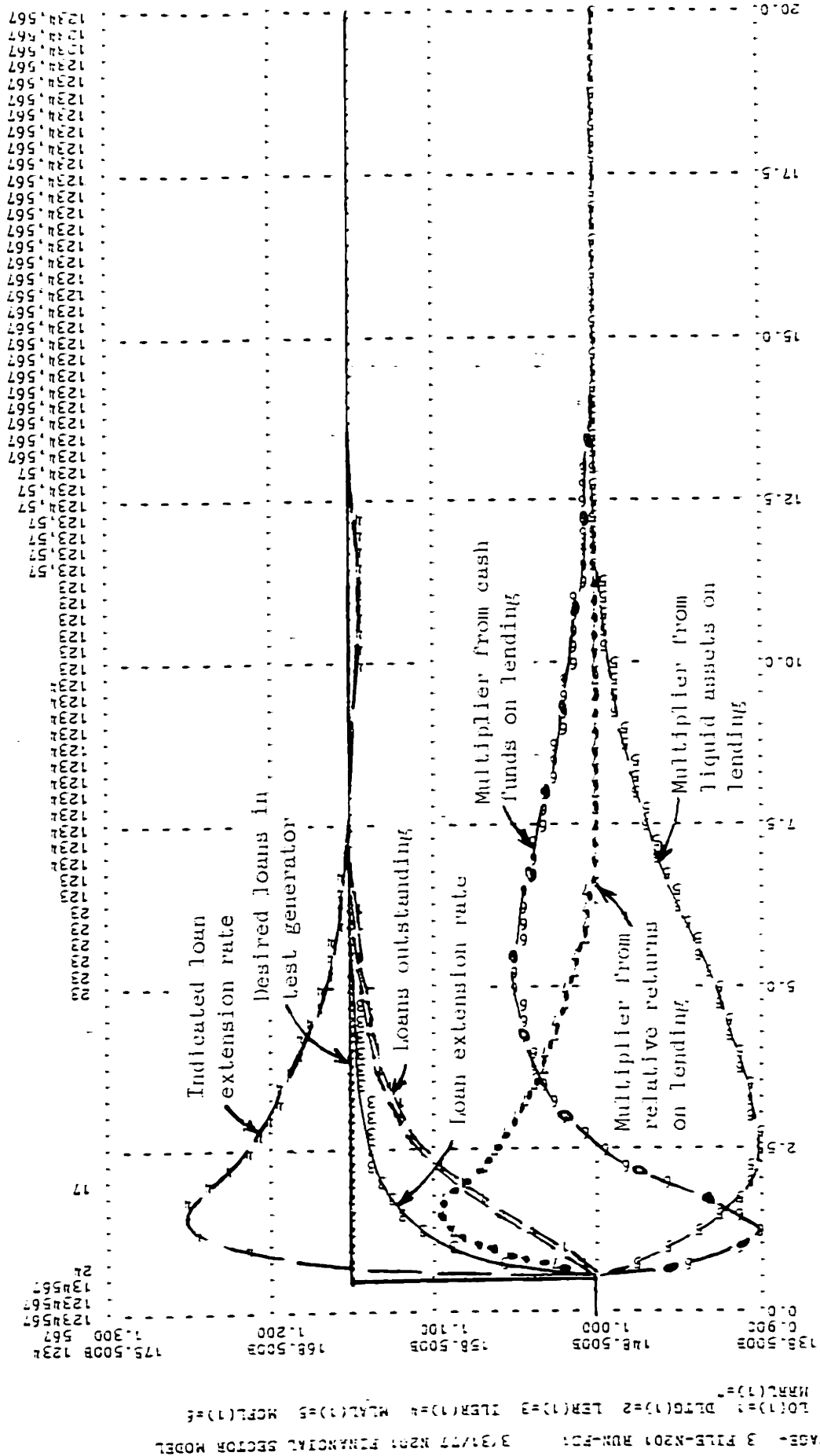


Figure IV-3. Bank lending Variables in Response to Step in Loan Demand - First Simulation

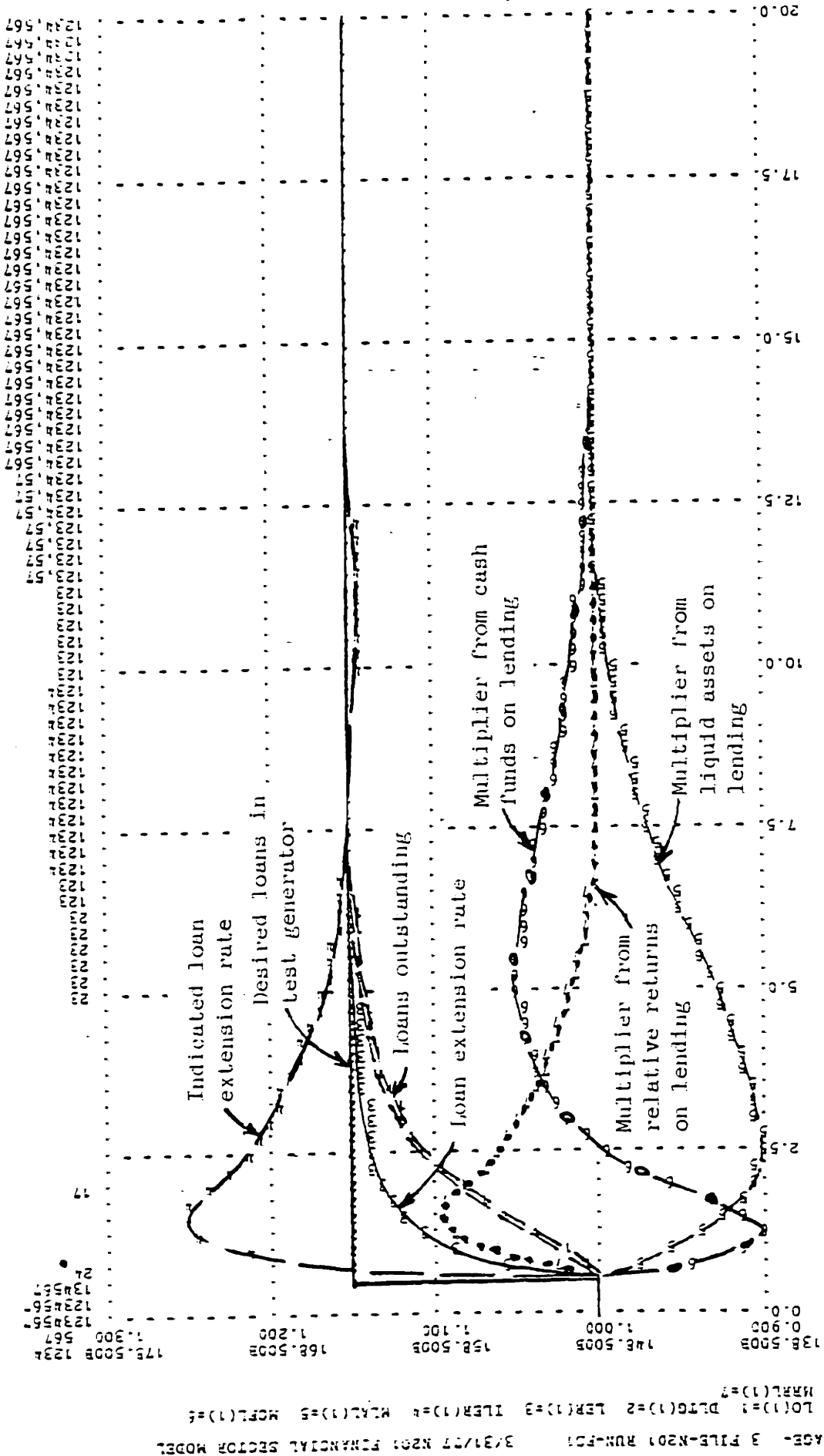


Figure IV-3. Bank Lending Variables in Response to Step in Loan Demand - First Simulation

If it weren't for the constraints imposed by inadequate liquidity (including cash funds), the loan extension rate would rise with the indicated rate and quickly adjust to the new equilibrium amount. However, the initial upward thrust in lending, which rises by over \$7 billion within the first three months, is suppressed thereafter mainly by the resulting drain on liquidity. Liquid assets (not shown) decline by \$4 billion within a year, while desired liquid assets (also not shown) rises rapidly in proportion to the indicated loan extension rate. As a result, the multiplier from liquid assets on lending causes the loan extension rate to fall as much as 8% behind the indicated rate within 1.5 years. Since lending cannot keep pace with demand, the backlog of unsatisfied loan demand, and with it the indicated loan extension rate, overshoots the eventual equilibrium value.

An additional, but less substantial influence serving to restrain lending is the multiplier from cash funds on lending. As we have seen, the availability of cash funds affects all asset transactions, while relative liquidity affects only transactions in non-liquid assets. In responding to higher loan demand, the Bank rapidly creates more demand deposits (not shown in the figure) and, thereby, depletes excess reserves (to which cash funds are proportional). This depresses the purchase of all assets over a short period of time until reserves can be brought back into line. Thus, the multiplier from cash funds on lending declines to 0.9 after six months before rising sharply again.

After two years, in fact, a condition of excess cash funds prevails, despite the overall inadequacy of liquidity. Cash funds (excess reserves) remain high for a long period partly because purchases of loans and bonds, which would help to eliminate the surplus, are suppressed by inadequate liquidity, which, in this run, can be obtained only by reducing bonds and not by attracting deposits. Moreover, since government security yields are constant, they remain unattractive relative to the higher return on loans and, therefore, fail to exert upward pressure on bill purchases that would also reduce excess cash.*5*

Counteracting the restraints already mentioned is the multiplier from relative returns on lending, which rises because of the higher return on loans outstanding. The return, which is shown in the next figure, rises precisely because the Bank has been unable to meet demand.

After about two years, liquid assets begin to rebuild, as we can see from the turn in the multiplier from liquid assets on lending. As already stated, the Bank is precluded from raising deposit rates and thereby selling more savings deposits. Therefore, government bonds

*5*In addition, since the Treasury's desired sales of bills equal maturities only, the Bank's capacity to increase its bill holdings depends on the multiplier on purchase of Treasury bills MPTB, which permits purchases to exceed desired sales by only a small amount and therefore restricts the speed with which the Bank can raise its bill portfolio.

provide the major source of additional liquidity, with some inflow of funds resulting from the higher earnings on outstanding loans.*6* Because liquidity begins to rebuild, the loan extension rate can continue its steady approach to the higher equilibrium value. At the same time the backlog and indicated loan extension rate decline slowly toward equilibrium. Loans initially expand abruptly and almost reach the desired level within 1.5 years. The liquidity restraint and the speed with which the bond portfolio declines, however, prevent loans from fully stabilizing until about the seventh year.

Figure IV-4 exhibits variables related to the return on loans outstanding, the only interest rate that is permitted to vary in the first simulation. As we have seen, three factors influence the return on loans (as well as the average return on assets): relative loan extension delay, relative profitability, and the relative spread between interest rates on assets and the cost of deposits. Each influence affects the desired return to which the actual returns adjust.

The loan extension delay, which reflects credit market conditions, constitutes the dominant pressure on the Bank's interest

*6*Note that liquid assets in the Bank equal a multiple of excess reserves plus Treasury bills (see Equation 7 in Appendix 1). A reduction in bonds, therefore, does not result in a flow of money to the Bank but, rather, causes money of the Treasury (contained in money in test generator MTG) to decline. This lower level of money, and therefore demand deposits, reduces required reserves, raises excess reserves, and therefore raises liquid assets and cash funds of the Bank. Similarly, when borrowers pay interest on loans, their checking accounts are debited by the bank; deposits and required reserves decline and excess reserves and Bank liquidity rise.

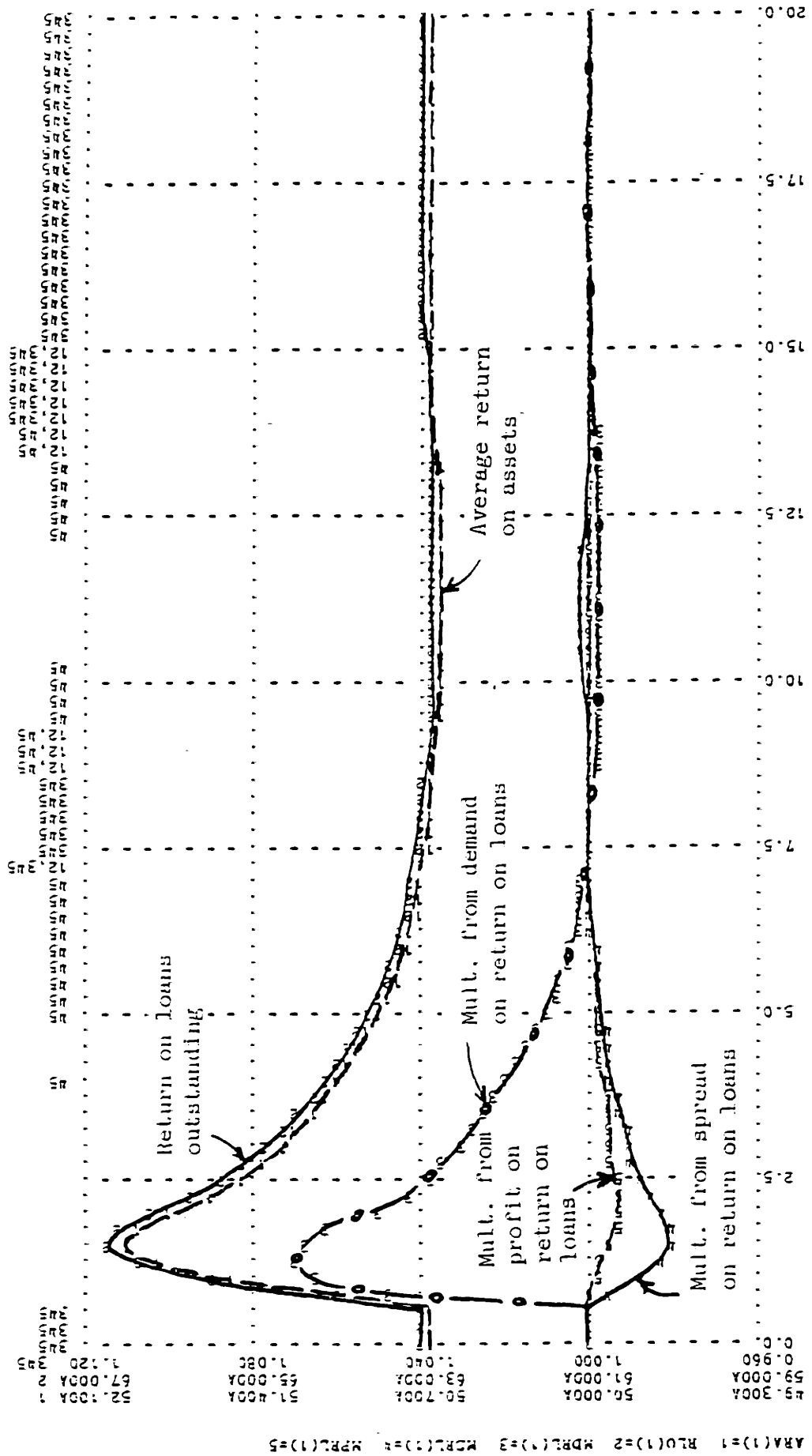


Figure IV-4. Return on bank loans in response to Step in Loan demand - First Simulation

rate. The loan extension delay (not shown in the figure) rises initially because of the accumulation of unrealized loan requests. Within nine months, the loan extension delay reaches a peak about 7% higher than its normal value of three months (0.25 year). As a result, the multiplier from delay on return on loans rises to about 1.07. In other words, excluding other forces discussed below, the return on loans would rise by 7% within a year*7* (because of the impact of the "delivery delay" on loans). Profitability and relative interest rate spread, however, provide counteracting pressures, which build up as the return on loans rises. As demand conditions cause banks to raise their charges, the spread between loan and deposit yields, as well as bank profits, expands. Relative to the acceptable rate spread, the current spread rises during the first year, as long, in fact, as the return on loans increases. As the spread expands, downward pressure is exerted on the interest rate. As the spread rises, so does profitability, which includes the higher earnings on a growing level of loans that yield expanded revenues to the Bank. Together, the impact of profit and spread partially offset the influence of loan extension delay. After about one year, the pressures on the loan yield start to diminish and the multipliers slowly return to 1. As loan demand is realized, then, the return on loans moves back to its original value of 6.3%, after

*7*The time to adjust return on loans outstanding TARLO is equal to 0.3. Within three adjustment times, or about one year, the return would adjust to its desired level.

having risen as high as 6.7%. As no other returns in this simulation are permitted to change, only the original value of 6.3% provides the acceptable ratios of profitability and spread that are consistent with a new equilibrium.

The adjustments in securities that permit the Bank eventually to meet loan demand are displayed in Figure IV-5. As we saw earlier, lenders can vary security holdings by purchasing more or less than the replacement volume. As bills or bonds mature and are not replaced by purchases, the total holding declines. The desired purchase rates are modeled in a similar fashion, and respond to available cash funds, liquidity (in the case of bonds) and relative returns. Figure IV-5 shows that both bills and bonds decline in response to the step in loan demand. As lending rises, the Bank's cash funds (not shown here) decline. Because these effective cash reserves now constitute a smaller-than-acceptable component of total liquidity, the multiplier from cash on Treasury bills falls to a low of 0.89 within nine months. At the same time, a rising rate of return on loans, compared with the constant bill rate, decreases the relative attractiveness of bills and provides additional, though less intense, downward pressure on bill purchases. Both forces cause bill holdings to decline initially by about \$4 billion (over 25%) within two years.

Thereafter, however, bills begin to accumulate slowly toward a new, higher level, as the Bank rebuilds its liquidity to accommodate the expanded lending activity. The source of this turn-around and expansion in liquidity can be traced to the net sale of government bonds. Within

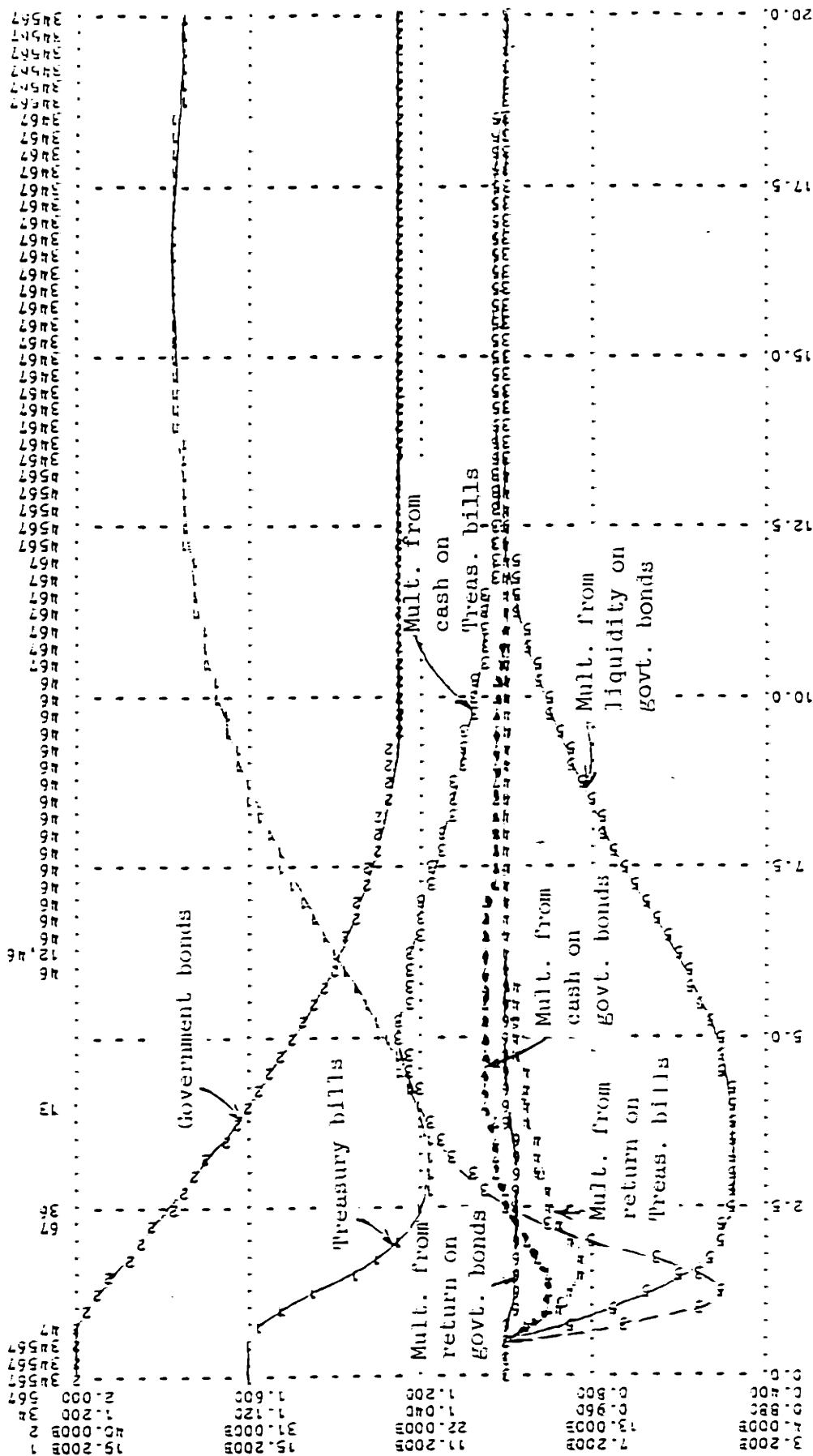


Figure IV-5. Bank-Held Securities in Response to Step in Loan Demand - First Simulation

two years of the step in demand, bond holdings are down by \$5 billion. When bonds are allowed to mature, the Treasury's money supply, represented in the pool of money in test generator (not shown in the figure), declines by the same amount. This reduction in total money frees up Bank reserves, thereby augmenting effective cash funds of the Bank by roughly the amount of the decline in bonds. Rising cash funds quickly redress the composition of Bank liquidity, equal to effective cash funds (proportional to reserves) plus bills, and thereby drives the multiplier from cash on Treasury bills from 0.89 to a peak of 1.05. Within two years of the worst cash squeeze, then, aggregate bill holdings for the banking system start to rise. The excess of actual effective cash funds over desired cash funds (not shown) peaks at about 16% and then gradually declines.

Although bills start to rise, bond holdings continue their steady decline. Within two years of the step in loan demand, net bond sales have eased the pressure on liquidity, and the multiplier from liquidity on government bonds starts to rise. For twelve years, however, liquidity remains below the desired amount. So inadequate liquidity, plus the relatively unattractive (constant) bond yield, causes bonds to fall, but at a decreasing pace. Eventually, bonds decline by almost \$17 billion, thereby permitting a \$15 billion expansion in loans and an additional holding of liquid assets.

Figure IV-6 traces the time plots of Bank reserves. Excess reserves, though a tiny fraction of total bank assets (about 0.1% at the

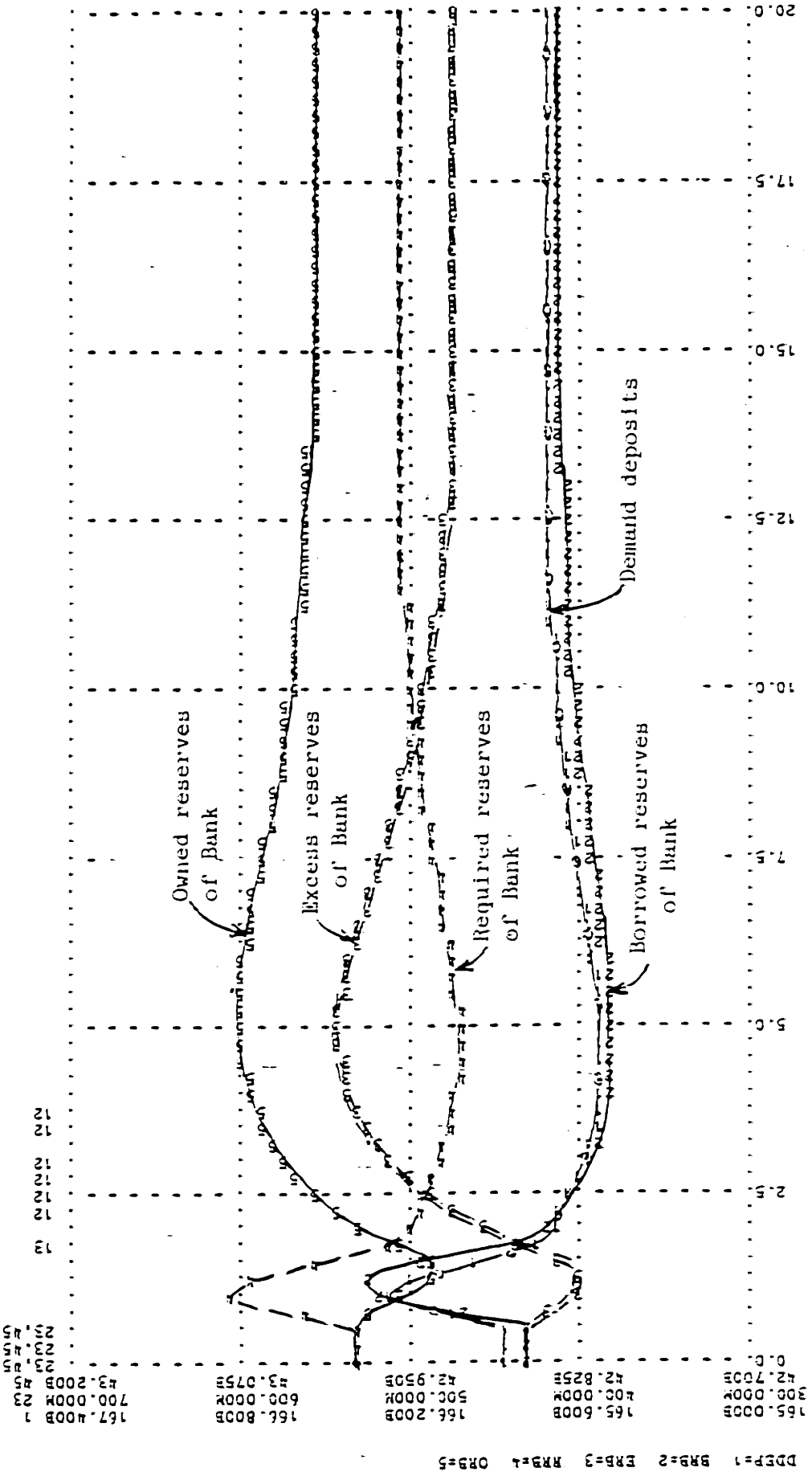


Figure IV-6. Bank Reserves in Response to Step in Loan Demand - First Simulation

end of 1975), constitute a widely accepted channel for official monetary policy and an important component of a bank's capacity to make loans. When net lending rises, total money supply, and therefore demand deposits, also expand. The figure shows that demand deposits rise in the simulation, but only by \$0.7 billion, before declining to a level slightly below its initial value. That is, even though loans rise eventually by \$15 billion, the total money supply hardly changes at all.*8* As the Bank's bond holdings decline, loans advance. In effect, the Treasury has permitted its money supply to decline so that private borrowing can expand. The economy's overall debt composition has changed in favor of the private sector.

Required reserves of the Bank move in phase with total demand deposits, as the Bank is required to hold a fraction of demand deposits (22% in the model) as reserves. Because demand deposits first rise, required reserves and therefore borrowed reserves expand by about \$0.15 billion. The subsequent reduction in required reserves is roughly, but not exactly, mirrored by changes in excess reserves. As explained in the equation description, excess reserves are influenced by the amount of owned reserves and by borrowed reserves, as well as by

8 Demand deposits end up slightly below (less than \$0.2 billion) the initial amount because the Bank needs a somewhat higher volume of cash funds (excess reserves) to support its expanded lending. To provide the added excess reserves, total demand deposits of the government (included in the pool of money in test generator) must decline, through reductions in the bond account, by more than the amount of new primary bank loans.

changes in reserve requirements.

In Figure IV-6, owned reserves decline at first, then rise above the initial value before gradually coming back to the new equilibrium amount. Except for a short lag that permits the public to adjust the ratio of currency to money, the movement in owned reserves mirrors the behavior of demand deposits. Initially, total money (not in figure), and therefore demand deposits, rises by about \$0.7 billion because of higher lending. Since the public wishes to hold a constant portion of money as currency, this portion ($= \text{DRCM} = 0.2$) of the higher money level is withdrawn from the Bank and thereby reduces owned reserves over a short adjustment time. When total money falls, the public deposits currency so as to maintain the desired composition of money; and owned reserves rise again. During the entire run, open-market operations, the only other influence on owned reserves, are held constant and have no impact.

Excess reserves also reflect borrowed reserves. At first, borrowed reserves climb sharply by about \$100 million and then decline again along with required reserves. On balance, the initial decline in excess reserves equals the reduction in owned reserves (approximately \$60 million on the plot) plus the rise in required reserves (\$75 million), less the expansion in borrowed reserves (\$100 million), or about \$70 million.

To complete this treatment of the first simulation, Table IV-1 exhibits balance sheets for the Bank before and after the transient response to stepped-up loan demand.

Table IV-1
 COMPARATIVE BALANCE SHEETS OF THE BANK--FIRST SIMULATION
 (\$ billions)

<u>Assets</u>	<u>t=0</u>	<u>t=40</u>	<u>Liabilities</u>	<u>t=0</u>	<u>t=40</u>
Reserves	43.4	43.4	Demand deposits	165.9	165.7
Treasury Bills	15.2	16.7	Savings deposits	65.0	65.0
Gov't bonds	40.0	23.3	Borrowed reserves	0.4	0.4
Loans	<u>148.5</u>	<u>163.5</u>	Equity	<u>15.8</u>	<u>15.8</u>
	247.1	246.9		247.1	246.9

At the new equilibrium, loans outstanding equal \$163.5 billion. Bonds, however, have fallen by \$16.7 billion, whereas one might have expected the decline to match the \$15 billion increase in desired loans. Most of the \$1.7 billion difference (\$1.5 billion) has gone into maintaining a higher level of liquidity commensurate with the higher lending rate. Thus the Treasury bill account exceeds its initial value while excess reserves are high enough so that the Bank's effective cash portion of liquidity attains the desired level. The remaining \$0.2 billion in the decline of the bond account offsets the previously explained decline in demand deposits.

The preceding discussion was designed mainly to relate a portion of the model to its behavior and to familiarize the reader with the basic dynamics of asset management in banking. The conditions of the test were somewhat artificial, but the simulation represented the way in which the banking system uses its securities portfolio to accommodate primary loan demand. For a qualitative comparison with

recent experience, consider the chart in Figure IV-7.*9* During 1973-74, when loan demand was rising sharply, total bank credit expanded by 32% while total security holdings rose by only 6%. Most of these securities were long-term bonds which actually declined during much of the two-year period, despite the overall growth trend in money supply, economic activity, etc. As loans leveled off during 1975, the bond account expanded by over 10% during the first six months, and then also leveled off.

*9*The chart is based on data supplied in various FRB Bulletins. Total bank loans and investments are shown directly in the Bulletin. The division of total securities into short-term and long-term categories is based on data showing bank holdings of government securities by maturity (< 1 year and > 1 year) and on the assumption that 8% of the remaining securities were short-term (which was approximately the short-term portion of total outstanding state and local securities during recent years).

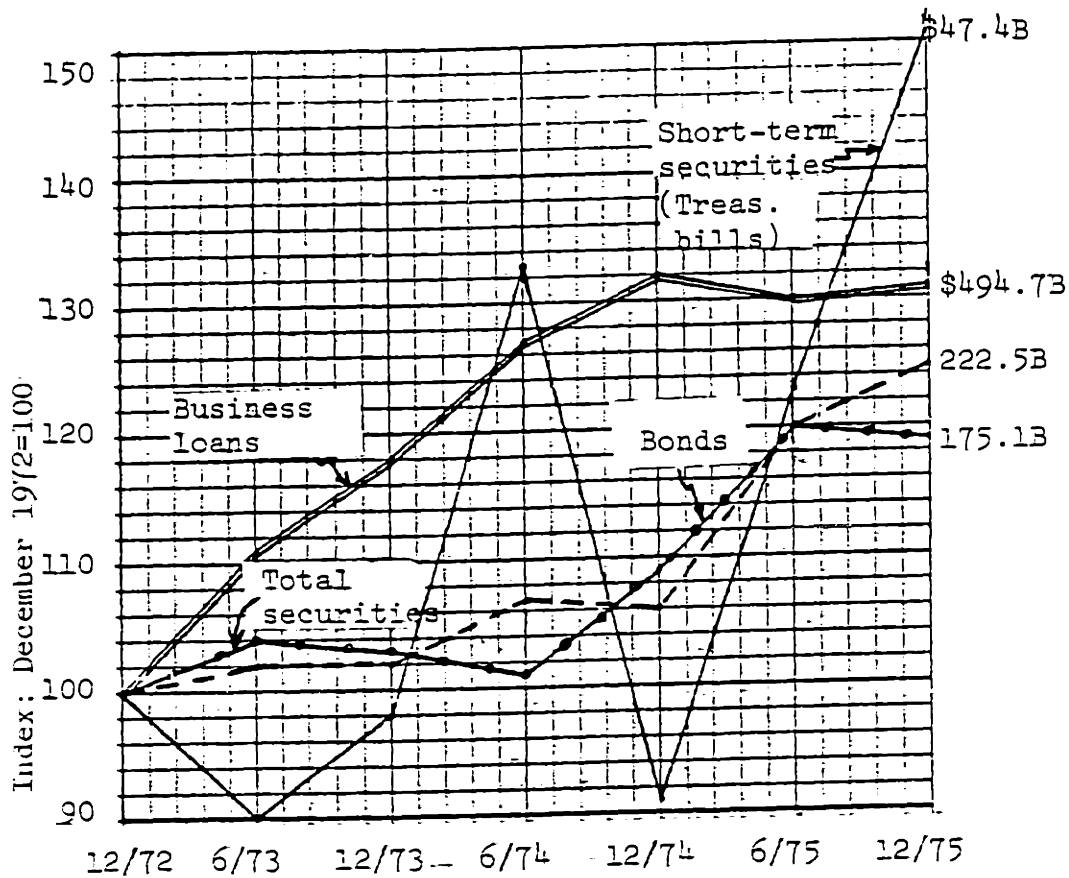


Figure IV-7. Bank Assets During 1972-1975.

This pattern in bond holdings is consistent with the theory and behavior of the Bank model, whose bond account declined in the first simulation to provide liquidity for primary lending. If liquidity had continued to flow into the Bank after the higher loan demand had been satisfied, the bond account also would have risen to take up the slack just as actual bond accounts rose during early 1975.

The Treasury bill account in Figure IV-7 is more volatile than the bond account. Although no close parallel can be drawn between the behavior of bills in the rather artificial model run and in reality over

the last three years, the general patterns are consistent. In the model (see Figure IV-4) Treasury bills first declined as liquidity was drawn down to permit a higher lending rate. Later, after loans started to level off, bill holdings rose as the Bank attempted to replenish its liquid assets. In Figure IV-7, bills also fall as bank credit rises during early 1973, and they rise sharply in 1975 when loan demand falls off. The pattern in 1974, when contrasted with the movement in bonds, is not reflected in the model, but seems to have more to do with relative returns on securities, which were not allowed to change in the first model run. The next simulation, however, will reflect the richer behavior that results from permitting investment returns to vary.

2. The Bank and Savings Investor--Step in Loan Demand

In the second model simulation, the Bank is combined with the Savings Investor to permit the Bank to manage both its assets and its savings deposit liabilities. As we saw in the first run, the Bank could adjust its securities portfolio so as to accommodate primary loan demand. But Bank savings deposits, as well as interest rates on deposits and government securities, were held constant. In the second run, the Bank can raise liquidity not only by reducing its bond portfolio, but also by attracting deposits from the Savings Investor. Other things being equal, the Savings Investor is encouraged to raise Bank deposits when the return on deposits exceeds the risk-adjusted returns on other holdings (government securities and savings deposits in other lending institutions).

In this run, however, other factors enter the Savings Investor's portfolio decision. First, interest rates on bills and bonds are permitted to change in response to the Bank's security transactions as well as those of the Savings Investor. As the Bank's holdings of government bonds are depleted, for example, the return on bonds rises and competes with the yield on Bank savings deposits. Second, the Savings Investor's cash portion affects its purchase of other liquid assets, which include savings deposits and Treasury bills. Thus, the conditions for this run are more complicated than before, in that two financial institutions are active, rather than just the Bank. The other two lenders, however, are totally passive. They cannot change their deposit returns, which enter into the Savings Investor's decisions; they maintain constant levels of deposits; and they hold a constant lending rate.*10*

Figure IV-8 shows time plots of major balance sheet items for the Bank over a 20-year period. In response to the same \$15-billion step in desired loans that we saw before, most of the adjustment to a new equilibrium occurs over the first 10 years. The behavior of this run differs from the previous case by exhibiting an overshoot in loans and securities. As we shall see later, this additional instability reflects the Bank's capacity to raise savings deposits, as well as

*10*To run this model configuration, the test generator parameters are the same as before. Now, however, the coefficient for testing financial sector CTFS equals 1 for both the bank and the Savings Investor (CTFS(2) = CTFS(3) = 0 as before).

PAGE- 6 FILE-N201 RUN-F52 4/02/77 N201 FINANCIAL SECTOR MODEL

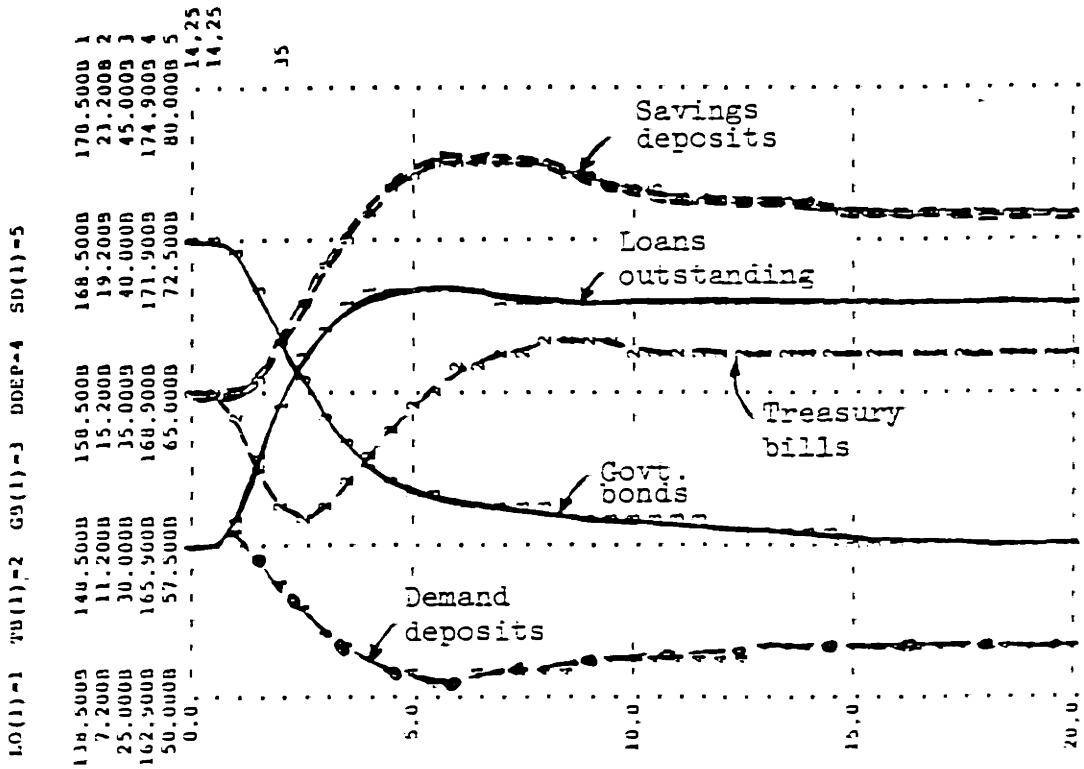


Figure IV-8. Bank Balance Sheet Variables in Response to Step in Loan Demand - Second Simulation

variations among alternative interest rates.

By attracting deposits as well as reducing bonds, the Bank produces a balance sheet after the transient period that looks different from the one shown earlier. This new balance sheet appears in Table IV-2.

Table IV-2
COMPARATIVE BALANCE SHEETS OF THE BANK--SECOND SIMULATION
(\$ billion)

<u>Assets</u>	<u>t=0</u>	<u>t=40</u>	<u>Liabilities</u>	<u>t=0</u>	<u>t=40</u>
Reserves	43.4	44.0	Demand deposits	165.9	163.6
Treasury Bills	15.2	16.5	Savings deposits	65.0	74.8
Gov't bonds	40.0	30.3	Borrowed reserves	0.4	0.4
Loans	<u>148.5</u>	<u>164.3</u>	Equity	<u>15.8</u>	<u>16.3</u>
	247.1	255.1		247.1	255.1

Unlike the comparison in the first run, total assets in Table IV-2 have risen by \$8 billion rather than returning to their initial value. Instead of relying entirely on reducing the government bond account to meet expanded loan demand, the Bank simultaneously reduces bonds and increases savings deposits (by raising the return on deposits). Bonds decline, therefore, by about \$10 billion, rather than \$17 billion as before, and savings deposits increase by almost \$10 billion. Most of the proceeds end up in the expanded loan account, which grows by \$15.8 billion. If the only net change in Bank liabilities were the \$10 billion growth in savings deposits, then we would see an equal expansion in total assets. The final increase,

however, is about \$8 billion, reflecting the growth in loans and the decline in bonds, plus somewhat higher bill holdings and reserves. Offsetting part of the growth in savings deposits is a \$2.4 billion decline in demand deposits, due, as we shall see, to the actions of the Savings Investor.

Changes in the asset holdings of both Bank and Savings Investor show that the economy, as before, has basically shifted its debt composition from public to private obligations. In addition to changes in government securities of the Bank, Treasury bills in the Savings Investor decline by about \$6 billion, thereby reducing government debt by about \$15 billion and permitting a similar rise in Bank credit. Because total savings are held constant here, some asset of the Savings Investor, other than bills, must decline by \$4 billion so as to permit the \$10 billion expansion in Bank savings deposits. In fact, because non-bank deposits are also held constant, only changes in cash funds and government securities of the Savings Investor can make room for the higher level of deposits. As shown in Table IV-3, the Savings Investor switches cash and bills for savings deposits, all forms of liquid assets. Bonds end up at their initial level.*11* The reduced cash, in turn, accounts for most of the decline in demand deposits on

*11*In equilibrium, given the nature of the test configuration, bonds held by the Savings Investor must equal the initial level. Appendix IV-2 provides a discussion of equilibrium conditions for the combination of a lender (in that case, the Mortgage Lender) and the Savings Investor, given the same formulations in the test generator as prevail in the simulation of Bank and Savings Investor.

the Bank's balance sheet; for expansion in the privately-owned money supply, through higher lending, offsets the decline in government-owned funds.

Table IV-3
COMPARATIVE BALANCE SHEETS OF THE SAVINGS INVESTOR--
SECOND SIMULATION (\$ billion)

<u>Assets</u>	<u>t=0</u>	<u>t=40</u>	<u>Liabilities</u>	<u>t=0</u>	<u>t=40</u>
Cash	13.0	9.1	Total savings	477.9	477.9
Treasury Bills	40.0	34.0			
Gov't bonds	70.0	70.0			
Savings Deposits:					
- Bank	65.0	74.9			
- Corp. Lender	126.3	126.3			
- Mort. Lender	153.6	153.6			
Equity (nominal)	10.0	10.0			

Figure IV-9 exhibits the major loan variables plotted over 20 years. During the first 2.5 years, the behavior looks similar to the behavior of the first run, where the Bank could obtain new liquidity only by letting bonds mature (and earning a higher return on loans). In response to the step in loan demand, lending expands rapidly during the succeeding quarters and thereby depletes cash and liquidity. Cash funds (not shown in the figure) fall during the first three quarters, thereby suppressing the lending rate, but then move sharply up again through adjustments in the Treasury bill account. Liquid assets (also not shown) fall during the first two years, causing the multiplier from liquid assets on lending to restrain the loan extension rate to 7.5% below the indicated rate.

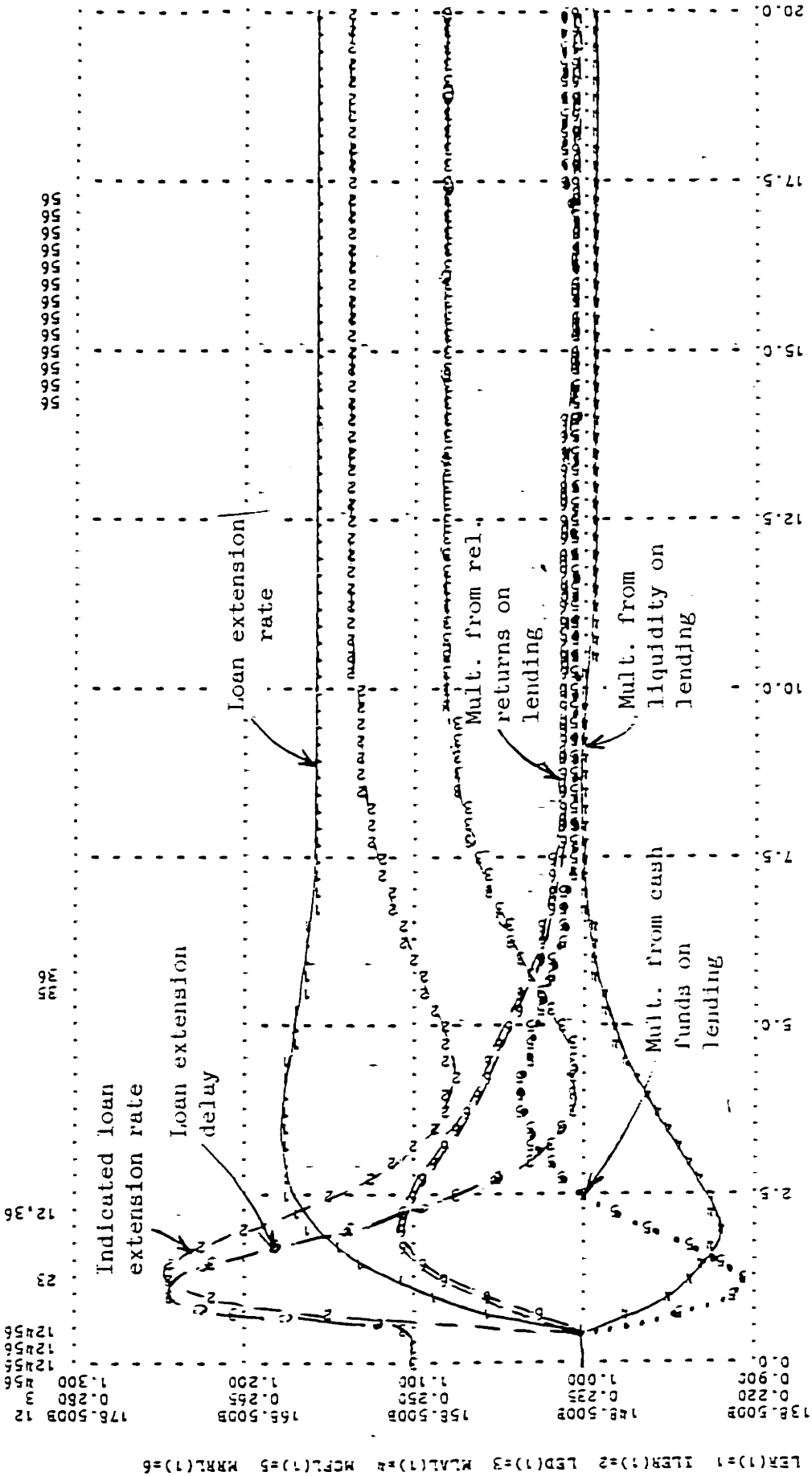


Figure IV-9. Bank lending variables in Response to Step in Loan Demand - Second Simulation

The restraint from insufficient liquidity is not as great as before, because during the first two years, the Bank obtains liquid assets from an expansion in savings deposits as well as from reduced bond purchases. Thus liquid assets fall by less than in the previous run. Subsequently, liquid assets rise faster because of the growth in savings deposits, so that desired and actual levels of liquidity are equal by year 7 (versus 12.5 before). At this point the multiplier from liquid assets on lending equals one and actually exceeds one by a slight amount during the next five years.

As explained earlier, this simulation differs from the first because of the Bank's capacity to change savings deposit rates and thereby attract funds from the Savings Investor, and because government security rates are also permitted to vary. The effect of a higher deposit return on Bank liquidity and, thereby, on lending, has been described. The impact on lending of variable rates on deposits and securities also can be seen in Figure IV-9. The multiplier from relative return on lending rises after two years to over 1.1, thus exerting considerably more upward pressure on lending than before, when the multiplier rose to a (earlier) peak of 1.1. Some of the factors that lie behind the behavior of this multiplier are exhibited in the next figure and will now be explained.

Figure IV-10 shows the return on loans outstanding and four other related variables. Compared with the previous simulation, the return on loans peaks higher (over 7.9% versus 6.7%) and later (at

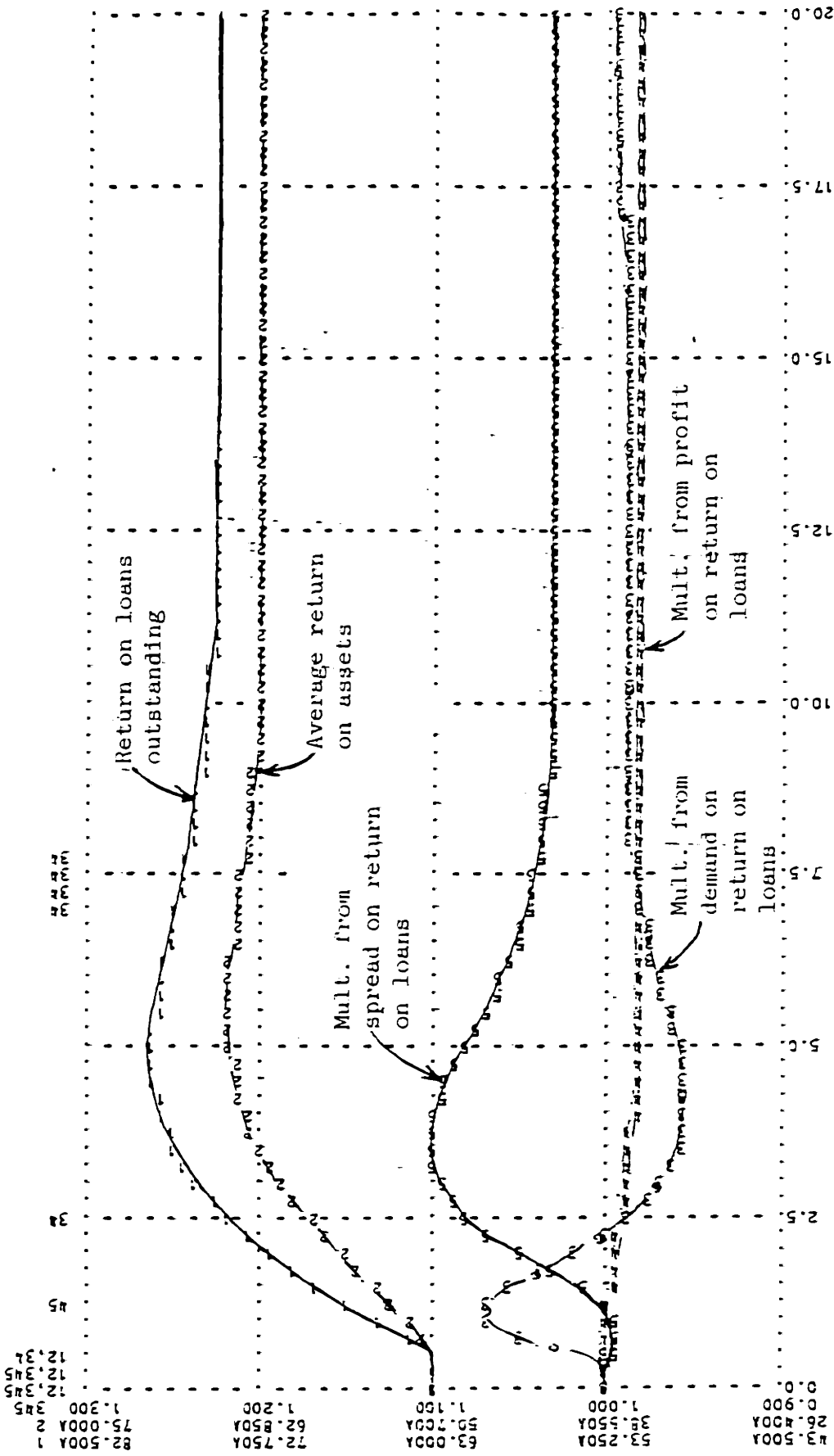


Figure IV-10. Return on Bank Loans in Response to Step in Loan Demand - Second Simulation

$t = 4.75$ versus $t = 1.5$). The higher peak value reflects two factors: the average return on assets and the return on savings deposits. The average return on assets in the figure lags the return on loans slightly, reflecting the phasing of government security rates that enter into the calculation of average return. If no other influences on loan rates were active, the return on loans would adjust over the short adjustment time ($= 0.3$ years) to the average return on assets (plus the constant risk and cost premium on loans). Thus, as the Bank sells off securities to meet loan demand and the Savings Investor reduces securities so as to increase savings deposits, interest rates rise, thereby encouraging loan rates to rise as well.

Other factors, however, cause the return on loans to peak before the average return on Bank assets. Initially, lending cannot keep pace with demand and the loan extension delay rises. Within two years, however, relative demand is more than satisfied; the delay falls below its normal value; the multiplier from demand on return on loans declines and stays below one. At the same time, however, the Bank has raised its return on savings deposits and thereby cuts into the spread between what the Bank can earn and what it must pay out for deposits. As a result, the multiplier from spread rises to a peak of 1.1, thereby causing the return on loans to keep rising. As the return rises, the spread declines. Simultaneously, the return on savings deposits (not shown here) rises less rapidly as the Bank regains liquidity, while the average return on assets keeps rising. The influence of the reduced

spread, therefore, peaks out well ahead of the return on loans (about one year).

The impact of profitability is weak for the Bank. Although the Bank raises deposit rates by a higher fraction than loan rates, the pool of outstanding loans exceeds the pool of deposits. Thus relative profitability rises even as the spread declines, and the multiplier from profit exerts some downward pressure on loan rates.

In addition to peaking at a higher level, the return on loans peaks later than in the first run because of the upward movements in other interest rates. Bill returns and bond yields rise over a five-year period. Initially, both the Bank and Savings Investor purchase fewer securities than the Treasury wants to sell, causing yields to rise. Even though Bank-held Treasury bills bottom out in the third year, bills in the Savings Investor, as well as bonds in both institutions, keep falling for about three more years, thereby driving rates up.

Relative returns in Figure IV-9 favor loans over government securities, although the peak in the multiplier from relative returns on lending occurs about two years before the peak in the return on loans. Following both plots out 20 years reveals that, while liquidity and cash eventually adjust to their desired levels, the return on loans remains

relatively attractive and sustains a loan extension rate and loan level that exceed their "desired" amounts.*12* The interest rates, in turn, stop moving when desired (Treasury) sales of government securities equal desired purchases and the actual return on loans outstanding equals the desired return. By year 12, the securities markets are roughly in balance and the average return on assets stabilizes. At this point, the influences that would move the loan rate away from the (risk-adjusted) average return are also in balance, with the upward pressure of a relatively low spread in returns offset by the downward pressure from relatively high profitability and low loan extension delay.

Figure IV-11 displays the major liability management variables plotted over 20 years. In response to the initial step in loan demand, relative liquidity declines and, through the multiplier from liquidity on return on deposits, causes the return on savings deposits to rise. Relative liquidity reaches its lowest point at year 2, and remains low for more than five years, considerably longer than relative demand (measured by the relative loan extension delay) remains high. Liquidity stays low over a longer period because, even after lending matches loan requests, liquidity must be brought up to the new, expanded level of activity. One way to raise liquidity is to attract deposits by paying a higher yield.

*12*Desired loans in test generator DLTG steps to 163.5E9, while loans equilibrate at 164.3. A comparable excess of backlog over desired backlog offsets the difference between desired and actual loans, so that the correction for loans and backlog in test generator CLBTG is equal to zero.

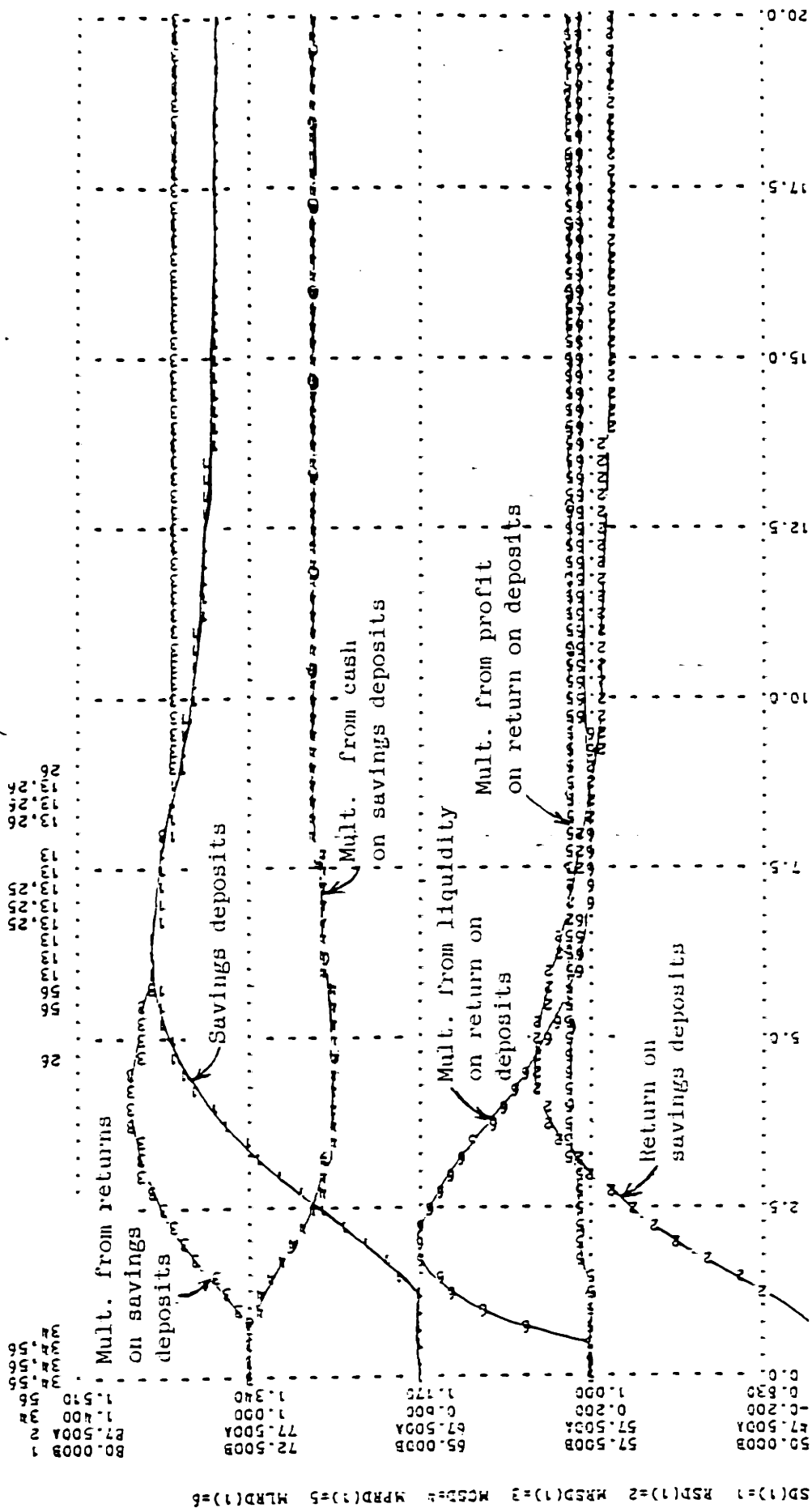


Figure IV-11. Bank Savings Deposits in Response to Step in Loan Demand - Second Simulation

In addition to the influence of liquidity on deposit yields, the increased return on loans also encourages a higher desired return. Thus a positive loop operates to push rates up: a higher return on loans lifts the return on deposits, which squeezes rate spreads and encourages higher loan yields. Downward pressures build up, however, as the expanded liquidity, resulting in part from higher savings deposits, permits growth in lending and stabilization of yields on government securities.

As the yield on Bank deposits rises, relative to the average return available on other assets of the Savings Investor, the multiplier from return rises and encourages expanded investment in Bank savings deposits. Because interest rates equilibrate at a level higher than the initial value, and because the yields on non-Bank deposits stay constant in this simulation, the multiplier from returns stabilizes at a level above one (1.18 at $t = 20$). Offsetting the attraction of a higher yield is the reduced level of cash funds in the Savings Investor, expressed in the multiplier from cash on savings deposits (0.85 at $t = 20$). Thus, the higher return successfully attracts deposits to the Bank.

The overshoot in savings deposits occurs because of delays inherent in establishing the return on deposits and in the Savings Investor's purchase and accumulation of deposits. As shown in Appendix 1, the return on savings deposits adjusts to a desired return over a one-year adjustment time. Then, in response to, say, a higher return, the Savings Investor purchases deposits which accumulate in a

level. The expanded liquidity that results puts direct and indirect downward pressures on loan and deposit rates. But these pressures take time to transmit to investors in the form of lower yields and a reduced rate of deposit accumulation. In effect, investors are responding to information which reflects previous, rather than instantaneous, conditions. The potential for instability described here has been treated elsewhere in connection with general price and quantity adjustments (Mass 1976) and is a feature of economic systems where stock variables (e.g., liquid assets) enter into management decisions (such as the loan extension rate and adjustments in the deposit rate).

Figure IV-12 reveals the asset management side of Bank behavior. As in the first simulation, Treasury bills and bonds decline during the first few years in response to the cash and liquidity squeeze. However, as liquidity comes in from the sale of additional savings deposits, cash funds encourage more purchases of bills than before; and higher liquid assets cause the multiplier from liquidity on government bonds to return years sooner to its neutral value of one. Although bills eventually come back to a level higher than at the beginning, in order to balance out the composition of liquid assets, bonds stabilize at \$10 billion less than the initial level.

Though not as significant as the influence of cash or liquidity, relative returns exert an interesting impact on the Bank's securities transactions. For bills, the multiplier from relative returns falls below one at the beginning because of the rise in return on Bank loans. But from then on, the multiplier encourages bill

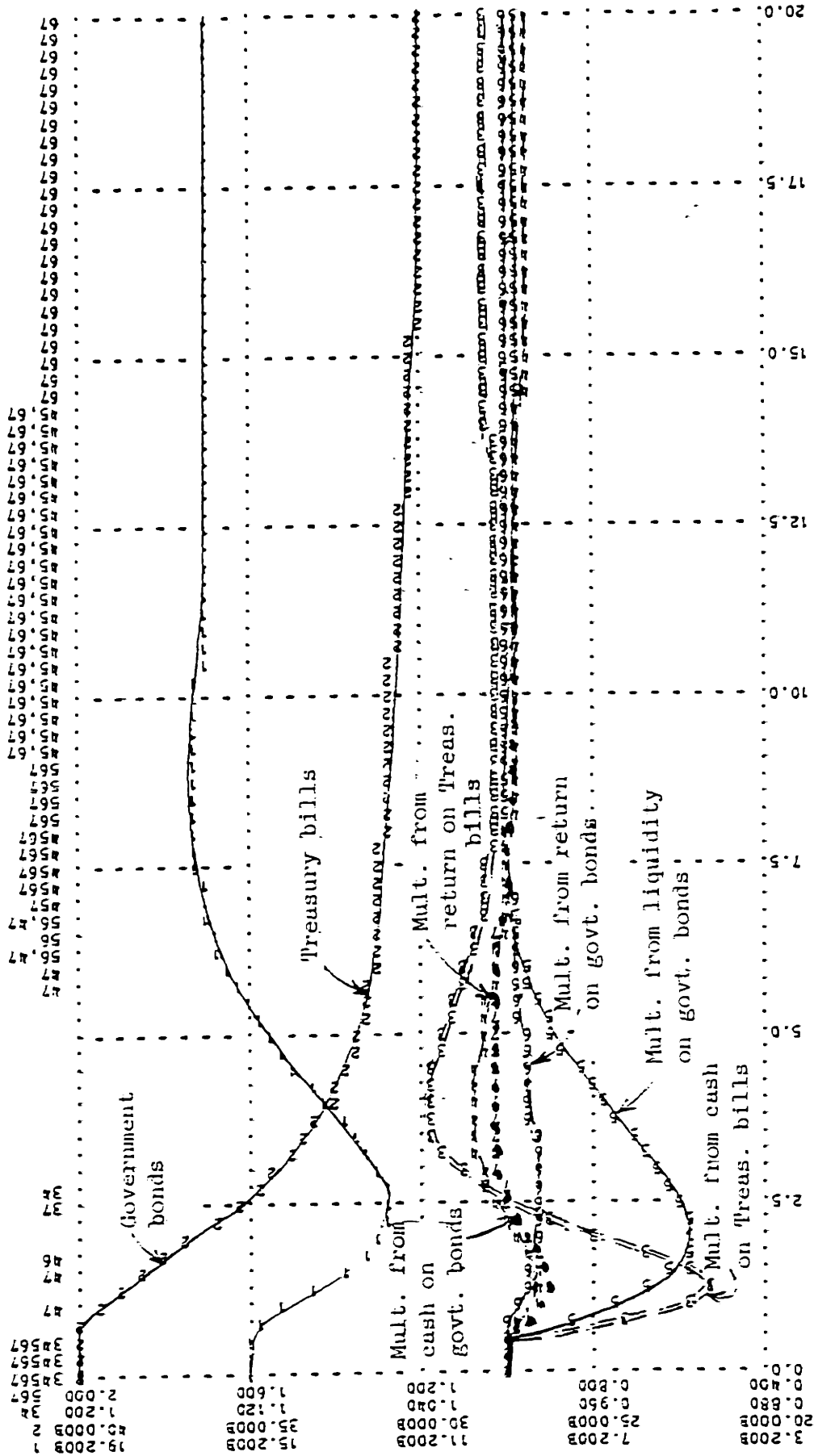


Figure IV-12. Bank-Held Securities in Response to Step in Loan Demand - Second Simulation

purchases because the effort of both Bank and Savings Investor to eliminate bills has raised the interest rate relative to other yields. For bonds, the timing is somewhat different. The relative return on government bonds (not plotted) does not rise at all above one. Even though bond rates increase, the return on bills and loans rises by a greater fraction, so that the Bank's purchase of bonds is discouraged because of both inadequate liquidity and a low relative return. At the same time as liquidity is restored and actually encourages bond purchases by the Bank, other interest rates decline more rapidly than bond yields and force the relative return (and multiplier from return on bonds) back toward one.

The behavior of the Bank in this simulation depends partly on the responses of the Savings Investor. Figure IV-13 plots three assets held by the Savings Investor, plus the ratio of relative returns that affect these asset transactions. Because of the Bank's early liquidation of Treasury bills, the relative return on Treasury bills rises and encourages the Savings Investor to increase its holding by \$1 billion. Thereafter, the reduced cash position affects the higher relative return on bills and causes bills in the Savings Investor to decline. As the return on savings deposits rises, its return relative

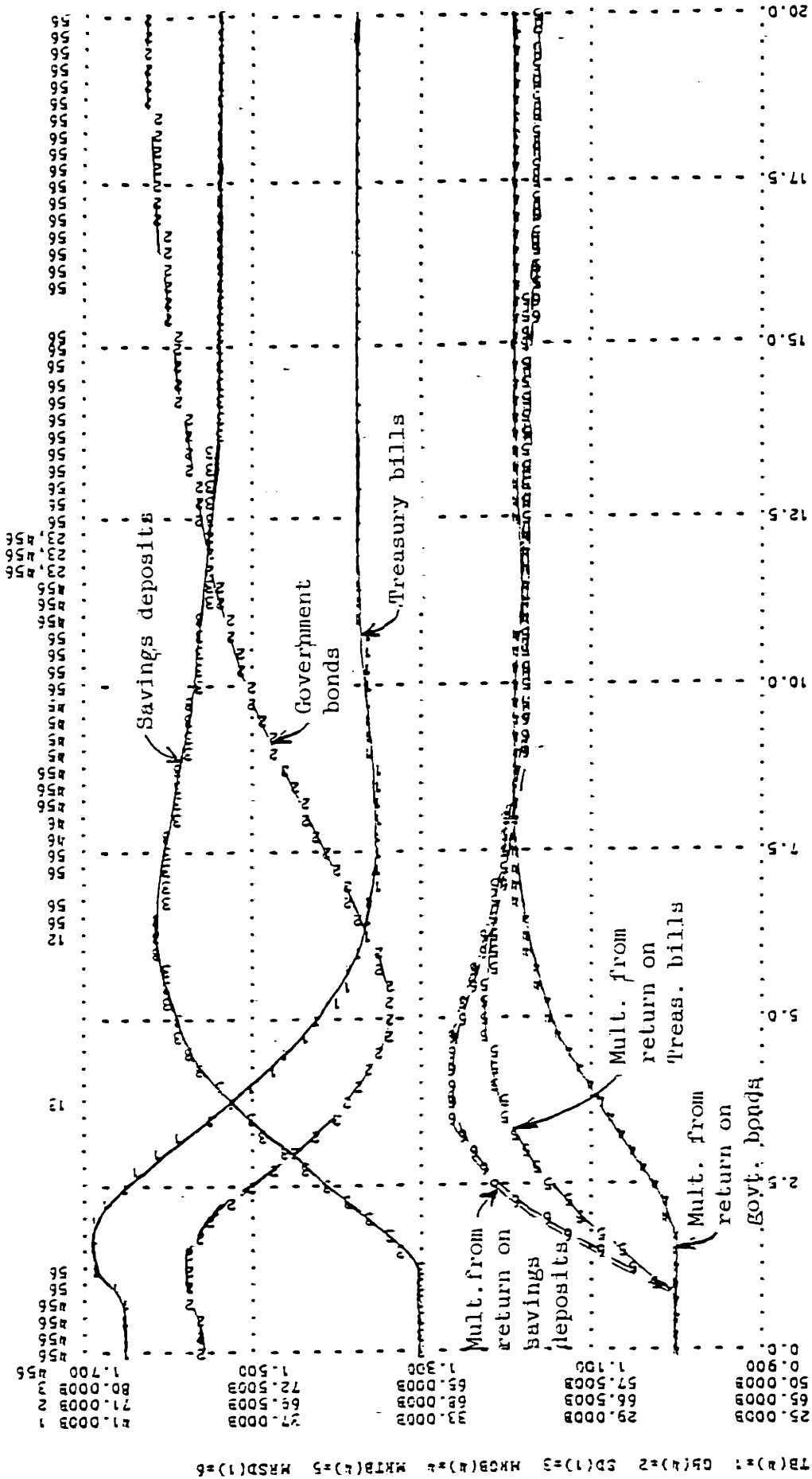


Figure IV-13. Savings Investor Assets in Response to Step in Loan Demand - Second Simulation

to the bill rate essentially causes a shift in the Savings Investor from bills to deposits.*13*

The relative return on bonds also increases, though after a slight decline at the beginning because of the rapid rise in the bill rate. Thus the returns on all three variable assets (bills, bonds, Bank savings deposits) are attractive relative to the average. Even though the multiplier from return on government bonds rises as high as 1.17, the bond level falls during the first five years by over \$5 billion, because of the declining level of cash funds. After five years, though, bond holdings start to rise again, as bond yields stay up relative to the declining rates on bills and deposits, and as excess liquidity (which grew because of the initial decline in bonds) exerts pressure to buy bonds.

At the beginning of this description, we saw that the system nearly stabilizes after about 10 years. The stability results from the Bank's having satisfied loan demand virtually fully after a few years. (The correction term in the test generator, not shown here, is close to zero within three years of the step input.) After adjusting internal

*13*The multiplier from returns on bills reaches about 1.14, while the multiplier from return on savings deposits reaches about 1.3. Both multipliers use the same table for multiplier from relative returns $TMRR$ and are based on a particular return (bill rate or deposit rate) with reference to the average return on assets of the Savings Investor. Therefore, if $MRSD > MRTB$, we know that the risk-adjusted return on savings deposits exceeds the return on Treasury bills. With an equal downward pressure from insufficient cash funds, we should expect the Savings Investor to favor deposits over bills.

liquidity and interest rates to the initial shock, the system faces no additional perturbation and moves smoothly toward equilibrium. In the next simulation, the exogenous input will vary continually, as a sine wave, over the entire test period.

3. The Bank and Savings Investor--Cyclical Loan Demand

The third simulation comprises the Bank and Savings Investor as they respond to a sine wave in desired loans, with a four-year period and a 10% amplitude. The other parameters and switches in this test are the same as before, except that desired sales of government securities equals maturities plus a term that corrects the outstanding amounts of bills and bonds to constant desired levels.*14* The discussion of this simulation will focus on the relative phasing and amplitudes of Bank assets and interest rates as they move over the full cycle imposed on demand. The four-year period of oscillation was chosen to represent the duration of a typical short-term business cycle.

*14*In the previous two runs, the time constants of the correction terms on desired sales of Treasury bills DSTB and desired sales of government bonds DSGB were set to high numbers (approximating infinity) so that desired sales simply equaled maturities. In this fashion, outstanding securities and interest rates could settle at a new equilibrium determined by the internal workings of the Financial Sector rather than by the test generator. In the oscillatory run, the correction term is active so as to avoid a drift that would result from making desired sales equal to maturities. Drift would reflect the downward bias in the multipliers affecting the purchase of bills and bonds (MPTB, MPGB). When desired sales exceed purchases, the level of securities would decline, causing desired sales (which depend on the level) to decline as well; when desired purchases exceed desired sales, however, MPTB and MPGB would not exert sufficient pressure to bring outstanding securities back up to preceding levels.

Figure IV-14 shows Bank loans and securities as they oscillate over a 10-year period, starting after the transient response to the sine-wave input has disappeared. The figure brings out several important features of the model. First, the Financial Sector combined with the test generator attenuates the oscillations so that a 10% amplitude in desired loans (= \$15 billion) produces an amplitude of about 3% in outstanding loans (approximately \$5 billion). Part of the attenuation occurs within the test generator. Despite swings of $\pm 15E9$ in the correction for loans and backlog in test generator (not shown in the figure), the requests for loans (not shown) moves over a narrower range, because requests equal maturities (a one-year delayed value of the lending rate) plus the correction term. The one-year average lifetime of loans, therefore, puts maturities about 130 degrees out of phase from the correction term (which also includes the backlog level) and helps to attenuate the oscillations.*15* Similarly, within the sector, the lending rate (also not shown) oscillates with an amplitude of over 7% while maturities (a one-year delay of lending) and the loan levels, to which maturities are proportional, move within a narrower range. Other variables, however, oscillate with a higher amplitude than the input signal. In the figure, for example, liquid assets move over a

*15*Forrester 1961, p. 417, shows that a simple first-order delay, such as maturities relative to the loan extension rate, reduces the amplitude of an incoming sine-wave signal by almost 50% when the ratio of the delay time to the period equals 0.25 (= 1 year average life of loans + 4 year period).

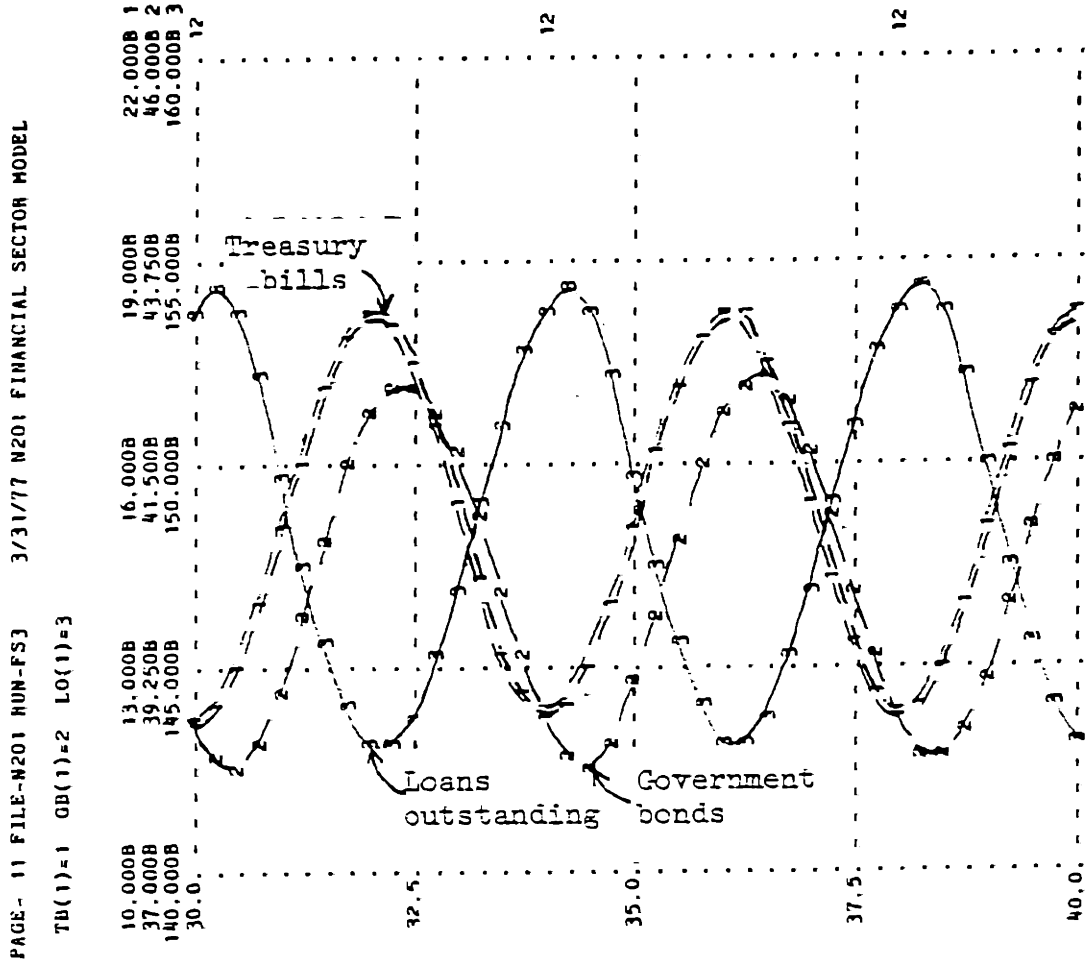


Figure IV-14. Bank Assets in Response to Cyclical Loan Demand - Third Simulation

range of $\pm 20\%$ of the mean value, a result that parallels the observed amplification of inventories in most production systems (see Forrester 1961, Chapter 15).^{*16*} As Figure IV-14 reveals, Treasury bills, which comprise most of the liquid assets, fluctuate by about $\pm 20\%$ around the mean value. The amplitude of oscillation in bills considerably exceeds that of government bonds, which vary by only about 5% around the mean. This relative volatility of Treasury-bill holdings seems consistent with available data on the composition of bank security portfolios.^{*17*}

The relative phasing of asset holdings is also consistent with observed behavior. Conard writes:

As is well known, bank loans and bank investments commonly move inversely to each other. The bank attempts to accommodate its loan customers and adjusts its investment portfolios as required to meet this need. If necessary, and sometimes when not necessary, it may borrow from the Federal Reserve instead of selling securities, but this does not prevent the opposite movements of loans and investments. The cyclical patterns reveal this inverse conformity clearly, with loans moving cyclically in agreement with business expansion and contraction. (Conard 1966, p. 67)

In the figure, bills held by the Bank move 180 degrees out of phase with loans, while bond holdings lag bills by six to nine months. As we have seen in the structure of the Financial Sector, the Bank

^{*16*}A full technical treatment of the system's response to a sine-wave input goes beyond the scope of this chapter and will not be pursued further here.

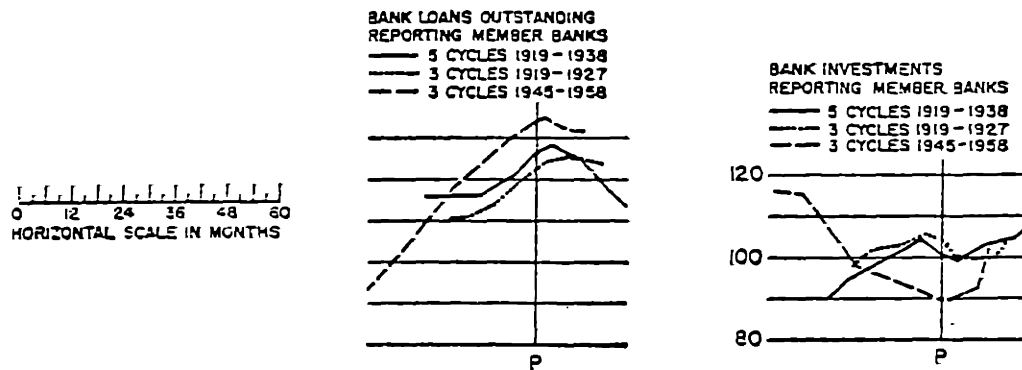
^{*17*}See, for example, the breakdown of commercial bank holdings of government securities by maturity in the FRB Bulletin, which shows greater changes in short-term securities than in long-term holdings. See also Figure IV-7 earlier in this chapter.

behaves in the manner described by Conard, with adjustments in government securities reflecting the primary credit needs of Bank customers.*18*

Figure IV-15 shows the impact of Bank portfolio adjustments on interest rates. Again, the behavior of the model accords with the pattern described by Conard:

This cyclical pattern [in loans and securities] makes it plausible to believe that one of the important factors causing interest rates on bills and bonds to rise during business expansion may well be the action of banks; that is, a changed demand for bank loans is transmitted directly to the capital market through the securities in which banks trade, primarily Treasury bills but significantly also intermediate-term government notes and bonds. When the demand for bank loans increases, bank sales of securities reduce their prices and raise their yields. At the same time, bank rates on loans also increase in response to expanding demand. (Conard 1966, p. 67)

*18*Gordon also shows the inverse correlation between bank loans and security investments in the context of NBER reference cycles. The comparison can be seen in two reference cycle patterns reproduced from Gordon 1961, p. 293:



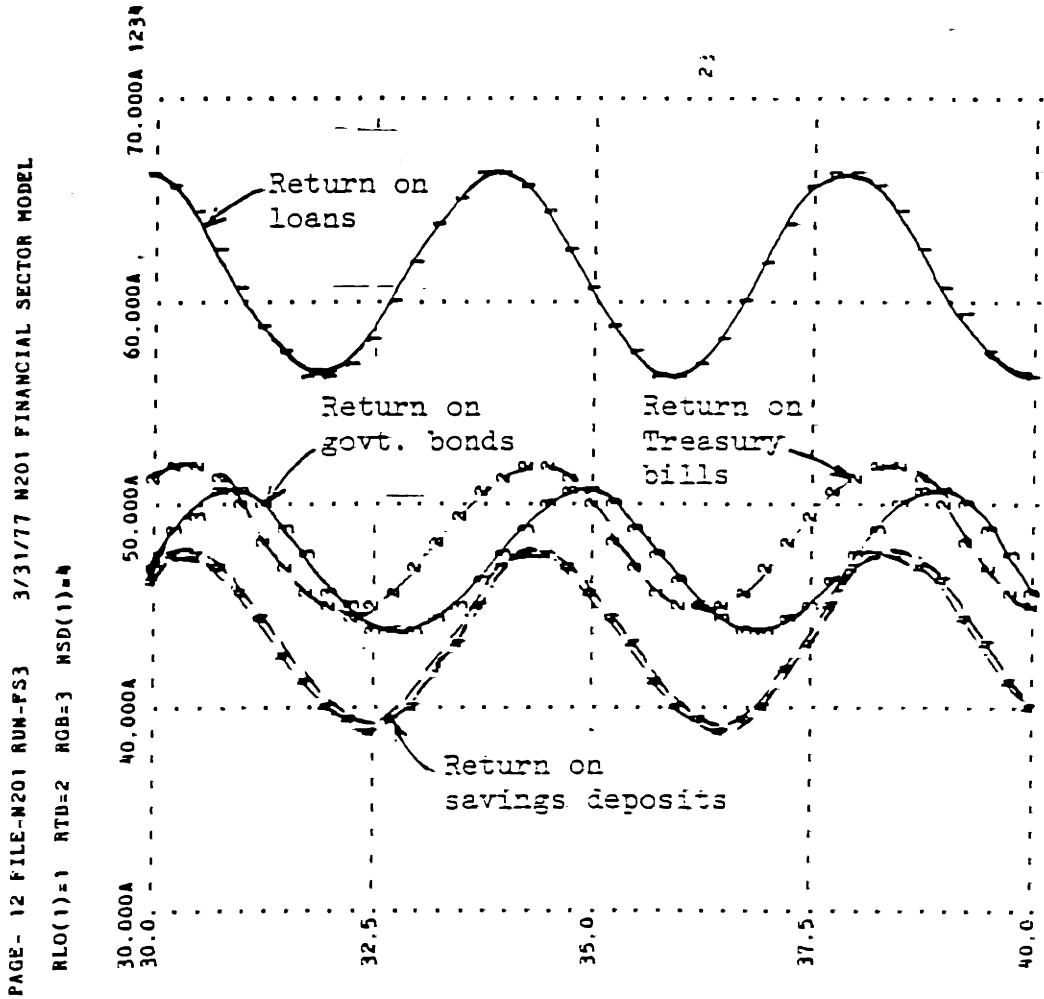


Figure IV-15. Interest Rates in Response to Cyclical Loan Demand - Third Simulation

In the figure, the returns on loans, bills, and bonds all move roughly together, with loan rates preceding bill yields by about one quarter and bond yields by two to three quarters. The historical pattern in interest rates is similar to the model's behavior. Until recently, for example, long-term bond rates tended to lag loan yields, with a lag of about eight months during the early part of this century (Conard, p. 56). Treasury bill rates, on the other hand, have synchronized more closely with loan yields, even tending to lead business-cycle (and loan-yield) peaks since 1920 (Conard, p. 58). Finally, the work of Cagan and Kessel shows greater volatility in short-term rates than in long-term rates. (See Kessel 1965 and Conard, p. 69). The model does not correspond as well to this last observation, as yields on both bills and bonds in the figure move over a comparable range.*19* The relative volatility of short and long rates in the model should be examined more closely when the Financial Sector is combined with other parts of the National Model.

4. The Bank and Savings Investor--Noise in Loan Demand

Some of the same relationships that were examined in connection with the pure sine wave input can also be explored when the

*19*The bill rate in Figure IV-15 stays above the bond yield over most of the run, despite the historical tendency of bond yields to exceed bill rates. One should not attribute much significance to this relationship in the model, however, as the model is initialized with the bill yield higher than the bond yield (5% versus 4.9%) and therefore retains the gap in steady-state oscillation.

Bank is subjected to random noise in loan requests. The noise input contains approximately all frequencies and, therefore, tends to elicit the natural, or inherent frequency of the system. As shown in Figures IV-16 and IV-17, the Bank combined with the Savings Investor exhibits a noticeable inherent frequency of 4 to 7 years.*20* The period is consistent with short-term business-cycle behavior, although there is no obvious reason to take this as validating or invalidating the internal structure.

The two figures also reveal phase and amplitude relationships similar to those uncovered in the sine-wave simulation. Investments move countercyclically with respect to loans, with greater relative amplitude in bill fluctuations than in bonds. Also, interest rates tend to move together, with bill yields and loan rates well synchronized, and bond yields lagging the other two by about six months.

In addition to interest rates, Figure IV-17 also plots the (fractional) change in the total money supply. Visually, the fluctuations in the change in money move counter to interest rates, especially loan and bill rates. Cagan has found a strikingly similar negative correlation between short-term yields (in his investigation, the commercial paper rate) and the rate of change in the money stock

*20*This period seems related to the one-year average life of Bank loans, although extensive testing was not performed to isolate the critical parameters. Note that another noise run, with the correction term removed from the request for loans in test generator RLTG, showed a similar periodicity (4.5 to 6.5 years), with somewhat greater amplitude in the oscillations.

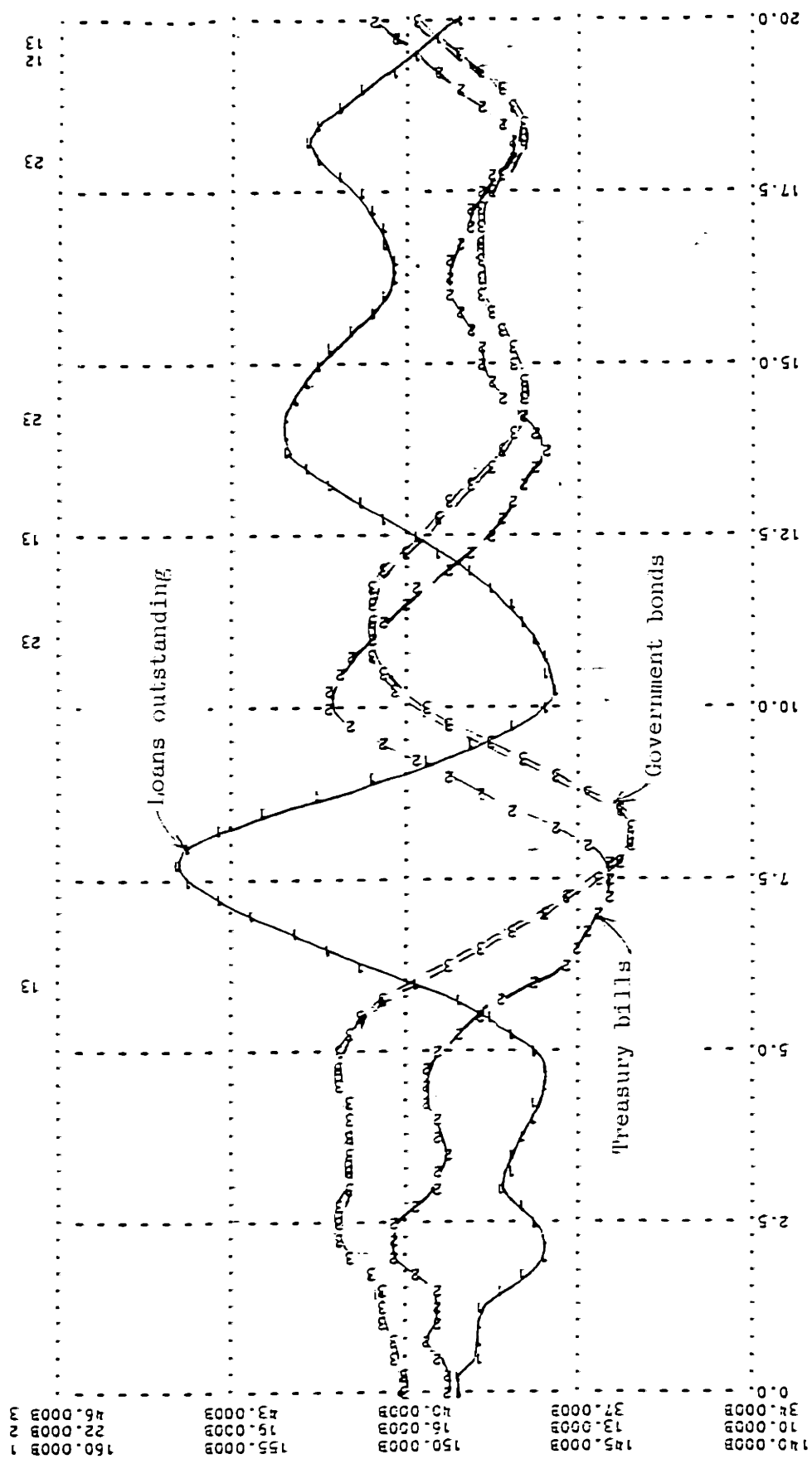


Figure IV-16. Bank Assets in Response to Noise in Loan Demand - Fourth Simulation

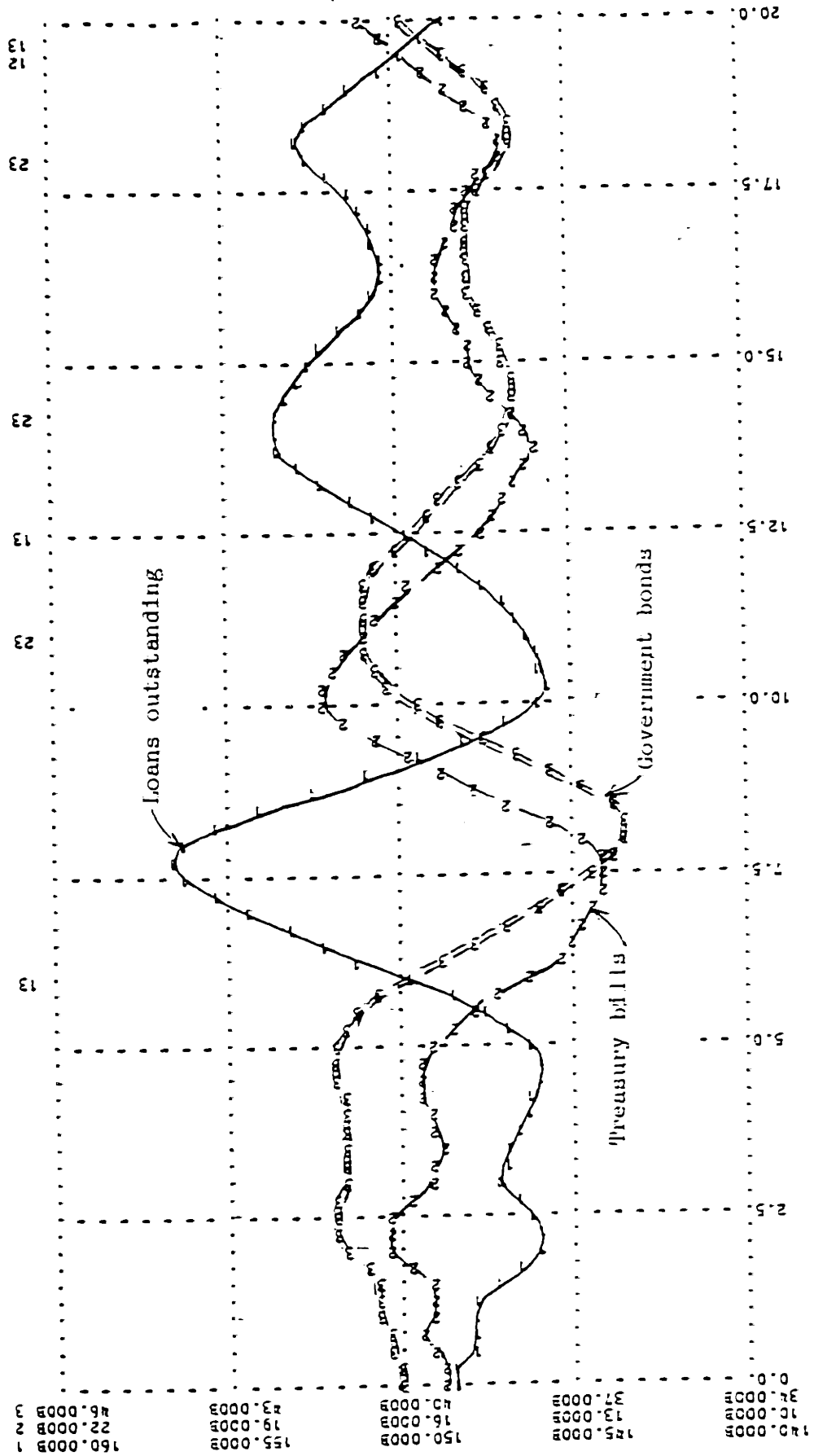


Figure IV-16. Bank Assets in Response to Noise in Loan Demand - Fourth Simulation

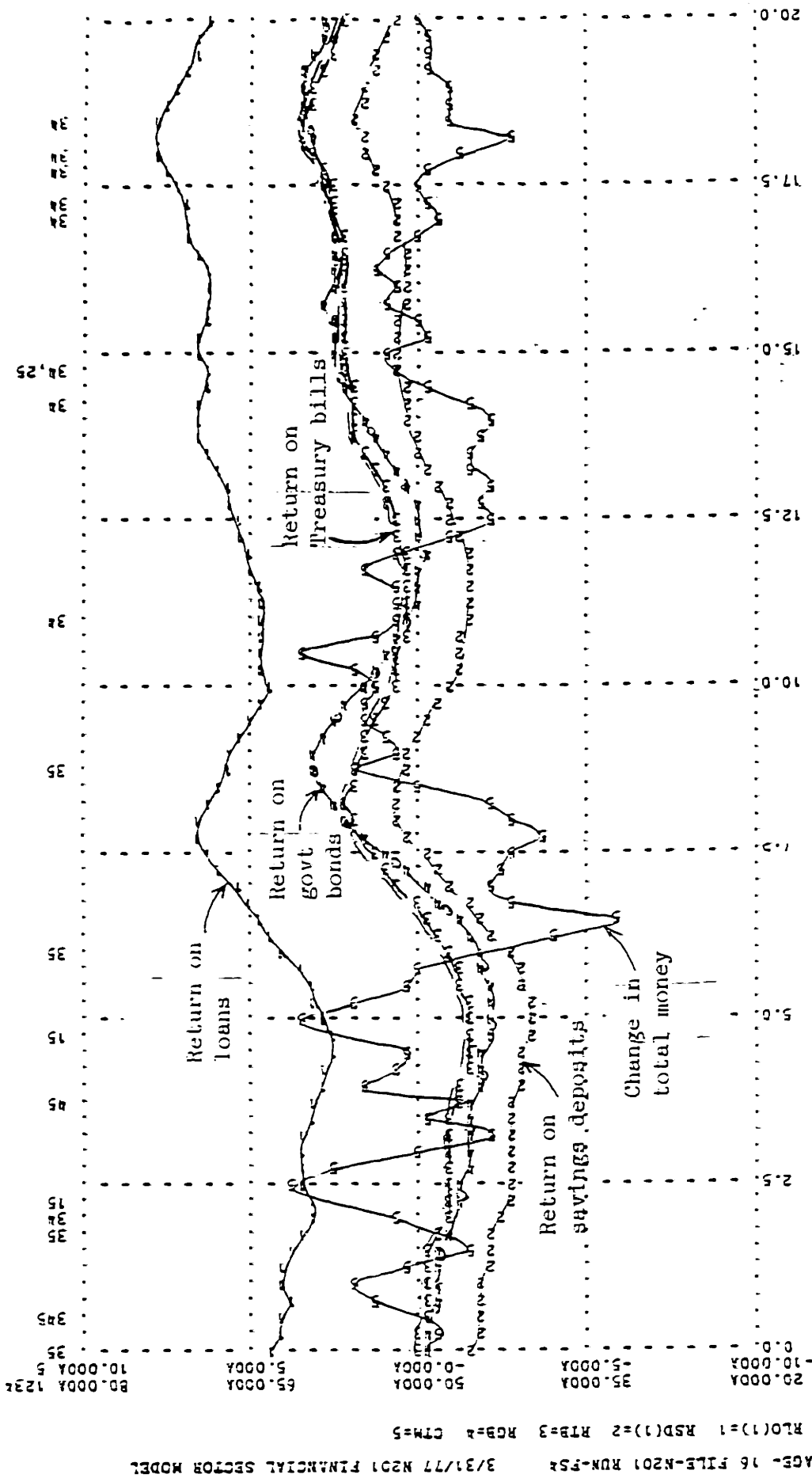


Figure IV-17. Interest Rates in Response to Noise in Loan Demand - Fourth Simulation

over the business cycle. The reference-cycle patterns are reproduced in Figure IV-18 (from Conard, p. 65). Figure IV-19 plots annual output from the noise simulation to show the relationship between the change in money and the return on Treasury bills that comes out of the model. Although a fairly wide scatter is evident, the negatively sloped regression line (here simply estimated visually) conforms to Cagan's conclusions.

The relationship is important from both theoretical and policy perspectives. The loanable funds theory of interest-rate behavior states that the rate of interest is determined at the level that equates the supply and demand of loanable funds--where demand consists of investment needs and the demand for net increases in idle funds, and supply consists of the current savings flow plus any net increase in the money supply (Conard, p. 6). Thus, if other things are equal, interest rates will decline if the rate of increase in the money supply grows. The observed negative correlation has led many economists to attribute a special monetary link with interest rates that is somehow disembodied from the real business and household decisions that seem to underlie business-cycle behavior. Conard notes, for example, "Taken together, evidence of this kind occurs often enough to demonstrate that the close association between money behavior and interest rates is not merely a reflection of the business cycle on each series, but is probably a genuine direct relationship." (Conard, p. 66)

It is not a long step from this statement to the assertion

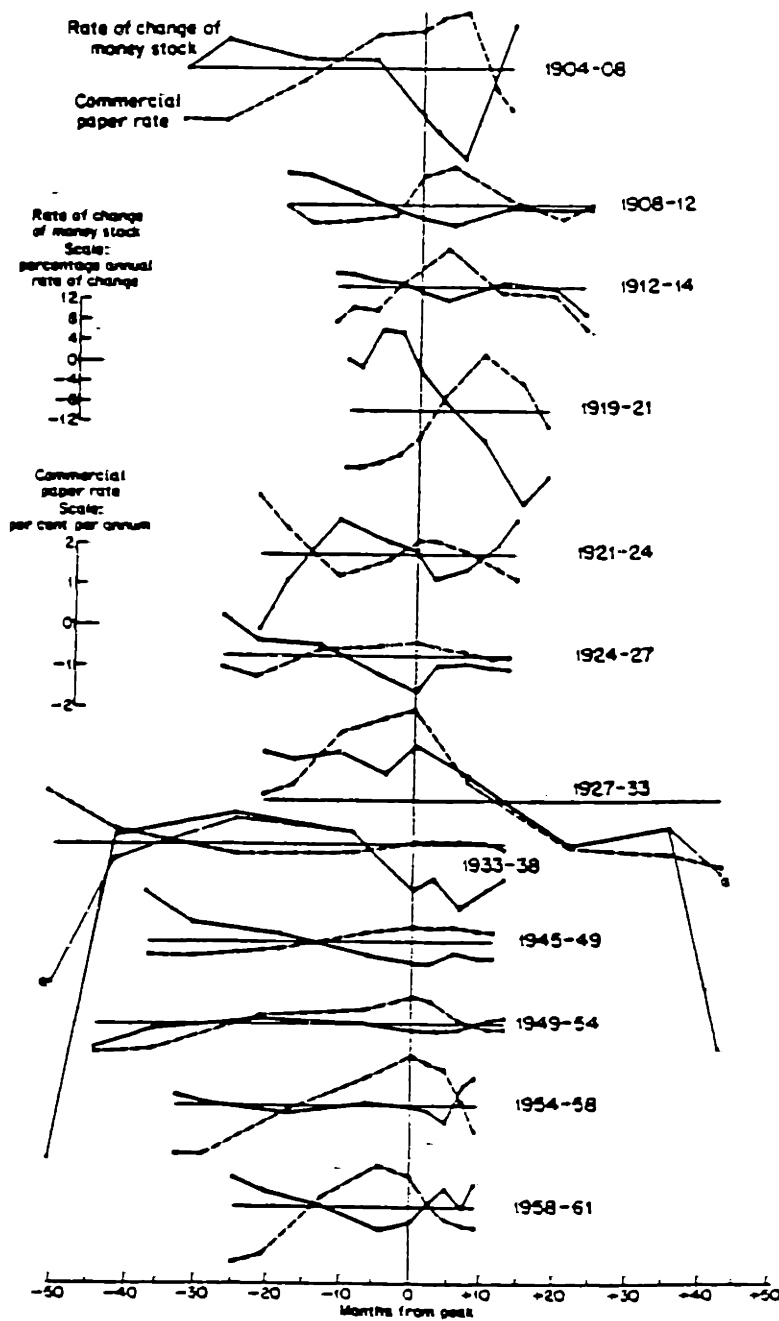
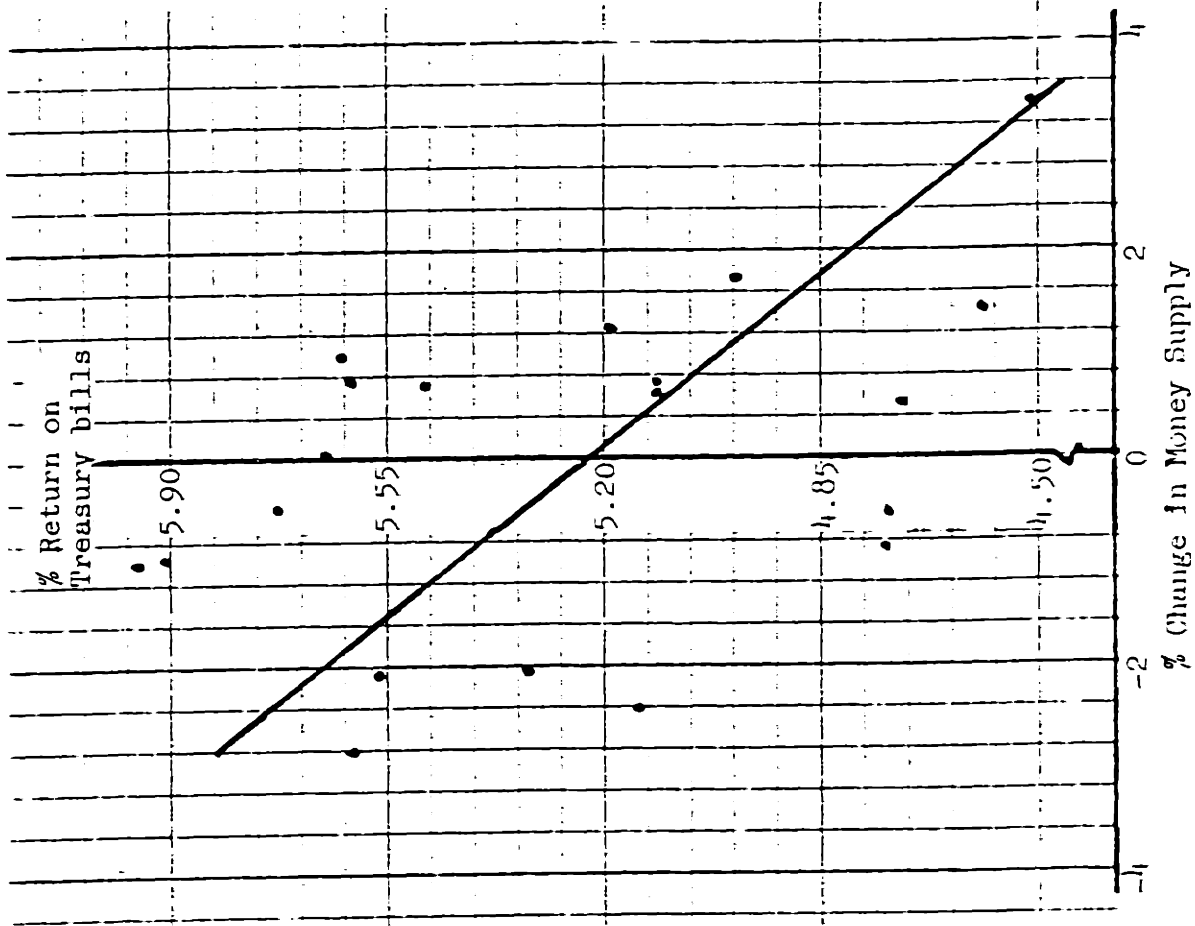


Figure IV-18. Reference-Cycle Patterns of Commercial Paper Rate and Monetary Growth Rate (Absolute Deviations from Cycle Averages)
(Source: Conard 1966, p.65)



TIME	CTM	RTB
E-00	E-03	E-03
0.0	0.0	50.000
1.000	1.7232	49.099
2.000	0.5647	47.171
3.000	-0.0504	47.346
4.000	1.4181	45.917
5.000	3.4371	45.146
6.000	-0.8500	47.353
7.000	-2.2222	51.451
8.000	-2.7696	55.955
9.000	0.7270	54.963
10.000	1.2434	51.895
11.000	0.6595	51.126
12.000	0.7305	51.167
13.000	-2.1461	53.115
14.000	-2.1035	55.742
15.000	0.9910	56.335
16.000	0.7604	56.100
17.000	-0.4792	57.168
18.000	-1.2226	59.452
19.000	-0.9812	59.121
20.000	0.0360	56.563

Figure IV-19. Relationship from Model between Return on Treasury bills and Change in Money Supply

that controlling the money supply directly leads to control of interest rates, a policy implication that is taken seriously by the Federal Reserve. Yet in the model that produces the observed relationship between changes in the money supply and the short-term interest rate, the cyclical pattern is produced by decisions of the banking system and other investors (represented by the Bank and Savings Investor) and not by decisions on the part of the Monetary Authority. In the test generator, the Monetary Authority purchases securities on the basis of maturities plus an adjustment of actual holdings to a constant desired amount. In other words, the decision-making process internal to the Financial Sector seems to govern the behavior rather than some externally-imposed decisions about the money supply. It appears that the primary forces governing interest rates, money, and other financial variables occur within the private sectors of the economy rather than as a result of official attempts to control economic behavior through changes in the money supply. This hypothesis can be tested when the Financial and Production Sectors of the National Model are linked together.

C. Other Simulations

The first simulation in this section repeats the experiment of linking one lender with the Savings Investor, where the Mortgage Lender replaces the Bank. Then the Bank, Mortgage Lender, and Savings Investor are combined to test the competition for funds that occurs during a

period of tight money. Finally all four institutions are combined to produce a complete Financial Sector simulation.

1. The Mortgage Lender and Savings Investor--Step in Loan Demand

In the first test, the Mortgage Lender is combined with the Savings Investor and subjected to a 10% (\$15 billion) step in desired loans. The system's response to increased loan demand resembles the response of the Bank and Savings Investor that were linked in the second test described earlier. Several important differences in behavior are apparent, however, and will be brought out in the following discussion.

As before, high loan demand augments the backlog of loan requests and elicits higher lending. To obtain the necessary liquidity, the Mortgage Lender must rely primarily on attracting deposits and liquidating its bond portfolio. To the extent that deposits increase, other assets of the Savings Investor must decline, as total savings in these tests are held constant. Because savings deposits of the Bank and Corporate Lender are also constant, the Savings Investor must seek reductions in its money or government securities in order to expand deposits in the Mortgage Lender. As described earlier, total outstanding Treasury bills and bonds are allowed to decline, as they mature, to new levels determined by actions within the Financial Sector. On balance, diminished public debt, combined with a reduced money supply within the Financial Sector, makes possible the expansion in private debt. While money in the sector declines, however, money outside of the sector (in the test generator) increases by the same amount. Total

money in the system remains constant in this test because, unlike the Bank, the Mortgage Lender cannot create or destroy money, but can only transfer funds from one place to another.

The figures in this section show that the Mortgage Lender responds to higher loan demand in a fashion similar to the Bank, but that the approach to equilibrium is by no means complete by the end of the 20-year simulation. In essence, lending adjusts quickly, as before, to a higher value; but other variables, such as interest rates and government securities, are still changing obviously after 20 years. It is appropriate, then, to ask what determines equilibrium in this system, and why the slow secondary adjustments occur once loan demand has been satisfied. These issues will not be resolved fully here but are considered in Appendix IV-2 and eventually may raise further questions about the system structure and behavior. The rest of this section, therefore, will deal mainly with the system's primary response to higher loan demand.

Three figures summarize the behavior of the Mortgage Lender and Savings Investor. Figures IV-20 and IV-21 reveal the movement of major balance-sheet items for the two institutions. As we have seen already, the behavior of these variables depends on a wealth of pressures, which will be referred to in the text even if not shown in computer plots.

After the 10% step in desired loans, the Mortgage Lender quickly expands its lending activity. In Figure IV-20, the loan extension rate jumps by over 50% within six months and then falls back

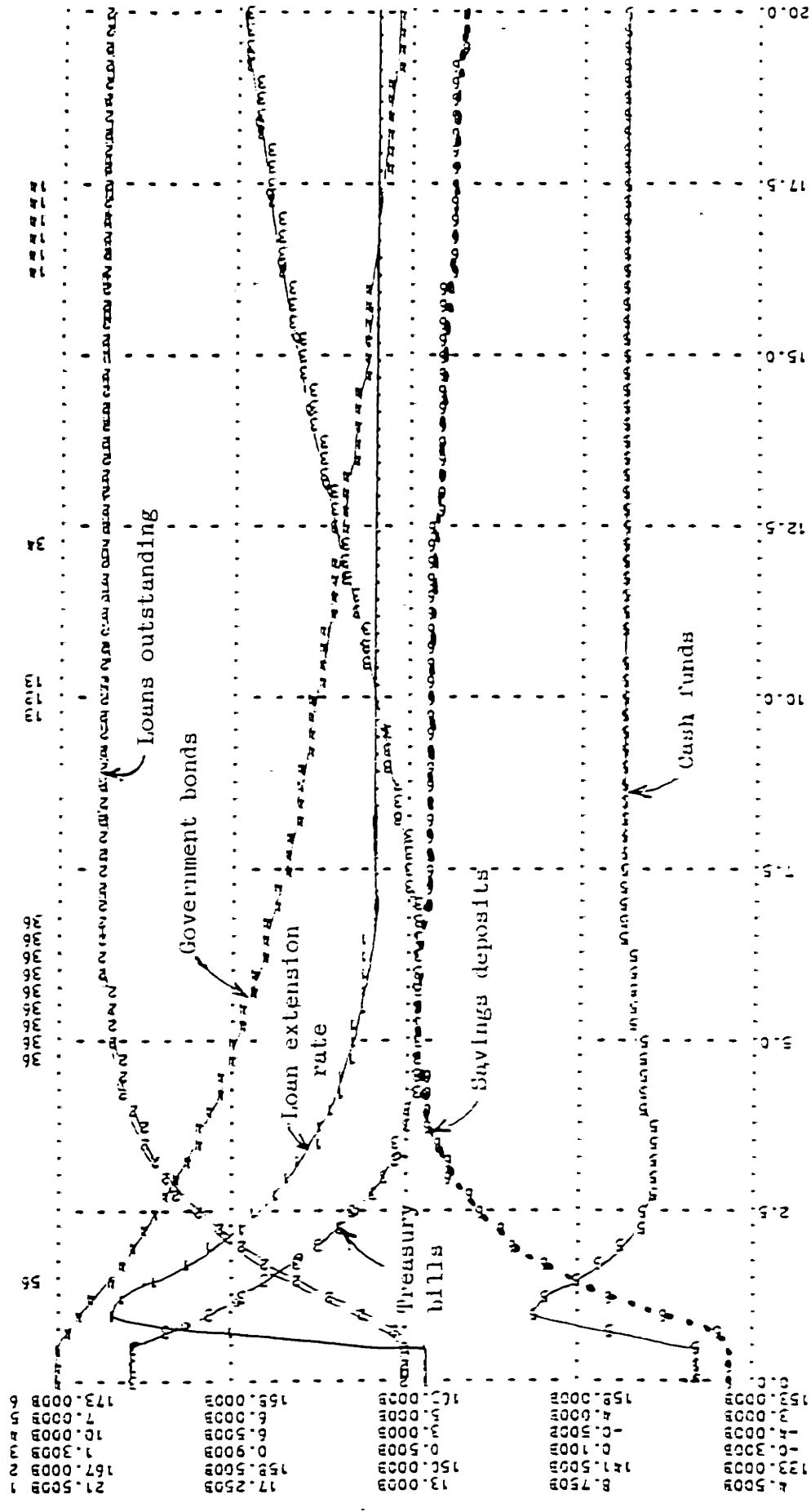


Figure IV-20. Balance Sheet Variables of the Mortgage Lender in Response to Step in Loan Demand - Fifth Simulation

gradually to a new value that is only 10% higher than the initial amount. The large and abrupt overshoot in lending differentiates the response of the Mortgage Lender from that of the Bank. Mortgage loans have an average life of 12 years in the model. When the desired level of loans rises by 10%, therefore, the full realization of that increase within one year would imply a 120% increase in lending. Since the time to adjust loans to desired loans in the test generator (ignoring the backlog correction portion) is 1.5 years, one would expect an increase in loan extensions of about 80% if other pressures on lending such as relative liquidity were not produced. In contrast, a 10% step in desired Bank loans, adjusted in the test generator over a period of nine months, implies a maximum expansion in lending of only about 13% (assuming influences on lending other than demand are neutral).

Although demand, represented by the backlog of loan requests, produces rapid expansion in lending, the actual loan extension rate fails to keep pace with the indicated rate (which is proportional to backlog) during the first year, because of restraints generated by insufficient cash and liquidity. After a year, however, two things occur to push lending above the rate indicated by demand: first, the effective sale of Treasury bills, bonds, and savings deposits replenish cash and liquidity and reduce the downward pressure on lending; second, the interest rate on loans rises relative to other returns so as to encourage more than the usual amount of lending. Thus, the indicated loan extension rate falls, as demand is realized, and brings down the

actual rate, though somewhat more slowly because of the relative attractiveness of loan yields. Within five years, as a result, loans have almost attained the desired level of \$165 billion.

Treasury bills in Figure IV-20 fall during the first five years, although bill holdings of mortgage lenders are small and cannot contribute much to the cash portion. During the first six months, cash actually rises a bit, mainly because of a small fractional increase in the large pool of savings deposits. As lending continues, however, money declines, and during all of the first five years the level of cash funds remains low relative to the desired level (which depends indirectly on loan demand). The pressure of insufficient funds, plus the fact that bill rates do not rise as fast as the return on loans, causes bills to fall by over 50%. Later, as unmet loan demand causes desired cash funds to decline, and loan yields actually begin to fall (shown in a later figure), the influence of relative cash and interest rates exert slight upward pressure on bill purchases, and the bill portfolio regains its original size.

Government bonds, meanwhile, fall steadily during the 20-year run, most rapidly during the first five years because of the strong force of inadequate relative liquidity. In fact, the multiplier from liquidity on government bonds, which does not appear in the figure, reaches a low of about 0.4 within six months, before coming back toward its original level as excess loan demand diminishes. Insufficient cash and a relatively low return also encourage the liquidation of bonds. By the end of 20 years, the cash and liquidity pressures are about neutral,

but a low relative bond yield (though rising slowly) still causes bonds to decline.

Because expanded lending cuts sharply into the Mortgage Lender's liquidity, the return on savings deposits starts to rise and, in response, savings deposits expand. As shown in Figure IV-20, deposits rise by 6% (\$9 billion) within three years. The forces encouraging this increase will be considered in connection with the next figure. The subsequent drift downward after 12 years is discussed in Appendix IV-2.

Table IV-4 summarizes the changes that have occurred in the balance sheet of the Mortgage Lender. To meet the \$15 billion increase in loan demand, the lender liquidated \$6.1 billion in bonds and attracted almost \$9 billion in new savings deposits. Although cash funds have increased somewhat, Treasury bills have fallen. Together the two forms of liquid assets after 20 years still fail to match the desired level of \$4.95 billion warranted by the higher lending activity (because of the relatively low yield on Treasury bills). As a result of higher lending, the total balance sheet has expanded by \$9.1 billion, largely due to the assumption of new deposit liabilities.

Table IV-4.
 COMPARATIVE BALANCE SHEETS OF THE MORTGAGE LENDER--FIFTH SIMULATION
 (\$ billions)

<u>Assets</u>	<u>t=0</u>	<u>t=20</u>	<u>Liabilities</u>	<u>t=0</u>	<u>t=20</u>
Cash funds	3.4	3.7	Savings deposits	153.6	162.2
Treasury Bills	1.1	1.0	Equity	11.0	11.4
Gov't bonds	10.0	3.9			
Loans	<u>150.0</u>	<u>165.1</u>			
	264.5	173.6		264.5	173.6

(Columns may not add due to rounding.)

Figure IV-21 summarizes the changes that occur in the Savings Investor. Because total savings remain constant in these tests, any expansion in savings deposits must be offset by a net decline in cash, bills, and bonds. As the figure shows, in fact, all three assets decline during the run, although bonds start to come back toward their initial level after about five years.

The multipliers that are plotted reveal most of the pressures on the Savings Investor's asset transactions. The multiplier from return on savings deposits, for example, rises sharply in response to the higher return offered by the Mortgage Lender. As the Savings Investor realizes this yield advantage, cash funds fall, so that the multiplier from cash on savings deposits about offsets the impact of relative returns within a few years, and savings deposits (approximately) stabilize.

Treasury bills move in the opposite direction from deposits, although, in equilibrium, the pressures from relative cash funds and

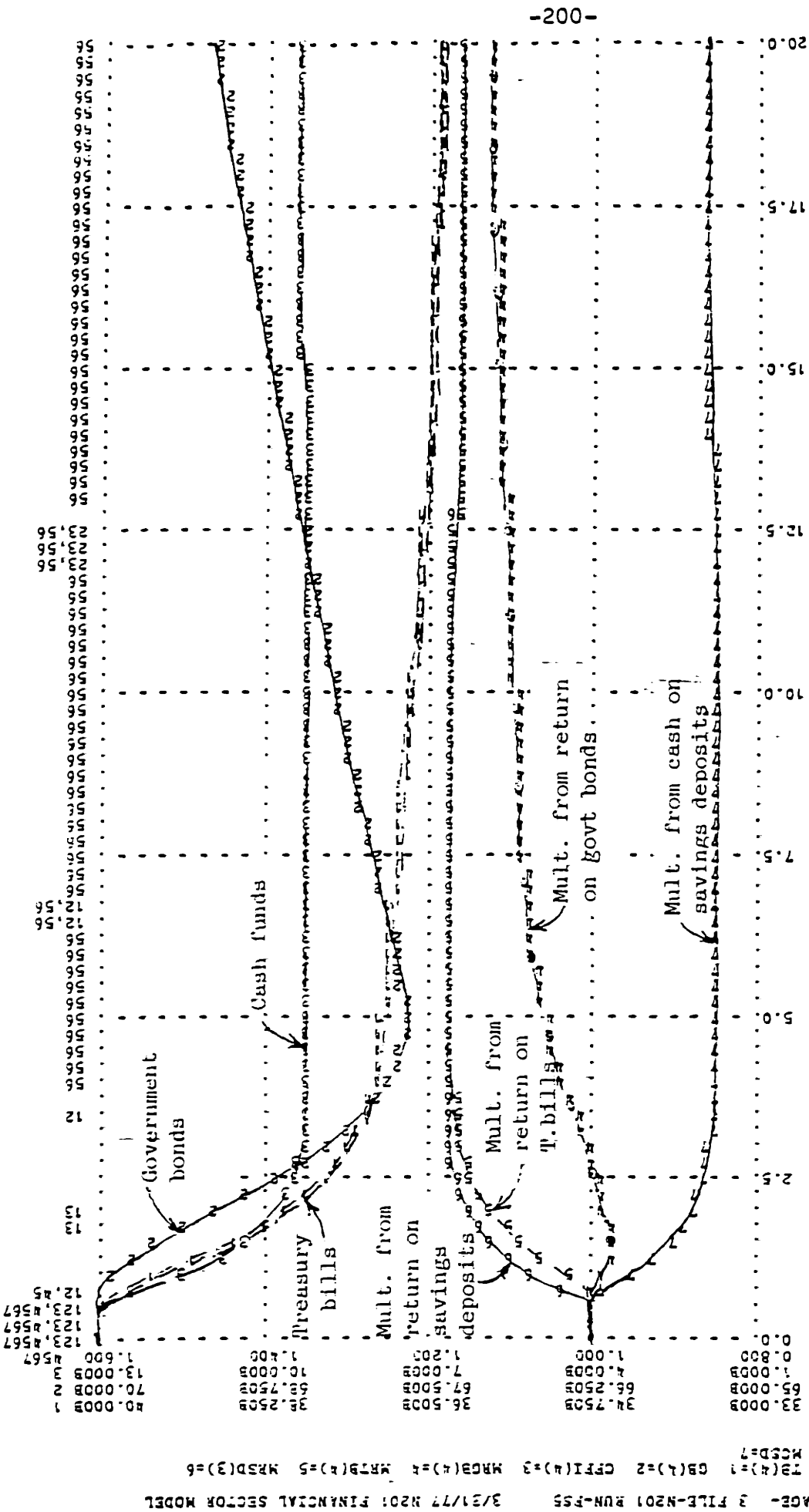


Figure IV-21. Balance Sheet Variables of the Savings Investor in Response to Step in Loan Demand - Fifth Simulation

relative returns must offset each other.*21* Because the return on deposits moves up more rapidly than the return on Treasury bills, money is diverted from bills to deposits. However, the act of selling bills, combined with the reduction of bills in the Mortgage Lender, causes the return on bills to rise, too; and the two multipliers expressing the impact of relative returns are about equal within four years.

Bond purchases of the Savings Investor reflect relative cash, returns and liquidity. As the return on deposits rises, the relative return on government bonds declines. The multiplier from return on government bonds, therefore, falls below 1 at first, so that both relative cash and returns generate the liquidation of bonds. This effective sale of bonds, however, causes bond yields to rise, thereby bringing the multiplier above 1, and causes liquid assets of the Savings Investor to rise relative to the (constant) desired level. Both forces halt the decline in bonds and eventually cause them to rise again.

Table IV-5 exhibits comparative balance sheets for the Savings Investor. While total savings and assets remain constant, deposits have risen by almost \$9 billion over the 20-year period, and other assets have declined. Cash and Treasury bills each account for almost \$4 billion of the shift into deposits, while bonds provide about \$1 billion.

*21*As explained in Appendix IV-2, $MCTB = MCSD$ at all times, which is why only $MCSD$ is plotted. Also, in equilibrium, $MCTB * MRTB = MCSD * MRSD = 1$; so $MRTB = MRSD$ in equilibrium.

Table IV-5.
COMPARATIVE BALANCE SHEETS OF THE SAVINGS INVESTOR--FIFTH SIMULATION
(\$ billions)

<u>Assets</u>	<u>t=0</u>	<u>t=20</u>	<u>Liabilities</u>	<u>t=0</u>	<u>t=20</u>
Cash funds	13.0	9.3	Total savings	477.9	477.9
Treasury Bills	40.0	36.2			
Gov't bonds	70.0	68.7			
Savings Deposits					
of M.L.	153.6	162.2			
Other assets	<u>201.3</u>	<u>201.3</u>			
	477.9	477.9			

(Column does not add due to rounding.)

Figure IV-22 reveals the four active interest rates in the model. A comparison between these rates and those produced by the simulation of Bank and Savings Investor (Figures IV-10 and IV-11) reveals some important differences between the two types of lending. Whereas the return on Bank loans rises by 30% in response to the 10% step in desired loans, the return on mortgage loans increases by only about 21% and peaks earlier (at $t = 3$ rather than at $t = 4.75$).

The amplitude and timing of peaks in loan yields reflects the movement of three influences--demand, profitability, and spread. The impact of demand is roughly the same in either case. In fact, if anything, the multiplier from demand on return on loans peaks a bit higher for mortgage lending than for short-term lending and does not reach quite as low a value once basic demand has been satisfied. Profitability, on the other hand, exerts an opposite influence for

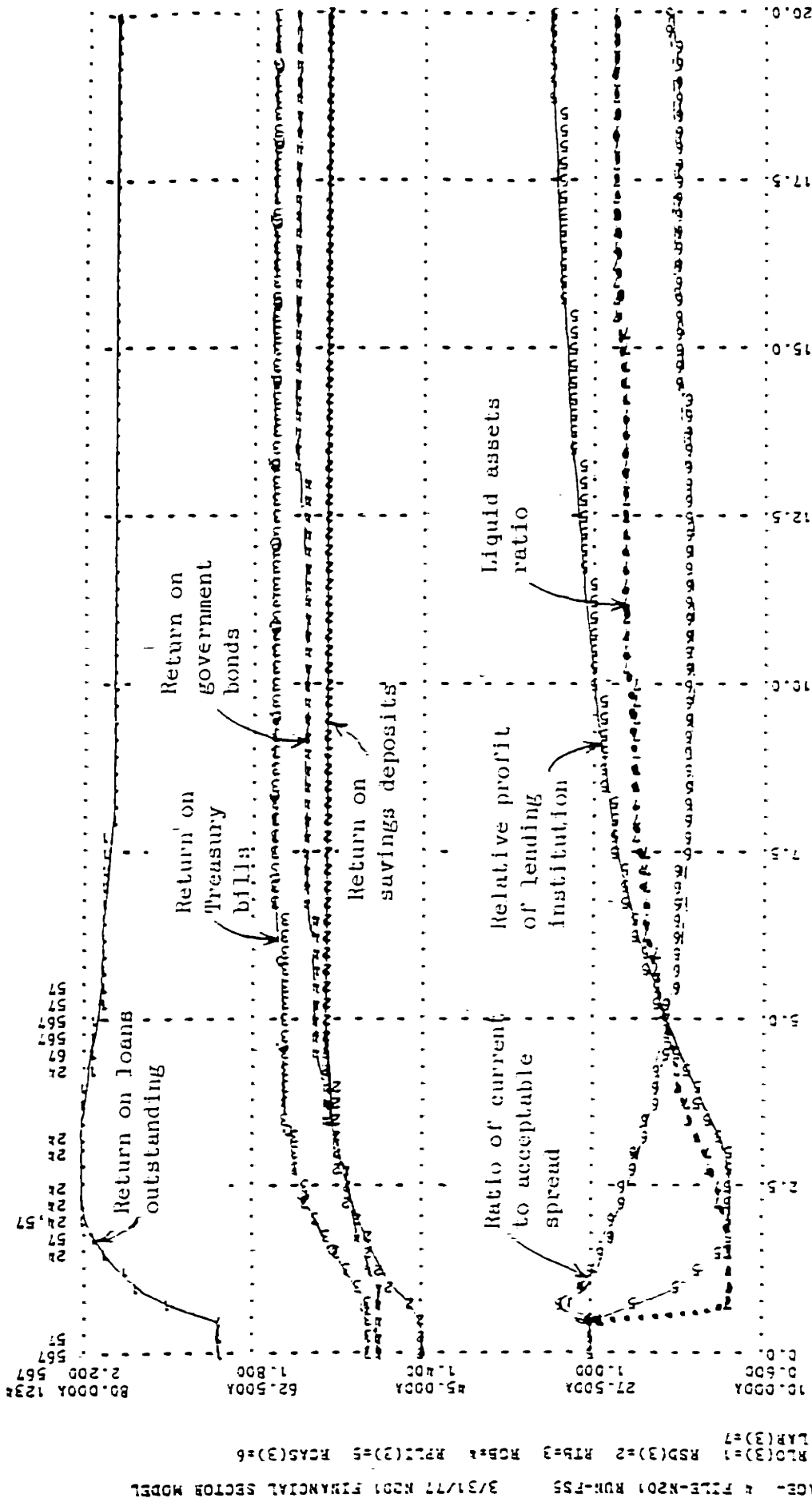


Figure IV-27, Interest Rates in Response to Step in Loan Demand - Fifth Simulation

mortgage loans. Profitability (relative return on assets) remains higher than 1 for the Bank and, therefore, exerts a slight downward pressure on the loan rate. Relative profitability in the Mortgage Lender, however, declines rather sharply during the two years after the step and stays below 1 throughout most of the run. This lower-than-acceptable return on assets encourages a higher return on deposits, through the multiplier shown in the figure, thereby causing an earlier peak for the Mortgage Lender than for the Bank. Profits fall for the long-term lender because the rising return on savings deposits applies immediately to all deposits, while the rising return on loans is not reflected in interest revenues until after a substantial delay. (The averaging time for the interest rate that determines interest receipts is six years.) Eventually, though, the addition of higher-yielding loans causes profits to rise again and, thereby, reduces the upward pressure on loan yields.

While profitability explains why loan yields peak earlier for long-term loans, the spread between average return on assets and the return on savings deposits explains in part why the return peaks at a lower value. For both short-term and long-term loans, the relative spread declines because of the lender's effort to attract new deposits. The upward impact of spread on the interest rate, however, is greater for the Bank, where the multiplier peaks at 1.1, than for the Mortgage Lender, where the multiplier rises slowly to a much later peak of 1.06. The long-term lender's relative spread does not fall as far as the

Bank's spread, because of the strong pressure of profitability on the Mortgage Lender's deposit rate. For a low return on assets, which pushes up the return on loans, exerts a strong restraint on the upward movement of deposit yields. In other words, to protect profits, the lender tries both to raise interest receipts and reduce interest costs.

The failure of government security yields to rise as high as before also contributes to the lower peak value in loan yield, as the return on loans is keyed to the average return on assets, which includes the interest rate on bills and bonds. These rates rise higher in the Bank simulation, because together the Bank and Savings Investor reduce their security holdings by more (roughly \$20 billion in the first five years) than the Mortgage Lender and Savings Investor (about \$11 billion). This difference, in turn, reflects several features of banking, including the need of banks to raise more savings deposits than pure fiduciary institutions to get an equal increase in liquidity (because of the relative reserve requirements), and the higher level of liquid assets required by banks to carry on an equal level of lending (because of greater uncertainty in the timing of bank loans and demand deposit withdrawals relative to mortgage loans and savings deposit withdrawals).

Some of the features that distinguish long-term mortgage lending from short-term lending of banks were revealed in this simulation of the Mortgage Lender. These features, as represented in the model, produced behavior which should be investigated when the Financial Sector is linked to household borrowers. For example, the

less extensive rise in mortgage rates in response to higher loan demand seems to correspond with the lower amplitude in actual mortgage yields (see the plots of comparative interest rates in the next chapter); but the earlier peak response of mortgage returns in the model simulation suggests an overly rapid adjustment by the Mortgage Lender to market conditions.*22* The next simulation test, which combines the Bank with the Mortgage Lender and Savings Investor, will show how some of the different characteristics influence the competition for funds that occurs during a period of tight monetary policy.

2. The Mortgage Lender, Bank, and Savings Investor--Open-Market Sale by the Monetary Authority

The 1960s gave rise to several important concepts in the financial literature. One of these concepts is "disintermediation" (and "reintermediation").*23* Disintermediation occurs when the public buys primary securities, such as equities and government bonds, directly rather than placing its funds in a financial intermediary, which in turn makes direct investments. The shifting occurs in response to changes in interest rates. When direct market rates climb, rates at financial

*22*In performing the time-series tests described in Chapter V, the model "fit" was improved by shortening the time to adjust returns on loans outstanding TARLO to the desired return. However, different combinations of time constants for the three lenders were not tested fully, and it may be more accurate for the Mortgage Lender in the model to adjust its rates more slowly than the short-term lender.

*23*Another important concept that evolved during the 1960s was liability management, which was considered earlier in this chapter.

institutions typically lag behind, and people move their holdings into credit and equity instruments. As returns on direct investments ease, the savings flow reverses. Figure IV-23 reveals these shifts over recent years. In relative terms, funds moved away from intermediaries and into direct credit and equity instruments during 1966; and in 1967 the process reversed. The surge into deposits and away from direct placements was even more dramatic in 1971-72.

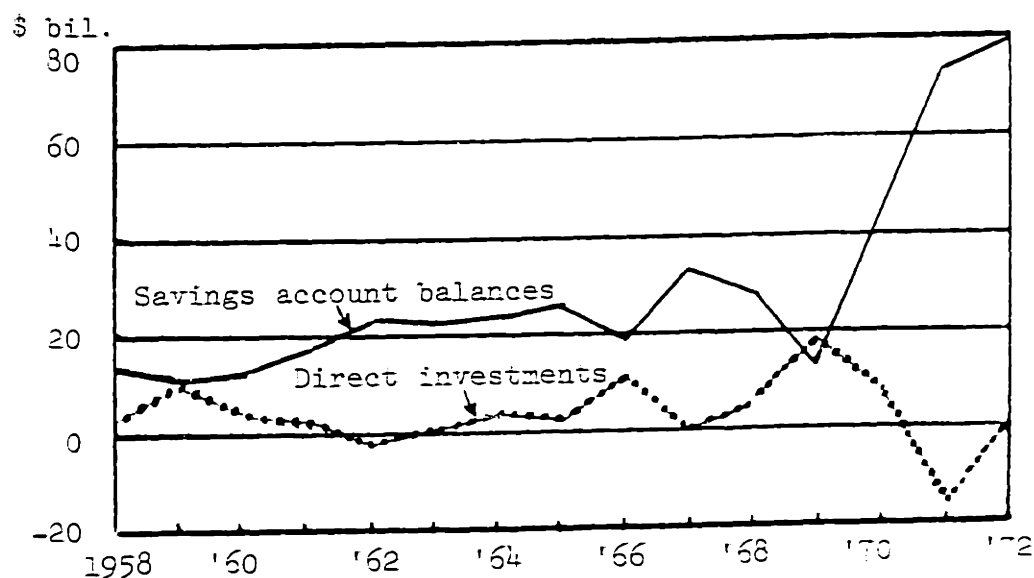


Figure IV-23. Annual Change in Savings Account Balances and Direct Investments of Households

(SOURCE: USL 1973, p. 12)

Similar to disintermediation is the shift of savings between different types of deposit intermediaries in response to changing interest rates. For example, if for reasons of officially-imposed

policy or internal management, the savings and loan institutions cannot pay as much as commercial banks for savings deposits, household funds will shift out of the S&L's and into banks. The result of this shift will hurt the mortgage market, because S&L's place virtually all of their inflow of savings into residential mortgages, while banks invest only around 15% (Brigham and Bartell 1970, p. 291). Monetary flows of this sort have been especially dramatic during recent periods of tight money, when an officially-induced "credit crunch" has encouraged savers to withdraw funds from S&L's and, thereby, imposed disproportionate pressure on construction markets. There have been periods in 1969-70 and in 1973, for example, when mortgage credit was hardly available at any price.

The impact of a "credit crunch" on both savings deposits (disintermediation) and the shift between different categories of savings deposits can be observed in the simulation described in this section. In response to an open-market sale of Treasury bills by the Monetary Authority (portrayed in the test generator),*24* savings deposits at both the Bank and Mortgage Lender decline at first, reflecting the higher relative returns on Treasury bills that results from the open-market sale. Then savings shift from deposits of the Mortgage Lender to savings deposits of the Bank, as the Bank is able to

24 A \$5 billion open-market sale is effected in the test generator by a negative step in desired Treasury bills in Monetary Authority SDTBM. This produces a discrepancy between desired and actual bills, which must be eliminated over the period prescribed by a one-year time to correct Treasury bills in Monetary Authority TCTBM.

bid more aggressively than the long-term lender for funds.

The Mortgage Lender's relative disadvantage in bidding for deposits stems not from officially-imposed ceilings, which, in fact, have been imposed in recent years, but from the internal management of the Mortgage Lender. Unlike Banks, whose short-term loans roughly match the "maturity" of their deposits, mortgage lenders rely almost entirely on "short-term," or liquid, deposits to make long-term, or highly illiquid, loans. As we saw in the previous simulation and shall see again, this mismatching of maturities affects the profitability of mortgage lenders and, thereby, the rates they are willing to pay for deposits.

The conditions for this simulation, though similar to those used for the other tests, should be noted, because they significantly affect the results. As before, the Treasury's desired sales of government securities equals maturities only, so that outstanding bills and bonds simply move to new levels in response to pressures within the Financial Sector. This means that both lending institutions in this test can obtain the funds they require by liquidating bonds, which, in turn, permits loans to settle at, or even higher than, their initial levels after the transient response to the Monetary Authority's open-market transaction. In other words, the tight money policy, as manifested by an open-market sale, fails to cut lending except over the short term. A more realistic Treasury policy (say, of maintaining a constant deficit) would force private credit to decline on balance, but

then other unexpected results would follow.*25*

One aspect of this test differs from previous tests. Whereas before, the multiplier from borrowed funds on lending MBFL always equaled one, now the amount (assumed constant) has an impact, over the short term, on Bank lending. Activating this influence permits a tight money program to have the usual direct impact on bank lending, through the Federal Reserve discount window, as well as the expected indirect effects, through relative interest rates. Among other important test conditions used here and previously, no feedbacks based on interest cost or loan extension delay occur between lender and borrower; and total savings remain constant, rather than varying in response to overall yields. Thus, the test conditions are not realistic and do not coincide with the conditions that would prevail when the sector is linked to other parts of the National Model. But the results seem logically appropriate to the given test configuration.

Figure IV-24 exhibits the variable assets of the Savings Investor as they move over a 20-year period. The figure portrays both the shift from savings deposits to direct investments (here government securities only, as variable equities are not in the current model) and the shift from one type of savings deposits to another. Disintermediation in its purest form occurs during the first two years

*25*For example, given constant savings and a constant desired Treasury deficit, interest rates would have to rise until desired Treasury sales equal total desired purchases and a very large unrealized backlog of loan requests accumulates.

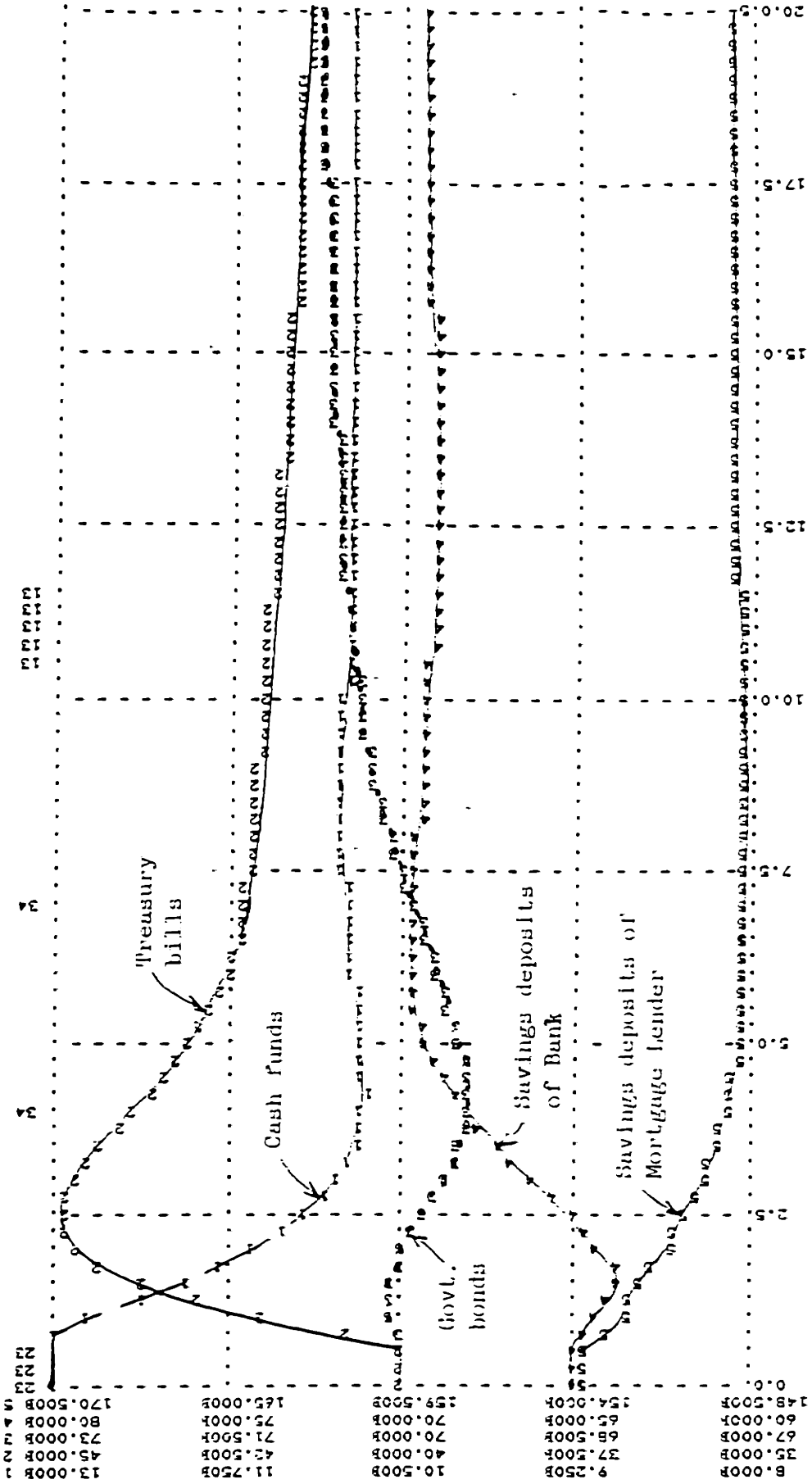


Figure IV-24. Assets of the Savings Investor in Response to Open Market Sale by the Monetary Authority - Sixth Simulation

after the Monetary Authority's open-market sale. In response to the higher interest rate on bills that results from the initial market imbalance, the Savings Investor starts to increase its holdings of bills. At the same time, the Bank, whose lending has been curtailed by the impact of the open-market transaction (see Figure IV-27), must sell bills in order to replenish its reserve position and reduce its debt to the Monetary Authority. And the Mortgage Lender, whose liquidity is affected by the net withdrawal of deposits, also reduces its bill portfolio. Thus, the open-market sale, which generates a small initial stimulus to interest rates, produces additional upward pressure on the bill yield through its effect on asset transactions throughout the sector. Bill holdings of the Savings Investor, therefore, continue to climb and, within two years, expand by almost as much as the holdings of the Monetary Authority (not shown) decline.

Government bonds in the figure rise by a slight amount at first and then fall over the next few years. The \$0.5 billion decline, however, fails to offset the \$5 billion rise in Treasury bills so that on balance the Savings Investor's direct investments have risen.*26* During the first year, both categories of savings deposits fall. In

*26*Bond holdings rise slightly at first because of the multiplier on purchase of government bonds MPGB which exceeds one when desired sales of bonds exceed total desired purchases. Over a short period, this small influence offsets the negative impact of a lower relative return on bonds and an eroded cash position. After a year, the increasing downward pressure of inadequate cash takes over and bond holdings begin to drop slowly.

both cases the decline reflects an initial lower relative return on deposits (not shown in the figure) when compared with Treasury bills, as well as the fact that cash funds decline abruptly with the additional purchase of bills. Over the first year, therefore, disintermediation occurs in its purest form: the two categories of savings deposits fall, the two kinds of variable direct investments rise.

After the initial period, however, the two types of deposits move in the opposite direction, while direct investments, on balance, remain above their initial value. Bank savings deposits rise sharply over a three-year period in response to the higher return available on Bank deposits. Deposits of the Mortgage Lender, on the other hand, continue to slide because, despite the rising yield on these deposits, the relative return continues to favor savings deposits at the Bank. Eventually, the two returns come into balance, providing just enough encouragement to offset the downward pressure of eroded cash balances.

The movement of interest rates that produces these changes will be shown in the next figure, but first observe the comparative balance sheets for the Savings Investor in Table IV-6. On balance, deposits in fiduciary institutions have hardly changed at all, with Bank deposits rising by about as much as the decline in the deposits of the Mortgage Lender. Yet the two direct investment categories are higher after 20 years, offset by a \$2 billion fall in cash funds. The final effect of the open-market sale, then, has been to encourage investors to forego the advantages of holding a comfortable, or normal, amount of money in favor of the higher yields available on their savings.

Table IV-6.
 COMPARATIVE BALANCE SHEETS OF THE SAVINGS INVESTOR--SIXTH SIMULATION
 (\$ billions)

<u>Assets</u>	<u>t=0</u>	<u>t=20</u>	<u>Liabilities</u>	<u>t=0</u>	<u>t=20</u>
Cash funds	13.0	10.9	Total savings	477.9	477.9
Treasury Bills	40.0	41.5			
Gov't bonds	70.0	70.7			
Savings Deposits					
- Bank	65.0	69.5			
- Corp. Lender	126.3	126.3			
Common stock	<u>10.0</u>	<u>10.0</u>			
	477.9	477.9			

The four active interest rates to which the Savings Investor responds are exhibited in Figure IV-25. The influences that directly affect the two savings deposit rates appear in Figure IV-26. Together, the figures tell the story that underlies both disintermediation and the relative effects of mismatched maturities among different kinds of financial institutions.

As a result of the Monetary Authority's sale of Treasury bills, the return rises sharply during the first few months and immediately encourages the purchase of bills and the reduction of other securities. The other interest rates also begin to move up, however. As the Savings Investor puts more money into bills and less into deposits, for example, liquidity in both lending institutions declines and encourages both the effective sale of bonds and the higher deposit yields necessary to recoup lost liquidity. The reduction in bonds

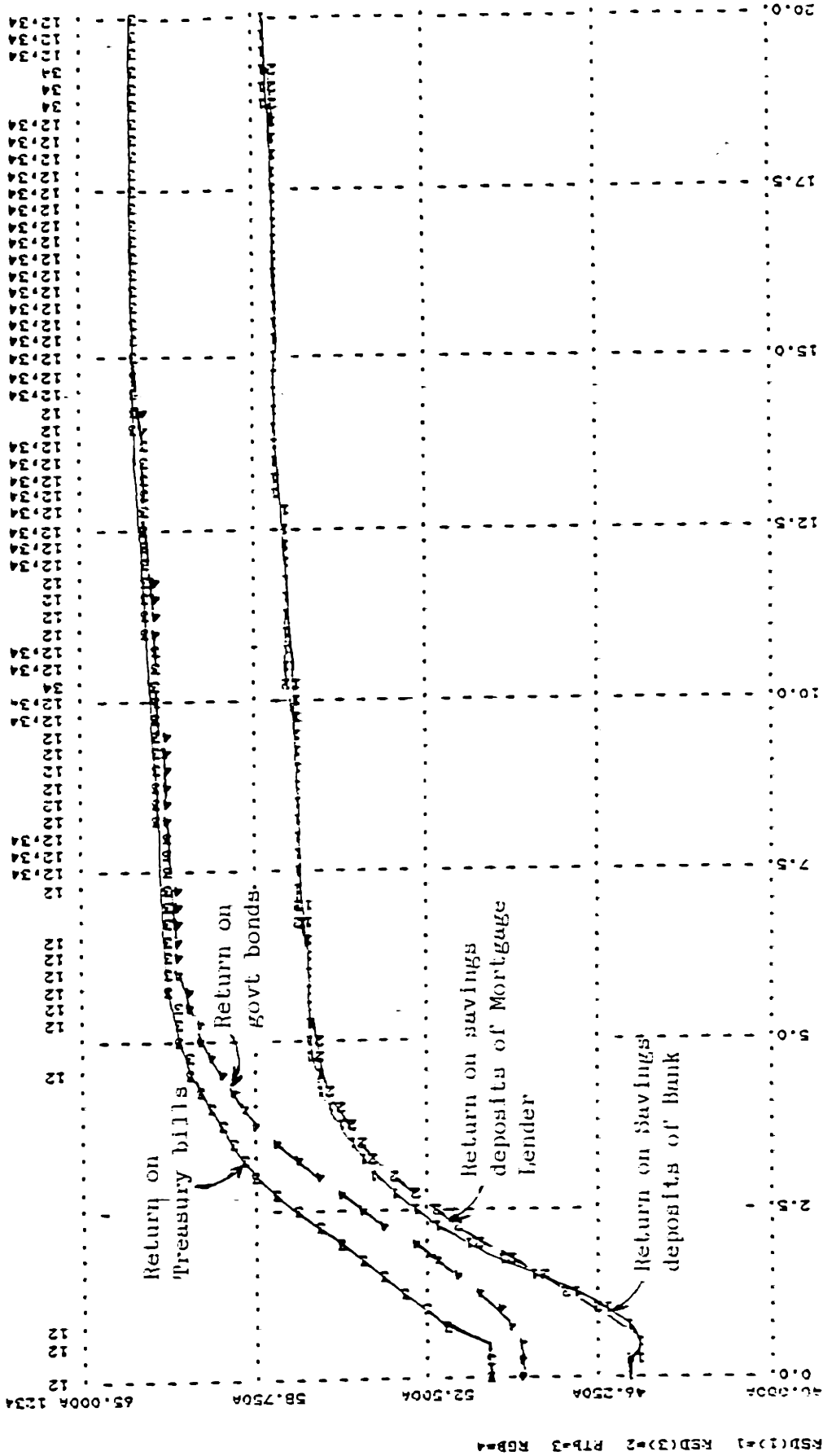


Figure IV-25. Returns on Assets of the Savings Investor
in Response to Open Market Sale by the
Monetary Authority - Sixth Simulation

causes desired sales to exceed total desired purchases, and the bond yield rises. The higher government security rates increase the average return on assets, which directly enters the determination of the return on deposits. So both the competition for funds from the government, as well as the lost liquidity, encourage rising deposit yields. On balance, the return on Bank deposits remains above the return on deposits of the Mortgage Lender, which explains the shift of funds into Bank deposits. Yet during the first half-year after the disturbance from equilibrium, the return on Bank deposits rises less rapidly than the other, so that deposits of the Bank actually decline faster as a fraction of the total than deposits of the Mortgage Lender.

In the (near) equilibrium at the end of 20 years, yields on the two types of deposits are equal, as they were in the beginning, a condition consistent with equilibrium.*27* The bond rate, however, has risen relative to the return on Treasury bills, also a condition that would prevail in equilibrium given that the Savings Investor's bond holdings exceed the initial value.*28*

*27*In equilibrium, the multiplier from return on savings deposits $MRSD(1) = MRSD(2)$, and $MRSD(1)*MCSD = MRSD(2)*MCSD = 1$, where $MCSD$ is the multiplier from cash on savings deposits and applies equally to the two kinds of deposits.

*28*In equilibrium, $MRGB(4)*MCGB(4)*MLGB(4) = 1$, where the three multipliers represent the influence of returns, cash, and liquidity, respectively. Given that bonds at $t = 20 >$ bonds at $t = 0$, $MLGB < 1$. Since $MCGB(4) = MCSD$, $MRGB(4)$ must exceed $MRSD(1)$ (and $MRSD(3)$). A higher relative return on bonds at the end of the run does imply $MRGB(4) > MRSD(1)$.

Figure IV-26 shows the major influences in each lender's savings deposit yield. Initially, the drain in deposits causes both lending institutions to lose liquidity, so the multiplier from liquidity on return on deposits rises in both cases. Because of the Mortgage Lender's greater dependence on savings deposits for liquidity, however, the multiplier for the Mortgage Lender increases more rapidly. Thus, the return on Mortgage Lender deposits actually rises above the return on Bank deposits during the first six months.

As in the previous simulation, however, profitability of long-term lenders is adversely affected during a period of rising returns, because interest costs rise with the return on deposits, while profits do not reflect higher loan yields until after some delay. As deposit rates and loan yields rise, therefore, profits of the Bank increase and cause some upward pressure on the deposit yield, while profits of the Mortgage Lender decline and cause sharp downward pressure on the deposit yield. The initial rapid rise in the yield on Mortgage Lender deposits slows down as a result, and Bank deposit rates pull ahead thereafter just enough to attract liquidity at the Mortgage Lender's expense.

Reduced profit in the Mortgage Lender not only causes deposit rates to lag, but also generates a sharp upward movement in the return on loans (not shown in the figure). As a result, the return on mortgage loans rises faster than the Bank rate. In fact, it actually overshoots the eventual values, because profits rise after revenues begin to

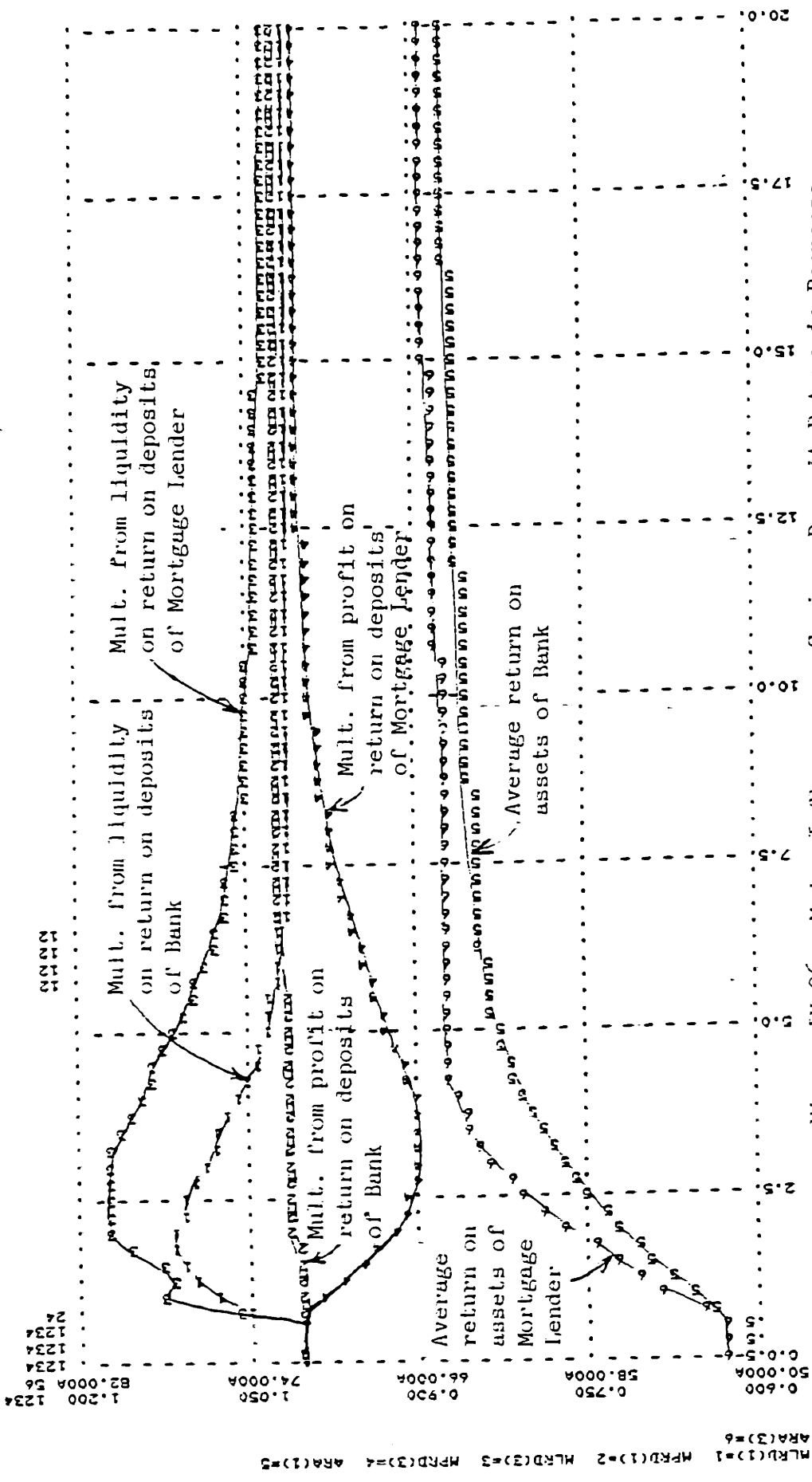


Figure IV-26. Major Influences on Savings Deposit Return in Response to Open Market Sale by the Monetary Authority - Sixth Simulation

MLRD(1)=1 MPRD(1)=2 MLRD(2)=3 MPRD(2)=4 APR(1)=5
 APR(2)=6

reflect the higher return and, thereby, cause reduced upward pressure on the loan yield. During the rapid rise, the average return on Mortgage Lender assets (ARA(3)) expands faster than the average return at the Bank (ARA(1)). As we have seen, though, the impact of relative profitability more than offsets this effect and causes the discrepancy in deposit returns.

The test described in this simulation produces the impact of mismatched maturities without the official ceiling on deposit yields that accounted in large part for the periods of reduced mortgage lending during recent years. Permitting the Mortgage Lender to respond solely to internally-generated pressures, therefore, has produced an effect similar to the imposition of a ceiling. The test suggests that even without official intervention, mortgage markets would be disproportionately affected during a credit crunch.*29*

To complete the consideration of this test, Figure IV-27 shows the Bank's loan extension rate and the multipliers that directly affect lending. Because of the Monetary Authority's sale of Treasury bills, Bank-owned reserves immediately decline, causing excess reserves (not shown) to fall simultaneously and borrowed reserves to rise. Eroded excess reserves affect lending through the multiplier from cash funds on lending, and higher borrowing also cuts lending through the multiplier

*29*However, if mortgage lending institutions were encouraged to apply floating, rather than fixed rates to mortgage loans, as recommended in (Lessard and Modigliani 1975), then the restraint from relative profits on deposit yields would be reduced.

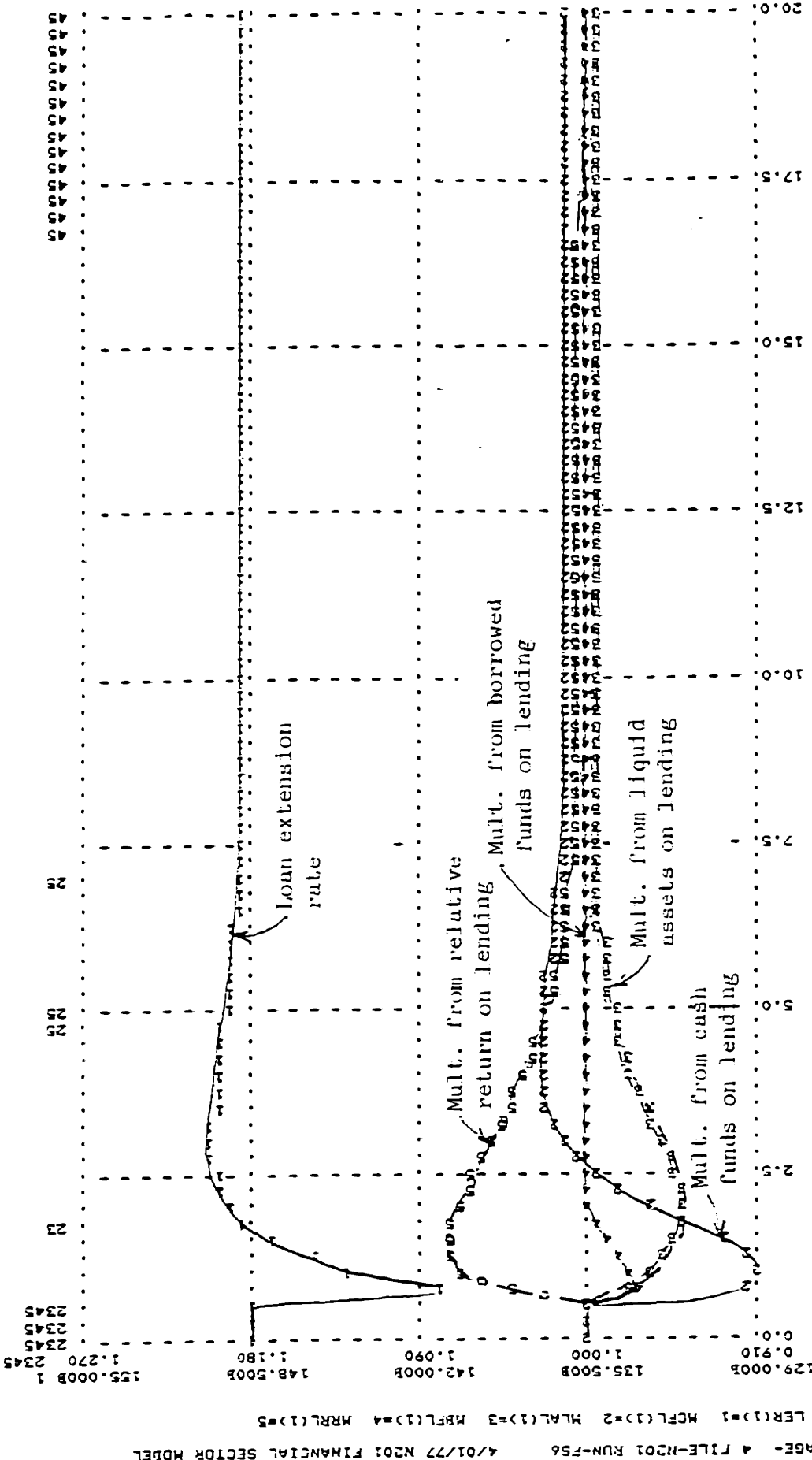


Figure IV-27. Bank lending Variables in Response to Open Market Sale by the Monetary Authority - Sixth Simulation

from borrowed funds on lending. Lending, therefore, falls by about 5% within three months, but then returns briskly to its original rate as backlog builds up, borrowing subsides, cash funds (excess reserves) begin to rebuild, and the return on loans rises. Within a short time, in fact, the impact of a higher loan yield offsets the drag reflected in the other three multipliers. Cash funds climb above the initial level, because of the Bank's success in converting bonds into cash and demand deposits into savings deposits. The lending rate actually equilibrates slightly higher than where it started, despite the Monetary Authority's initial act of restraint.*30*

Tables IV-7 and IV-8 provide balance sheets for the Bank and Mortgage Lender that summarize how each institution has managed eventually to meet loan demand in the face of restrictive monetary policy. For the Bank, lending is slightly higher at $t = 20$ than at the beginning. To recoup the \$5 billion lost in owned reserves, the Bank sells off bonds, thereby reducing demand deposits (of the government) and freeing up excess reserves. At the same time, additional demand deposits are converted into savings deposits. The net change in deposit composition causes required reserves to decline by \$2.1 billion ($= 0.22*11E9 - 0.1*4.5E9$).

*30*This unexpected new "equilibrium" seems to reflect the manner in which the Treasury (test generator) accommodates to the Financial Sector by reducing its loan demand, and the lack of price and availability feedbacks to borrowers. A higher-than-initial lending rate resulting from a similar test with a more realistic environment for the Financial Sector could indicate structural problems that are not apparent from the current tests.

At the same time, owned reserves (not shown in the table) fall by an equal amount. This decline reflects the fact that government debt and, therefore, total money, declines by about \$14.6 billion. To retain the desired ratio of currency to money, the public deposits about \$2.9 billion ($= 0.2 * 14.6E9$) with the Bank. Therefore, the effect of the initial bill transaction is partially offset by currency deposits, and owned reserves decline by only \$2.1 billion rather than by the full \$5 billion. The decline in required reserves equals the fall in owned reserves, so that excess reserves end up close to the initial value.

Table IV-7
COMPARATIVE BALANCE SHEETS OF THE BANK--SIXTH SIMULATION
(\$ billions)

<u>Assets</u>	<u>t=0</u>	<u>t=20</u>	<u>Liabilities</u>	<u>t=0</u>	<u>t=20</u>
Reserves	43.4	41.3	Demand deposits	165.9	154.2
- Owned	(43.0)	(40.9)	Savings deposits	65.0	69.5
- Required	(43.0)	(40.9)	Borrowed reserves	0.4	0.4
Treasury Bills	15.2	14.8	Equity	15.8	15.0
Gov't bonds	40.0	34.0			
Loans	<u>148.5</u>	<u>149.0</u>			
	247.1	239.1		<u>247.1</u>	<u>239.1</u>

Comparative balance sheets for the Mortgage Lender are more straightforward. Like the Bank, total assets decline. To compensate

for lost deposits, the Mortgage Lender sells off bonds by a roughly equivalent amount, and loans stay level.*31*

Table IV-8
COMPARATIVE BALANCE SHEETS OF THE MORTGAGE LENDER--SIXTH SIMULATION
(\$ billions)

<u>Assets</u>	<u>t=0</u>	<u>t=20</u>	<u>Liabilities</u>	<u>t=0</u>	<u>t=20</u>
Cash funds	3.4	3.6	Savings deposits	153.6	149.0
Treasury Bills	1.1	0.6	Equity	11.0	10.1
Gov't bonds	10.0	4.9			
Loans	<u>150.0</u>	<u>150.0</u>			
	164.5	159.1		<u>164.5</u>	<u>159.1</u>

(Columns may not add due to rounding.)

Together, the balance sheets of the three institutions reveal that a \$5 billion sale of bills by the Monetary Authority has produced three times as large a reduction in total government securities. Simultaneously, the sale has raised interest rates by about 30%. If the government were not prepared to accept such a reduced budget, as one would expect in reality, the impact of the open-market transaction on interest rates would have been considerably greater. It appears,

*31*Lending of the Mortgage Lender actually changes slightly during the first few years, exhibiting a disturbingly short (about 15 months) fluctuation before settling back to the original value. The short-term fluctuation also appears in the first time-series run described in Chapter V, attributed to the effective short time constant in adjusting the small pools of cash and liquidity through the large flow of savings deposits. The second time-series test reflects a longer average turnover of savings deposits, thereby eliminating the short-term instability.

therefore, that official monetary actions can produce a cascaded, and therefore, substantial impact on financial markets.

3. The Full Financial Sector--Noise in Demand for Bank Loans

Considerable space could be devoted to this and other tests of the entire Financial Sector. On the other hand, the basic mechanisms of asset and liability management have come out in the preceding, more restrictive simulations. This test, therefore, simply touches the surface of the rich behavior produced by the Financial Sector structure. While the results generally appear reasonable, certain aspects of the behavior raise questions that could lead to eventual model refinement.*32*

The test described here involves the same exogenous noise in (Bank) loan demand as was used to produce the simulation of Bank and

*32*Most troublesome is the system's sensitivity to the computation interval (DT) being used. With DT anywhere near the length used for other parts of the National Model (DT = 0.0625 in recent tests), the Financial Sector exhibits spurious behavior that can only be eliminated with a smaller value. For most of the tests in this chapter, a DT of 0.03125 (roughly 11 days) has been sufficiently small. But with several interacting sectors each competing for a limited pool of savings, a smaller DT becomes necessary. Thus, for the noise run, and for the time-series test in Chapter V (similar to a full sector noise test), a DT of 0.015 is employed. As discussed previously and in Chapter VI, the problem seems to lie with the relationship between the large flows of savings deposits, especially for long-term lenders, and the small levels of cash and liquidity that affect asset purchases. The problem is technical in nature, as it does not affect the conclusions or basic structure of the current Financial Sector; but it could lead to changes in the way deposits are modeled and, possibly, in the definition of certain operating concepts, such as cash and liquidity, that would permit larger relative values than currently appear in the model.

Savings Investor described previously. Thus we should compare the results with that test to see if the same phasing and amplitude patterns are observed and what differences exist as a result of adding the two long-term lenders.

Figure IV-28 shows the three loan levels from the model. Unlike the noise test of the Bank and Savings Investor, no distinct period of oscillation is readily discernible, although the movement in Bank loans, and more obviously the change in loans of the non-Bank lenders, show more turning points than before. Basically, a 2- to 5-year cyclical pattern is suggested, although repeated noise tests and sine-wave inputs with different periods would be necessary to establish the inherent frequency (or frequencies) of the system. A variety of such tests have not been performed, however, because of the focus here on phasing and relative amplitudes among the major financial variables.

Bank loans in the figure, which respond directly to the portion of demand affected by noise, exhibit a far wider range of fluctuation than non-bank loans, with a maximum excursion of about 4% away from the mean (initial) value. Long-term loans, on the other hand, oscillate within less than 0.5%. Despite the large amplitude difference in loan levels, however, the relative amplitudes of fluctuation in lending rates (not shown in the figure) are roughly equivalent, due to the long average lifetimes of outstanding credit of the Corporate Lender and Mortgage Lender. No part of the system is immune, therefore, to disturbances from one source of loan demand.

In addition to amplitude differences, the two long-term loan

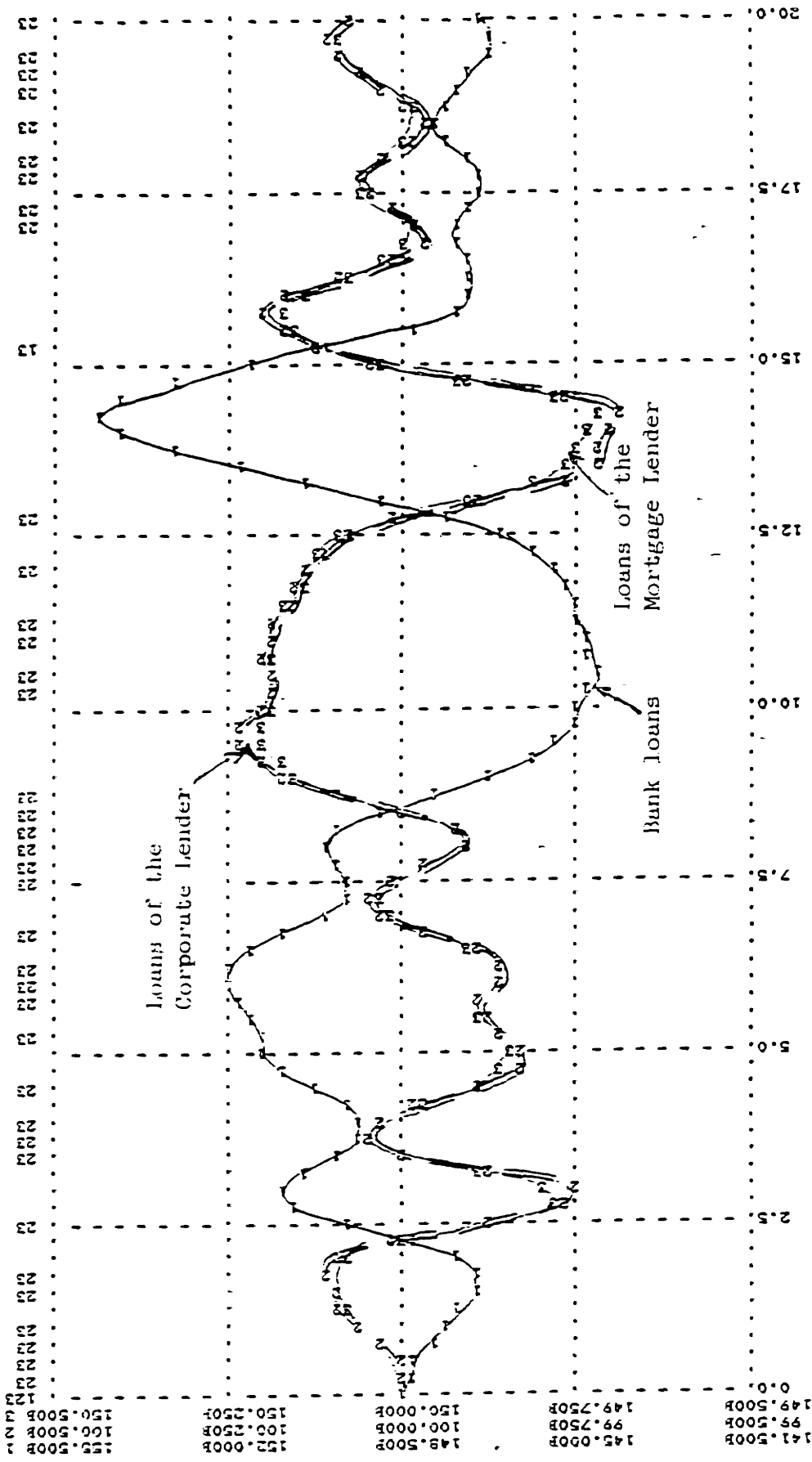


Figure 1V-28. Loans Outstanding in Response to Noise in Demand for Bank Loans - Seventh Simulation

levels move exactly in phase and, together, are about 180 degrees out of phase with Bank loans. In the model, this relative phasing results in the competition for deposits among the three lending institutions. But is this result realistic? In Figure IV-29, data on the three categories of primary credit, as they are defined in the model, are plotted over the period 1961-75.*33* Because the period exhibits consistent growth (except for short-term loans in 1975), fractional growth rates from year to year, rather than absolute values, were used for the three series.

The figure exhibits some, but not complete similarity with the data generated by the model. First, growth in all three forms of debt tended to oscillate with a 3- to 4-year period during the last 15 years. Accompanying the regular fluctuations in all of the credit categories, moreover, growth in short-term debt covered a range of 20% while growth in long-term debt ranged over only 10%. The phasing between two of the loan categories also coincides with the model's behavior, as growth in short-term loans in the figure moved roughly 180 degrees out of phase with long-term corporate loans. Mortgage credit, on the other hand, seemed to move more in phase with short-term debt than with the other long-term category. Except for the phasing of mortgage credit, however, loan data and model output compare fairly well. Yet we should not attribute too much significance to such a comparison until the sector is linked to a more detailed loan demand structure.

*33*The data is based on the time-series used in Chapter V and appearing as tables in the full program listing found in Appendix 3.

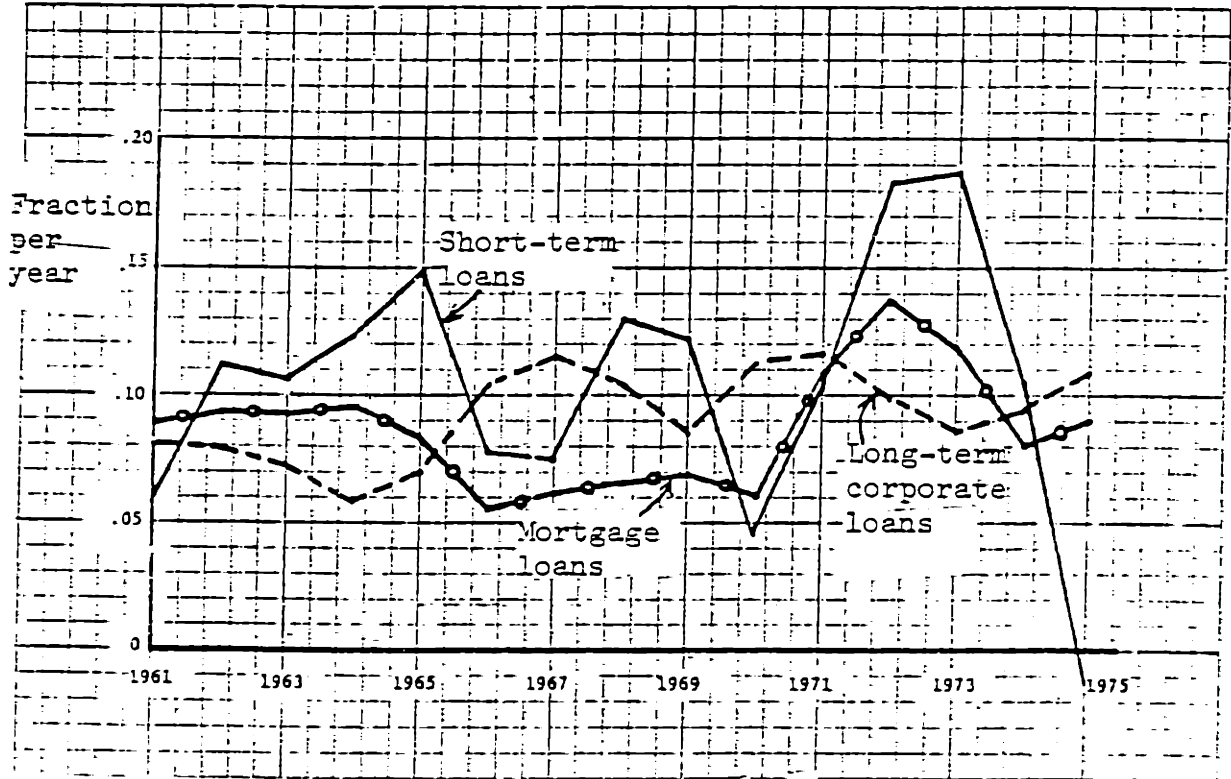


Figure IV-29. Annual Change in Three Categories of Primary Credit, 1961-1975

Figure IV-30 exhibits data from the model for total bonds outstanding and bills owned by the Bank and Savings Investor. As in the previous sine-wave and noise tests of the Bank and Savings Investor, Treasury bills tend to fluctuate countercyclically with Bank debt, a result, we saw, that coincides with investigations of Conard, Kessel, and others (see Tests #3 and #4 in this chapter). In the simulation of the full sector, in fact, the change in total outstanding bills reflects mainly the activities of the Bank, whose holdings, as before, move directly counter to short-term loans and show a considerably greater degree of fluctuation. Total bills, however, do not move over as wide a range as Bank holdings alone, because of the tendency of the Savings Investor to buy when the Bank is selling and vice-versa. Since the Bank and Savings Investor are the only large holders of Treasury bills in the model, this countercyclical behavior appears to be important in stabilizing the various public and private credit markets.

Similar phasing in the holdings of Treasury bills can be seen in data from the last 15 years. Figure IV-31, like Figure IV-29, portrays relative asset holdings (here, Treasury bills) over the last 15 years by plotting fractional changes, rather than absolute amounts. During most of the period, growth in Treasury bills held by the

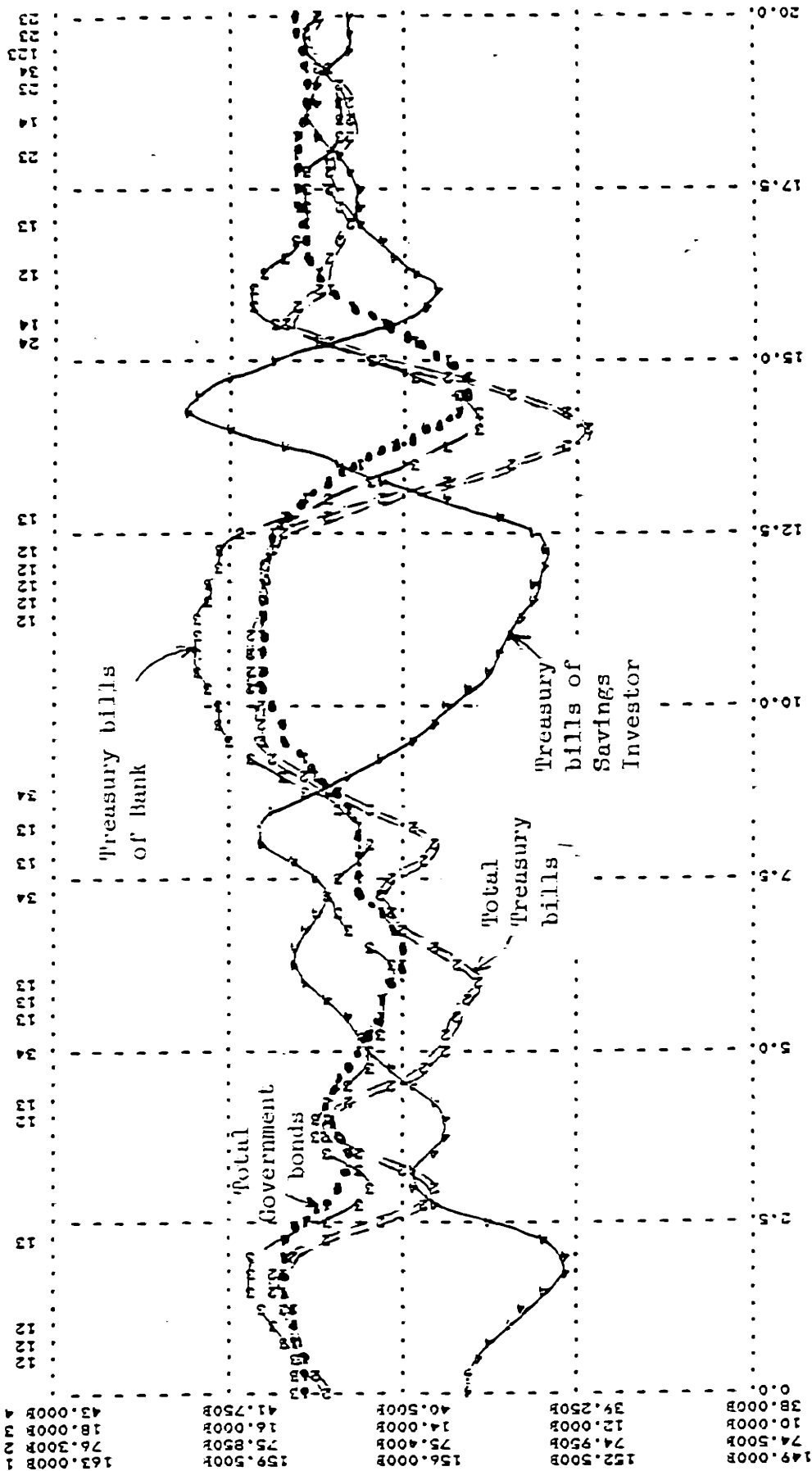


Figure IV-30. Government Securities in Response to Noise in Demand for Bank Loans - Seventh Simulation

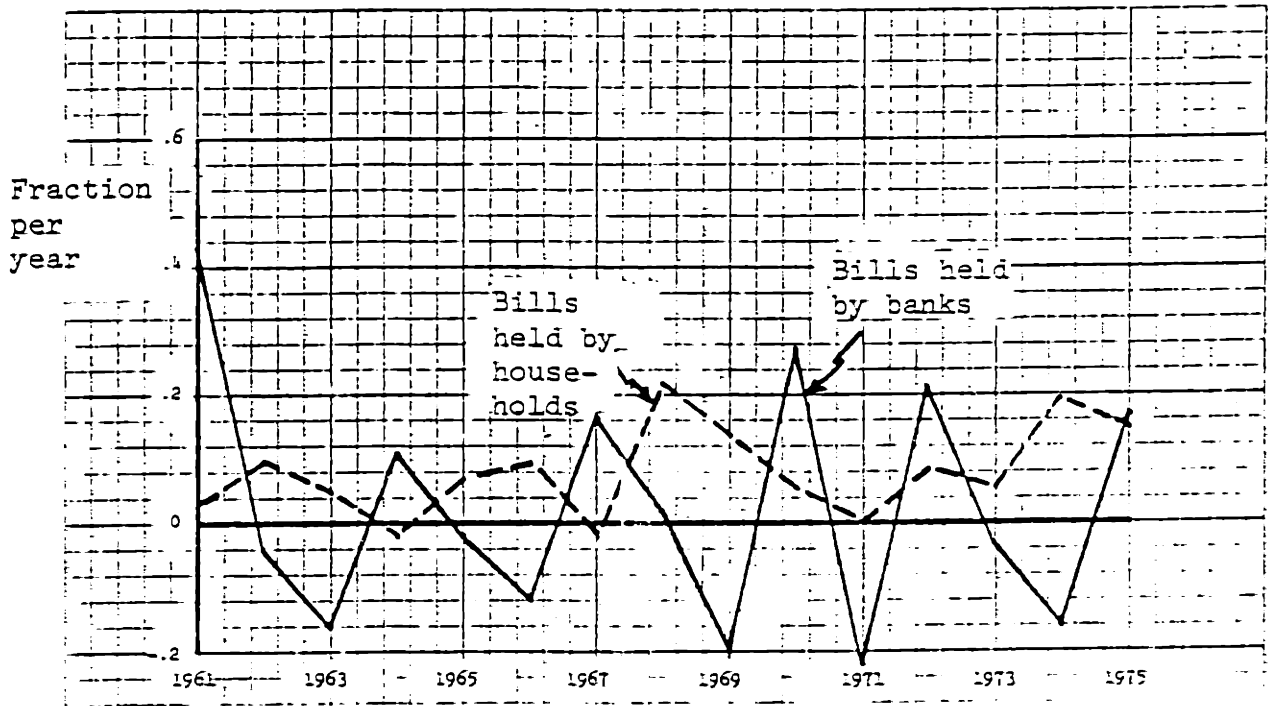


Figure IV-31. Annual Change in Treasury Bills Held by Banks and Households, 1961-1975

commercial banking system moved directly counter to the growth in bills held by households.*34* The only obvious exception occurred in 1971, when growth in bill holdings declined for both categories. But in that year, unlike almost all of the previous years, total outstanding Treasury bills declined, so that the change in household ownership compared with the change in the total (0% versus about -4%) was positive; whereas bank holdings declined by a full 22%. In addition to exhibiting the same phasing as the model, the time-series data show the same tendency of bank-held Treasury bills to fluctuate over a far wider relative range than bills held by households.

Figure IV-30 also shows total government bonds from the model. As in the previous tests of the Bank and Savings Investor alone, bonds tend to move counter to Bank loans, but with a similar lag of about 9 months. In the previous tests, the relative phasing of government bonds appeared consistent with observation. But in this test, the amplitude of oscillation is greater than the relative amplitude in total Treasury bills, which is not consistent with empirical evidence.

The last figure for this test plots the eight active interest rates in the Financial Sector. As in the simpler, partial sector tests, the phasing of loan yields and government security yields compares well

*34*The data is derived from the FRB Bulletin series entitled, "Ownership of Marketable [U.S. Government] Securities by Maturity." "Treasury bills" includes all U.S. government securities with < 1 year to maturity. The series indicates holdings by major investor groups, where "all others" consists mainly of households and is the source of the "household" data in Figure IV-31.

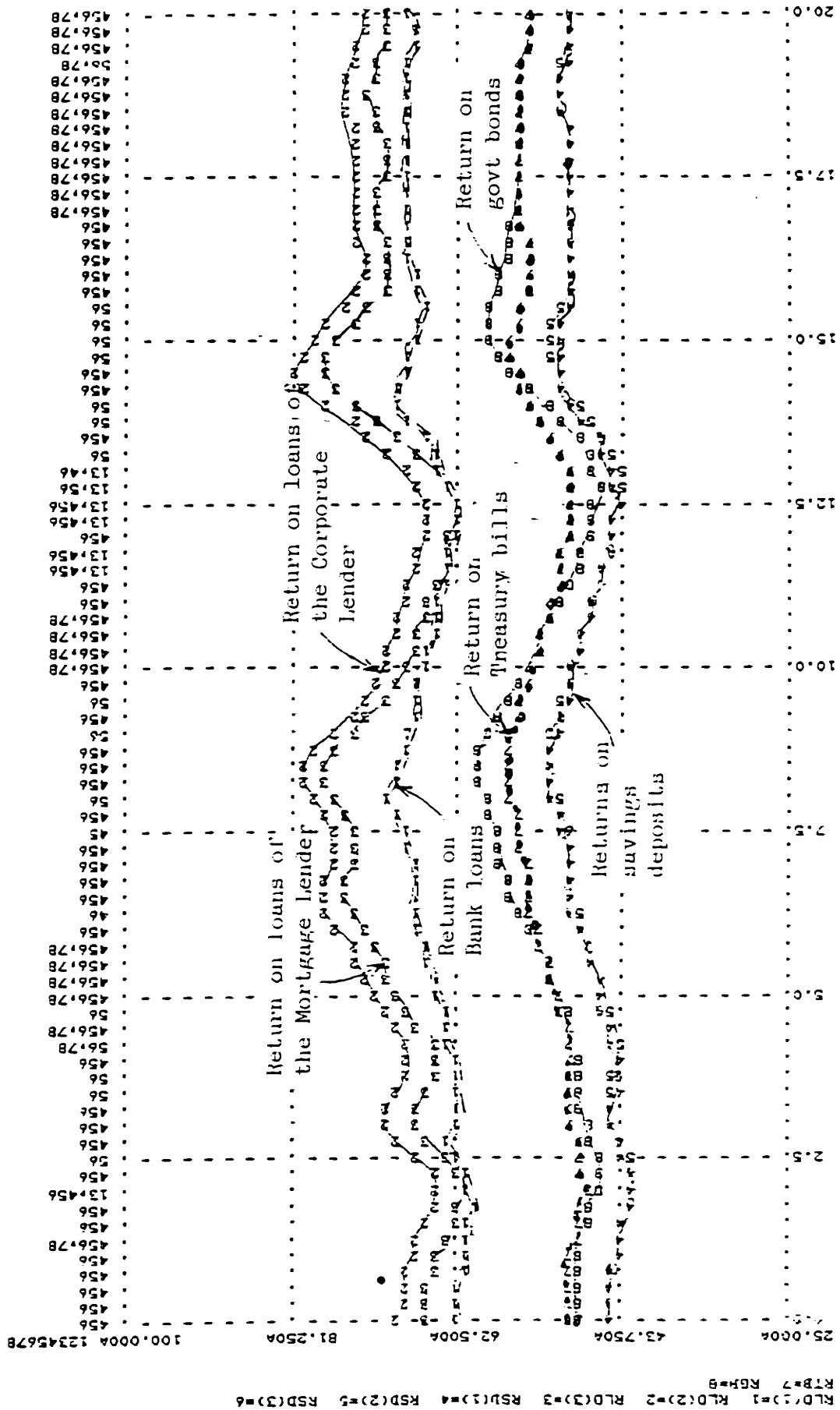


Figure IV-32. Interest Rates in Response to Noise in Demand for Bank Loans - Seventh Simulation

with observed patterns. The three loan returns move roughly in phase, with a slight lag, as observed, in long-term yields. The returns on bank loans and bill rates appear to move in phase, while the bond rate lags the other two by about 6 months. However, the relative amplitude patterns do not compare well with observed behavior. The bond yield tends to oscillate over a wider range than the return on bills, while the opposite seems to be true in reality. And, similarly, long-term rates exhibit greater amplitude than the return on short-term loans. In the model, the wider excursions in long-term yields reflect the strong tendency of low relative profits to push interest rates up, as we saw in the tests of the Mortgage Lender. This mechanism, though important in the model, may be less significant in reality and perhaps should be modified.

D. Conclusions

The series of dynamic tests described in this chapter has revealed a process of model development as well as a set of results. Simulations under a variety of conditions have investigated the model's internal consistency and the manner in which the model compares with empirical observation. This process is by no means complete, however, as one should conduct additional tests of parameter sensitivity as well as the model's response to extreme conditions (what might be called "destructive testing"). A few words about both kinds of tests will reveal what has already been done or remains for the future.

The Financial Sector model contains a large number of

parameters that could be varied alone or in different combinations. Fortunately, however, many of the parameter values are confined to fairly narrow ranges because of general consensus or internal logic. For example, most people would agree that the average life of government bonds ALGB in the model should be about 6 years. Or, in another case, the overall shape of the table for multiplier from relative returns TMRR (see Appendix 1, Equation 18) can be defended in terms of logical consistency, which then prescribes the slope over most operating conditions to a fairly narrow range. Therefore, parameters like these do not require as much testing as other parameters, whose meaning may be more abstract or which apply to more aggregate relationships.

Some tests, mostly unreported in this chapter or the next, have examined the impact of parameter changes on model behavior. For example, changing some parameters in the test generator modifies system stability considerably,*35* while increasing the exponent for multiplier from liquid assets on lending EMLAL increases the direct impact of liquidity on lending and reduces the sector's stability. In most cases, however, changes in parameter values pass the burden of control from one point in the system to another, thereby introducing a shift in feedback loop dominance but producing few important variations in overall system behavior. Most likely, such compensating shifts would

*35*Reducing the values of time to correct loans and backlog in test generator TCLBTG produces greater instability, as does eliminating the backlog correction term in the request for loans by setting the coefficient for backlog correction in test generator CBCTG to zero.

serve to reduce the impact of parameter variations in the test generator if the test generator were expanded to include the more realistic details of the other National Model sectors.

As reported in Chapter V, some of the system parameters were modified during the process of time-series testing. Thus the slope of the table that determines the fractional change in government security yields (TFCR, in Equations 54 and 77) was increased to produce more realistic changes in amplitude and speed of adjustment. Section C.2 of Chapter V reports a test of the system's sensitivity to a change in the average life of savings deposits ALSD. The increased value (from 0.5 to 3 years) portrays a more realistic average turnover and eliminates the troublesome instability alluded to in connection with the last two tests of Chapter IV. Moreover, the test also reveals the shift in loop dominance, as discussed earlier, that restricts the overall impact of the parameter variation to a narrow aspect of behavior. Other parameter sensitivity tests, especially in connection with the impact of demand, profitability, and spreads on interest rates, should be conducted in the future.

Extreme-condition, or "destructive" testing should also be pursued. In most econometric models, the assumption of conditions that did not prevail during the period used to estimate parameters, for example 1% unemployment when a higher percentage existed during the sample period, can produce absurd (illogical) results. System dynamics models should be able to accommodate such extreme conditions if the principle of conservation is properly observed. Thus a 100% step in

loan demand should generate logical, even if unusual behavior in the Financial Sector.

Certain conditions, however, could produce problems. If there were literally no loan demand, desired liquid assets DLA, which is proportional to the backlog of loan requests, would equal zero. Apart from the computation problem that would result (some ratios would have a zero denominator), one would have to consider the logic of a bank or other lending institution not wanting any liquid assets under such conditions. Such extreme-condition tests, which can be simulated or imagined, can lead to important structural revisions. As with parameter sensitivity testing, "destructive" testing, therefore, will be pursued in the future.

While the process of simulation reported in this chapter has revealed some weaknesses in the Financial Sector model, many features of the structure and its behavior compare well with empirical observation. The nature of bank asset management, for example, produces reasonable lending and securities investment behavior. The addition of liability management, mainly involving the determination of savings deposit rates, generates observed flows of liquidity between fiduciary deposits and direct investments. The use of sine-wave and noise inputs reveals, in most cases, the phasing and amplitude changes that have been observed in the movement of asset holdings and interest rates. On balance, then, the tests in this chapter have made a successful start to the on-going process of model development.

APPENDIX IV-1: Rerun Conditions Used to Simulate the Financial Sector Model

CHANGES FOR RERUN - FS1

ORIGINAL LENGTH	10.000					
PRESENT LENGTH	20.000					
ORIGINAL CTFS	1.000	1.000	1.000	1.000		
PRESENT CTFS	1.000	0.0	0.0	0.0		
ORIGINAL TFCR	-2.000	-1.500	0.0	1.500	2.000	
	2.300	2.500				
PRESENT TFCR	0.0	0.0	0.0	0.0	0.0	
	0.0	0.0				
ORIGINAL CTSD	1.000	1.000	1.000			
PRESENT CTSD	0.0	0.0	0.0			
ORIGINAL TDFSD	0.400	100.000A	20.000A	1.000A	0.500A	
PRESENT TDFSD	0.500A	0.500A	0.500A	0.500A	0.500A	
ORIGINAL TARSD	1.000	1.000	1.000			
PRESENT TARSD	12.000R	1.000	1.000			
ORIGINAL SDLTG	0.0	0.0	0.0			
PRESENT SDLTG	15.000B	0.0	0.0			
ORIGINAL TSDL	0.0					
PRESENT TSDL	0.500					
ORIGINAL TCTB	0.400					
PRESENT TCTB	12.000R					
ORIGINAL TCGB	0.750					
PRESENT TCGB	12.000R					

CHANGES FOR RERUN - FS2

ORIGINAL LENGTH	10.000					
PRESENT LENGTH	20.000					
ORIGINAL CTFS	1.000	1.000	1.000	1.000		
PRESENT CTFS	1.000	0.0	0.0	1.000		
ORIGINAL CTSD	1.000	1.000	1.000			
PRESENT CTSD	1.000	0.0	0.0			
ORIGINAL TDFSD	0.400	100.000A	20.000A	1.000A	0.500A	
PRESENT TDFSD	0.500A	0.500A	0.500A	0.500A	0.500A	
ORIGINAL SDLTG	0.0	0.0	0.0			
PRESENT SDLTG	15.000B	0.0	0.0			
ORIGINAL TSDL	0.0					
PRESENT TSDL	0.500					
ORIGINAL TCTB	0.400					
PRESENT TCTB	12.000R					
ORIGINAL TCGB	0.750					
PRESENT TCGB	12.000R					

APPENDIX IV-1: Rerun Conditions Used to Simulate the Financial Sector Model

CHANGES FOR RERUN - FS1

ORIGINAL LENGTH	10.000					
PRESENT LENGTH	20.000					
ORIGINAL CTFS	1.000	1.000	1.000	1.000		
PRESENT CTFS	1.000	0.0	0.0	0.0		
ORIGINAL TFCR	-2.000	-1.500	0.0	1.500	2.000	
	2.300	2.500				
PRESENT TFCR	0.0	0.0	0.0	0.0	0.0	
	0.0	0.0				
ORIGINAL CTSD	1.000	1.000	1.000			
PRESENT CTSD	0.0	0.0	0.0			
ORIGINAL TDFSD	0.400	100.000A	20.000A	1.000A	0.500A	
PRESENT TDFSD	0.500A	0.500A	0.500A	0.500A	0.500A	
ORIGINAL TARSD	1.000	1.000	1.000			
PRESENT TARSD	12.000R	1.000	1.000			
ORIGINAL SDLTG	0.0	0.0	0.0			
PRESENT SDLTG	15.000B	0.0	0.0			
ORIGINAL TSDL	0.0					
PRESENT TSDL	0.500					
ORIGINAL TCTB	0.400					
PRESENT TCTB	12.000R					
ORIGINAL TCGB	0.750					
PRESENT TCGB	12.000R					

CHANGES FOR RERUN - FS2

ORIGINAL LENGTH	10.000					
PRESENT LENGTH	20.000					
ORIGINAL CTFS	1.000	1.000	1.000	1.000		
PRESENT CTFS	1.000	0.0	0.0	1.000		
ORIGINAL CTSD	1.000	1.000	1.000			
PRESENT CTSD	1.000	0.0	0.0			
ORIGINAL TDFSD	0.400	100.000A	20.000A	1.000A	0.500A	
PRESENT TDFSD	0.500A	0.500A	0.500A	0.500A	0.500A	
ORIGINAL SDLTG	0.0	0.0	0.0			
PRESENT SDLTG	15.000B	0.0	0.0			
ORIGINAL TSDL	0.0					
PRESENT TSDL	0.500					
ORIGINAL TCTB	0.400					
PRESENT TCTB	12.000R					
ORIGINAL TCGB	0.750					
PRESENT TCGB	12.000R					

CHANGES FOR RERUN - FS3

ORIGINAL LENGTH	10.000				
PRESENT LENGTH	40.000				
ORIGINAL CTFS	1.000	1.000	1.000	1.000	
PRESENT CTFS	1.000	0.0	0.0	1.000	
ORIGINAL CTSD	1.000	1.000	1.000		
PRESENT CTSD	1.000	0.0	0.0		
ORIGINAL TDFSD	0.400	100.000A	20.000A	1.000A	0.500A
PRESENT TDFSD	0.500A	0.500A	0.500A	0.500A	0.500A
ORIGINAL AMPSW	0.0	0.0	0.0		
PRESENT AMPSW	15.000B	0.0	0.0		
ORIGINAL PLTS1	0.0				
PRESENT PLTS1	30.000				

CHANGES FOR RERUN - FS4

ORIGINAL LENGTH	10.000				
PRESENT LENGTH	20.000				
ORIGINAL PRTPER	0.0				
PRESENT PRTPER	1.000				
ORIGINAL CTFS	1.000	1.000	1.000	1.000	
PRESENT CTFS	1.000	0.0	0.0	1.000	
ORIGINAL CTSD	1.000	1.000	1.000		
PRESENT CTSD	1.000	0.0	0.0		
ORIGINAL TDFSD	0.400	100.000A	20.000A	1.000A	0.500A
PRESENT TDFSD	0.500A	0.500A	0.500A	0.500A	0.500A
ORIGINAL SDNTG	0.0	0.0	0.0		
PRESENT SDNTG	50.000A	0.0	0.0		

CHANGES FOR RERUN - FS5

ORIGINAL LENGTH	10.000				
PRESENT LENGTH	20.000				
ORIGINAL CTFS	1.000	1.000	1.000	1.000	
PRESENT CTFS	0.0	0.0	1.000	1.000	
ORIGINAL CTSD	1.000	1.000	1.000		
PRESENT CTSD	0.0	0.0	1.000		
ORIGINAL TDFSD	0.400	100.000A	20.000A	1.000A	0.500A
PRESENT TDFSD	0.500A	0.500A	0.500A	0.500A	0.500A
ORIGINAL SDLTG	0.0	0.0	0.0		
PRESENT SDLTG	0.0	0.0	15.000B		
ORIGINAL TSDL	0.0				
PRESENT TSDL	0.500				
ORIGINAL TCTB	0.400				
PRESENT TCTB	12.000R				
ORIGINAL TCGB	0.750				
PRESENT TCGB	12.000R				

CHANGES FOR RERUN - FS6

ORIGINAL LENGTH	10.000					
PRESENT LENGTH	20.000					
ORIGINAL CTFS	1.000	1.000	1.000	1.000		
PRESENT CTFS	1.000	0.0	1.000	1.000		
ORIGINAL CTSD	1.000	1.000	1.000			
PRESENT CTSD	1.000	0.0	1.000			
ORIGINAL TDFSD	0.400	100.000A	20.000A	1.000A	0.500A	
PRESENT TDFSD	0.500A	0.500A	0.500A	0.500A	0.500A	
ORIGINAL TCTBM	0.500					
PRESENT TCTBM	1.000					
ORIGINAL SDTBM	0.0					
PRESENT SDTBM	-5.000B					
ORIGINAL TCTB	0.400					
PRESENT TCTB	12.000R					
ORIGINAL TCGB	0.750					
PRESENT TCGB	12.000R					
ORIGINAL CTBRB	1.000					
PRESENT CTBRB	0.0					

CHANGES FOR RERUN - FS7

ORIGINAL DT	31.250A					
PRESENT DT	10.000A					
ORIGINAL LENGTH	10.000					
PRESENT LENGTH	20.000					
ORIGINAL TDFSD	0.400	100.000A	20.000A	1.000A	0.500A	
PRESENT TDFSD	0.500A	0.500A	0.500A	0.500A	0.500A	
ORIGINAL SDNTG	0.0	0.0	0.0			
PRESENT SDNTG	50.000A	0.0	0.0			

APPENDIX IV-2: Equilibrium Conditions for the Financial Sector--
Mortgage Lender plus Savings Investor

In equilibrium, asset purchases must equal maturities, which means that the multipliers affecting the purchase of each asset must together equal 1. This note is designed to show how one might work out the various combinations of forces that could produce an equilibrium condition. One cannot infer, however, that the model necessarily reaches a real equilibrium when confronted with a step change in desired loans. The discussion is offered, therefore, as an indication of how one might think about equilibrium in the model or, indeed, in the real economy. Are there situations in reality, for example, where either all goals can be realized simultaneously and thus produce equilibrium (unlikely), or where conflicting goals somehow balance each other out and imply an equilibrium (more likely)? If simultaneous pressures fail to offset each other, do goals change rapidly enough in relation to each other so as to bring about equilibrium in the absence of random or other exogenous disturbances?

In the Financial Sector, there are many objectives--including equating cash to desired cash, attaining acceptable ratios of profitability, and maximizing relative return. Some of the objectives or influences are expressed as parameters, whereas in reality they most likely would adjust over time and, thereby, would introduce the

possibility of equilibrium where it may not otherwise exist.*36* Some of the objectives, therefore, may be inconsistent under certain cases and require further investigation.

For the lender (assume the Mortgage Lender), the following conditions must prevail:

$$\begin{aligned} \text{MRRL}(3) * \text{MLAL}(3) * \text{MCFL}(3) &= 1 \\ \text{MRTB}(3) * \text{MCTB}(3) &= 1 \\ \text{MRGB}(3) * \text{MCGB}(3) * \text{MLGB}(3) &= 1 \end{aligned}$$

MRRL - MULTIPLIER FROM RELATIVE RETURN ON LENDING
MLAL - MULTIPLIER FROM LIQUID ASSETS ON LENDING
MCFL - MULTIPLIER FROM CASH FUNDS ON LENDING
MRTB - MULTIPLIER FROM RETURN ON TREASURY BILLS
MCTB - MULTIPLIER FROM CASH ON TREASURY BILLS
MRGB - MULTIPLIER FROM RETURN ON GOVERNMENT BONDS
MCGB - MULTIPLIER FROM CASH ON GOVERNMENT BONDS
MLGB - MULTIPLIER FROM LIQUIDITY ON GOVERNMENT BONDS

For the Savings Investor these conditions must hold:

$$\begin{aligned} \text{MRSD}(3) * \text{MCSD} &= 1 \\ \text{MRTB}(4) * \text{MCTB}(4) &= 1 \\ \text{MRGB}(4) * \text{MCGB}(4) * \text{MLGB}(4) &= 1 \end{aligned}$$

MRSD - MULTIPLIER FROM RETURN ON SAVINGS DEPOSITS
MCSD - MULTIPLIER FROM CASH ON SAVINGS DEPOSITS

In response to a step increase in desired loans, the Mortgage Lender plus Savings Investor configuration passes through an obvious transient phase that is discussed in Section C, and then moves into a very slow adjustment phase that "resembles" equilibrium (in that the

*36*The acceptable ratios of profitability and spread, for example, are constants in these tests, rather than floating references. The risk and cost premiums that relate each asset to the average returns on assets are constant parameters when, in fact, they change over time, sometimes even rapidly.

changes are vitually minute) but still does not reach a solid equilibrium. Some of these changes are distorted by computational inaccuracies, which will be considered later. Ignoring the computational aspect, though, one can identify at least one condition toward which the system could move, albeit very slowly.

In one form of equilibrium, we may assume that desired and actual liquid assets of the lender are equal. Thus $MLAL(3) = MLGB(3) = 1$. Since the table function for the cash influence on each asset is the same, we know that $MCFL(3) = MCTB(3) = MCGB(3)$. Therefore, returns on the three yield-bearing assets of the lender (bills, bonds, loans) must be equally attractive. Since the average return on assets $ARA(3)$, to which cash yield is compared for determining the relative return, is the simple average of the three returns, the three can only be equally attractive if they equal $ARA(3)$ (after adjustment for risk and cost premiums).^{*37*} Therefore, $MRRL(3) = MRTB(3) = MRGB(3) = 1$. It follows, then, that $MCFL(3) = MCTB(3) = MCGB(3) = 1$.

For the Savings Investor, the table function relating cash to asset purchases is also the same, so that $MCSD = MCTB(4) = MCGB(4)$. Here, however, the cash multipliers must be less than 1. Why? $ARA(4)$

^{*37*}This condition gives a clue to the apparently long system adjustment times that appear to influence behavior after the primary transient response to a step in loan demand. As each rate of return changes, $ARA(3)$ also changes by one-third as much. If one return moves up, for example, ARA rises and produces pressures to increase the other yields. These movements, in turn, also cause ARA to rise. The positive loop described here does not produce explosive growth, because the gain < 1 , but adjustment through this process can be slow.

is the simple average of five returns, including two that are constant (RSD(1), RSD(2)); the effort of the lender to meet higher loan demand by reducing government securities causes RTB and RGB to rise; thus $MRTB(4) > 1$. If $MRTB(4) > 1$, then $MRS(3) = MRTB(4)$ and is also > 1 . If we assume liquid assets $LA(4)$ to equal desired liquid assets $DLA(4)$, then $MLGB(4) = 1$ and $MRGB(4) = MRS(3) = MRTB(4)$. In fact, $LA(4)$ must = $DLA(4)$, given that $LA(3) = DLA(3)$, because we have already seen that, for the lender, the relative return on bonds = the relative return on bills. Thus, $LA(3) = DLA(3)$ implies (a) that $LA(4) = DLA(4)$, and (b) that for each of the two institutions all available assets are equally attractive with respect to relative return.

A second combination of pressures seems consistent with equilibrium, although this case is more complicated, and a more thorough analysis would be required to prove consistency. Suppose $LA(3) > DLA(3)$. Then all returns are not equally attractive to the lender. To see how they relate, look at the Savings Investor. Because $MCS(3) = MCTB(4)$, we know $MRS(3) = MRTB(4)$, and, as before, they exceed 1. Given that $MLAL(3) > 1$ and $MLGB(3) > 1$, the cash multipliers (which are equal) must be < 1 . They cannot exceed 1, because then all three multipliers from relative return would be < 1 , which is impossible. The cash multipliers cannot = 1, because then $MRRL(3) < 1$, $MRTB(3) > 1$, and $MRGB(3) < 1$, which is also impossible. Therefore, $MRTB(3) > 1$ and $MRTB(3) > MRGB(3)$. Moreover, since $MCF(3) =$

MCGB(3) < 1, and assuming $MLAL(3) = MLGB(3) > 1$,*38* then $MRRL(3) = MRGB(3) < 1$. This implies that $MRTB(4) > MRGB(4)$, and since $MCTB(4) = MCGB(4)$, then $MLGB(4) > 1$. However, things get murkier here. If $MRRL(3) = MRGB(3)$, then $MRSD(3)$ (which = $MRTB(4)$) cannot exceed $MRGB(4)$, unless somehow the combination of higher liquidity and a lower-than-acceptable spread between $ARA(3)$ and $RSD(3)$ is offset by a higher-than-normal profitability.*39* All of these conditions seem consistent with each other and with equilibrium, although the ambiguity that stems from such a complex, nonlinear model precludes a stronger statement without considerably more effort.

One additional word about computational inaccuracies. In several instances, numerical truncation causes distortions that seem to maintain unexpected changes in some variables while cutting certain stabilizing feedbacks. For example, the multiplier on purchase of Treasury bills $MPTB$ is a function of $DSTB/TDPTB$, where $DSTB$ is desired purchase of Treasury bills and $TDPTB$ is total desired purchase of Treasury bills. Over a long period of time, in the simulation, $DSTB < TDPTB$, yet $MPTB = 1$ (rather than some number > 1), because the difference between the two large numbers is small. This causes the

*38*In fact, $MLAL(3)$ is an exponential function, while $MLGB(3)$ is a table function, so they are not equal.

*39*High liquidity encourages a lower return on savings deposits RSD ; low spread encourages a lower RSD ; high profitability encourages a higher RSD . For $MRSD(3) > MRGB(4)$ and $MRRL(3) < 1$, then, the spread must be relatively low.

lender to obtain fewer bills than it should and also exacerbates the positive loop wherein fewer outstanding bills causes faster decline in desired sales (which are proportional to Treasury bills outstanding TBO). Similarly, the fractional change in return on Treasury bills $FCRTB = f((DSTB - TDPTB)/TBO)$. Again, small differences between DSTB and TDPTB, relative to TBO, are inaccurately transmitted to FCRTB.

Even a small inaccuracy in this case can distort the results, for the return on Treasury bills RTB (or, for similar reasons, on bonds) affects the multiplier from return on savings deposits MRSD. If RTB is slightly wrong, MRSD will also be slightly off. MRSD affects the very large purchase of deposits by the Savings Investor PDSI (on the order of $300E9$ for the Mortgage Lender) which, in turn, affects the small level of liquidity (around $10E9$). Liquidity discrepancies, in turn, affect the level of bonds, which, after bonds have been reduced in order to expand loans, is smaller still (around $3E9$). Thus the tendency of a small computational inaccuracy to cause a small relative drift in savings deposits (about 0.1% over 30 years) produces a bigger relative drift in bonds of the Mortgage Lender (which is about 4% over 30 years). Given the lack of important feedbacks from the Sector to both public and private borrowers in these tests, this drift does not seem very significant. Yet one should be aware of the capacity of a small error (e.g., in FCRTB) to influence a large flow (PDSI(3)) which in turn feeds back through small levels (GB(3)) to affect the large flow [(PDSI(3) through MRSD(3))].

CHAPTER V. TIME-SERIES TEST OF THE FINANCIAL SECTOR

A. Introduction

Chapter V describes time-series tests of the Financial Sector. The sector is driven by inputs drawn from real-world data for the 15-year period 1960 IV to 1975 IV. A selection of model variables is compared with real-world counterparts to see how closely the model "fits" the data. The coefficient of determination (R^2) is used as the primary measure of fit, while the Durbin-Watson statistic is used to measure the degree of autocorrelation in the residuals (i.e., in the discrepancies that exist between model variables and their real counterparts). The procedure follows the format already described by Dale Runge in Chapter V of his thesis (see Runge 1976).*1*

Time-series tests permit one to examine the behavior of the Financial Sector model when it is driven by more realistic inputs than the pure steps and sine waves employed in Chapter IV. Analysis of the results will focus more on statistical measures than on underlying model structure, which is treated extensively in Chapter IV. However, the qualitative, as well as quantitative, result of a change in one of the

*1*A summary of the R^2 and D-W statistics used by Runge appears later in this chapter. Runge also calculates a standard error statistic (SE) for each of his comparison variables. I have not included the SE, however, because it appears to serve no useful purpose in the context of these tests. Runge's SE cannot be compared with tests based on least-squares regression, because his computation requires a different interpretation for degrees of freedom. Moreover, multiple simulations based on different parameter values are not performed here, so a comparison of SE's for different runs of the same model does not seem warranted.

model parameters will be examined in Section C.2. In general, the model fits the data fairly well and, therefore, may serve to develop confidence in the structure and the model's eventual capacity to generate appropriate policy conclusions. Some anomalies exist that could lead to structural improvements or refinements in test assumptions. Moreover, many of the feedbacks that link the sector to its environment in the National Model are missing. The tests pursued in this chapter, therefore, do not necessarily indicate model validity. But such time-series tests are commonly performed on other models and are considered by many to be an important aspect of model development.

Runge writes that "a major value of the time-series test is the opportunity it provides to scrutinize carefully all parameter choices." (Runge 1976, p. 290) Such scrutiny, presumably, permits one to select parameter values that will produce good fits (R^2), although the manner in which one might select the "best" parameter values according to the criterion of fit goes beyond the scope of this chapter. This chapter describes the procedure and reports the results, leaving more complete parameter testing for future research.

B. Procedure

1. Output Variables

To perform this test, a group of model-generated time-series outputs (e.g., interest rates) is compared with available data over the

period 1960 IV through 1974 IV.*2* The outputs include three types of loan levels and lending rates and six interest rates. They were chosen as being of most interest to financial modelers and, therefore, most likely to be compared in time-series tests of other models. The outputs are listed in Table V-1 along with their equivalent real-world counterparts. In many cases, model variables represent an aggregate or cross-section of different real-world concepts, so that the comparison data have to be derived indirectly and approximately from available data. These cases are clarified in the discussion that follows the table.

*2*Comparisons cover a 14-year period while inputs, which in some cases require leading values of actual data, cover the 15-year period to 1975 IV.

Table V-1
OUTPUTS OF THE FINANCIAL SECTOR USED IN TIME-SERIES TESTS

<u>Model Variable</u>	<u>Real-World Counterpart</u>
1. Loans outstanding of Bank LO(1)	Short-term loans and installment credit
2. Loans outstanding of Corporate Lender LO(2)	Corporate bonds of non-financial corporations and commercial mortgages
3. Loans outstanding of Mortgage Lender LO(3)	Home mortgages and multi-family residential mortgages
4. Loan extension rate of Bank LER(1)	Quarterly first difference in (1) plus assumed replacement volume
5. Loan extension rate of Corporate Lender LER(2)	Quarterly first difference in (2) plus assumed replacement volume
6. Loan extension rate of Mortgage Lender LER(3)	Quarterly first difference in (3) plus assumed replacement volume
7. Return on Loans outstanding of Bank RLO(1)	Bank rates on short-term business loans
8. Return on loans outstanding of Corporate Lender RLO(2)	Yield on Baa corporate bonds
9. Return on loans outstanding of Mortgage Lender RLO(3)	Contracted interest rate on conventional first mortgages for new homes
10. Return on Treasury Bills RTB	Market yield on 6-month Treasury bills
11. Return on government bonds RGB	Market yield on long-term US bonds
12. Return on Federal Funds RFF	Return on Federal Funds

The real-world data for time-series comparisons come from various Bulletins and Flow of Funds Accounts prepared by the Federal Reserve System. All of the interest rates, as well as short-term loans

(including installment credit), are introduced on a quarterly basis, drawn from end-of-quarter reports. Thus for each of these categories, 61 data points extending over 15 years are introduced by means of a DYNAMO TABHL function. For the other variables, annual data are used, involving TABHL functions with 16 data points for the 15-year period. Values of these input variables for times other than the end of each year are linear interpolations of the two adjacent values in the TABHL functions. In computing R^2 and D-W statistics, therefore, the "real" data with which model variables are compared on a quarterly basis are actually linear interpolations based on annual data.

The real-world variables shown in Table V-1 were selected to conform most closely to the institutions and functions contained in the Financial Sector model. Bank loans (#1), for example, consist of total loans of commercial banks, minus mortgage loans of banks, plus installment credit of all financial institutions (including banks). So that the three lenders in the model will account for all categories of short-term and long-term credit,*3* consumer installment loans are considered as short-term loans, even though a more disaggregated model might contain these credits in a separate category. Two series, both from the Federal Reserve Bulletin, are used to produce these data ("Principal Assets and Liabilities by Number, by Class of Bank" and "Installment Credit by Non-Bank Lenders").

Both kinds of long-term credit (#2 and #3) are derived from

*3*Some agricultural, real-estate, and foreign credits are excluded.

Flow of Funds data. For the Corporate Lender, bond liabilities of "corporate business" are added to "commercial mortgages." For the Mortgage Lender, the annual Flow of Funds data are used rather than quarterly data available in the Bulletin, so as to be consistent with Corporate Lender credits (which include the commercial mortgage portion of "mortgages by type") and because quarterly data were not available in the Bulletin until 1965.

To compare lending rates, a series of calculations is required to transform available data on outstanding loan levels into the "real" counterpart of loan extension rates LER in the model. For each type of lending, the difference between the current loan amount and the volume outstanding at the end of the previous quarter indicates the net quarterly change in loans outstanding. To this amount is added the replacement of maturing loans, which is assumed to occur at a fraction per year equivalent to the inverse of the normal average life of loans NALL (= 1 year for Bank loans, 7 years for the Corporate Lender, and 12 years for the Mortgage Lender). The net change plus the replacement of maturing loans yields a gross lending rate that can be compared with loan extension rates LER. However, the first difference calculation gives a net change in loans over one quarter, and one must add one-quarter of the annual replacement volume to yield a gross "real" lending rate in dollars per quarter. This is compared with one-quarter

of the loan extension rate LER in the model (which is expressed in dollars per year) to make the statistical computation.*4*

With respect to interest rates, several observations should be made. The return on bank loans reflects actual interest rates on "all (commercial bank) loans" as contained in the Bulletin, rather than the posted prime rate, which would be lower than the average actual rate. The yield on US government securities appears as the counterpart to the return on government bonds RGB, even though the bond category in the model includes municipal, as well as federal, debt. Using the return on US bonds distorts the average yield, partly because risk characteristics of the two kinds of debt differ and partly because earnings on US bonds are fully taxable while earnings on most municipals are tax-free. Nevertheless, the use of one bond category seems more appropriate for

*4*For example, the computation for long-term lending of mortgage lenders LTLML is:

$$LTLML = \Delta MCH + 0.25 * MCH/12,$$

where MCH is data on mortgage credit to households, and " Δ " stands for the quarterly first difference (the first difference performed by a specially-constructed MACRO in the program). Bank lending receives somewhat different treatment in these calculations. Unlike the long-term lending categories, data on short-term lending of commercial banks is taken on a quarterly basis. During most years of the sample period bank loans fluctuated rather sharply during each year, peaking in June and December and slowing considerably during the intervening quarters. Calculating actual gross short-term lending of banks STL_B in the way that other data-based lending is computed, therefore, leads to unrealistically sharp 6-month cycles (mainly because the replacement portion of gross short-term lending equals current short-term credit divided by 1). Therefore, for STL_C, the replacement portion is computed as a one-year exponential average of outstanding credit rather than the current amount.

our purpose than a complicated attempt to adjust for tax differences in order to derive some sort of weighted average return.

The return on Federal Funds RFF is a model-generated variable that does not influence other variables in the Financial Sector (defined here to exclude the Monetary Authority). The Funds rate varies sharply over periods as short as one day. In contrast, the National Model is designed to explore policy issues that relate to periods of months or years. The Federal Funds rate, however, is considered by many to be an important source of information and target for actions of the monetary authorities. Therefore, RFF appears as one of the outputs to be compared with real time-series data (averaged over the last 7 days of each quarter).

2. Data-Based Input Variables

Tests of the Financial Sector model with time-series inputs, rather than the pure test inputs employed in Chapter IV, use the same model configuration as before. All parameter values in the sector are identical; and the test generator is the same except that variable data-based inputs are used in place of the values that previously were held constant or varied as a pure test input. For example, desired loans in test generator DLTG was the primary test input used in Chapter IV. By changing the switch for time series SWTS from 1 to 0, DLTG becomes a variable drawn from actual data. Setting SWTS to 0 also replaces other values, for instance a constant initial reserve ratio on demand deposits IRRDD, with actual values. Table V-2 exhibits the

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time-series inputs used in testing the model. The manner in which some of the data are derived will be clarified below.

Table V-2
TIME-SERIES INPUTS USED TO TEST THE FINANCIAL SECTOR

<u>Model Variable (in Test Generator)</u>	<u>Real-World Counterpart</u>
1. Desired loans (of Bank) in test generator DLTG(1)	Short-term loans and installment credit--leading value
2. Desired loans (of Corporate Lender) in test generator DLTG(2)	Corporate bonds of non-financial corporations and commercial mortgages--leading value
3. Desired loans (of Mortgage Lender) in test generator DLTG(3)	Homemortgages and multi-family residential mortgages--leading value
4. Desired Treasury bills in Monetary Authority DTBM	Treasury bills held by Federal Reserve--leading value
5. Desired government bonds in Monetary Authority DGBM	Government bonds held by Federal Reserve--leading value
6. Desired Treasury bills outstanding DTBO	Total US government securities and municipal bonds outstanding with less than one-year maturity--leading value
7. Desired government bonds outstanding DGBO	Total US government securities and municipal bonds outstanding with greater than one-year maturity--leading value
8. Reserve ratio on demand deposits RRTD	Required reserve ratio on demand deposits in large banks
9. Reserve ratio on time deposits RRTD	Required reserve ratio on time deposits in banks with greater than \$5 million in time deposits

The first three inputs, desired loans in test generator DLTG for the three loan categories, represent variables that cannot be observed and for which no data exist. In the National Model, desired loans are determined in each production sector and respond to such influences as interest rates, availability of credit, and debt/equity ratios. In the Financial Sector test generator, which represents the rest of the National Model, the flow of loan requests is adjusted so as to equate actual loans outstanding with desired loans outstanding over an adjustment time.*5* Whereas in Chapter IV the desired loan level represented test inputs such as steps or sine waves, in Chapter V DLTG is generated by real time series. Thus the input does not enter the Financial Sector directly, but enters only indirectly through the test generator correction term.

Because of this test configuration and the fact that desired

*5*As explained in Chapter IV, requests for loans in test generator RLTG equals maturities of loans in test generator MLTG plus a correction term that adjusts loans to the desired level and backlog to its desired level. Whereas both the loan correction and the backlog correction are active in the tests performed in Chapter IV, only the loan correction is activated here, on the assumption that any feedback in reality between the amount of unfilled loan demand is already taken into account in the data for desired loans. Thus, for time-series testing, the equation for requests for loans in test generator RLTG reads:

$$RLTG = MLTG + (DLTG - LOTG)/TCLBTG$$

RLTG - REQUESTS FOR LOANS IN TEST GENERATOR (\$/YEAR)
MLTG - MATURITIES OF LOANS IN TEST GENERATOR (\$/YEAR)
DLTG - DESIRED LOANS IN TEST GENERATOR (\$)
LOTG - LOANS OUTSTANDING IN TEST GENERATOR (\$)
TCLBTG - TIME TO CORRECT LOANS AND BACKLOG IN TEST GENERATOR
(YEARS)

loans is an unobserved variable, a leading value of the actual level of loans outstanding is used for the desired level. The lead time equals the adjustment time in the correction term.*6* To the extent that desired loans cannot be obtained, we would expect a discrepancy between actual and model-generated loans outstanding. However, if the Financial Sector responds properly to changing loan demand, and if desired loans are realized, then the loans outstanding LO generated by the model should conform closely to the actual level of loans outstanding. As shown previously, these two variables are compared for quality of "fit." High agreement does not constitute a powerful test of model validity, because loans are driven by the actual values; but lack of agreement would certainly indicate structural problems in the model.

Desired government securities in the Monetary Authority are handled in a fashion similar to desired loans. In addition to generating primary loan demand, the test generator also represents certain functions of the Monetary Authority (described in Behrens 1975) and the government sector (now under development). For example, the test generator produces desired purchases of Treasury bills by Monetary Authority DPTBM, which influences transactions and interest rates in the bill market. The desired purchase rate, in turn, equals maturities of bills already held by the Monetary Authority plus a term that adjusts

*6*The lead time is 0.75 year for Bank loans and 1.5 years for both categories of long-term loans. Because data on loans is required for up to 1.5 years beyond the test period, the statistical comparison is made only to year-end 1974.

the actual bill holding to a desired (level of) Treasury bills in Monetary Authority DTBM. The desired level equals a 0.5-year leading value of actual bills held by the Federal Reserve.*7* Similarly, desired government bonds in Monetary Authority equals a 0.5-year leading value of actual bonds held by the Federal Reserve. Introducing the two desired security holdings for the Federal Reserve permits one to represent the expansion of reserves in the banking system that occurred during the comparison period as a result of official market transactions.

While the Monetary Authority in the test generator produces desired purchases, the Treasury generates desired sales.*8* Again, a correction term appears in the desired sales rates for both bills and bonds, so that the Treasury can adjust actual outstanding securities to some desired level. The desired (level of) Treasury bills outstanding DTBO, for example, equals a 0.4-year leading value of total outstanding short-term government and municipal securities.*9* Desired government bonds outstanding DGBO equals a two-year leading value of total

*7*Data for both bills and bonds are taken from the Federal Reserve Bulletin series entitled "Ownership of Marketable Securities by Maturity."

*8*In equilibrium, desired sales by the Treasury equal total desired purchases by the three lending institutions, the SI and the Monetary Authority.

*9*The short-term portion of municipal bonds is an approximation based on the breakdown of securities by maturity on aggregate balance sheets of the commercial banking system, found in the Bulletin.

long-term US government and municipal securities.

Required reserve ratios are drawn from the Federal Reserve Bulletin. The requirement for demand deposits applies to Reserve City banks up to 1972 and, subsequently, to banks with over \$400 million in demand deposits. The requirement on time deposits applies to all bank time deposits above the first \$5 million. Like the desired levels of government securities in the Monetary Authority, the two required reserve ratios affect the amount of excess reserves, and therefore the amount of liquidity for making loans.

3. Assumptions About Other Inputs

In addition to the time-series inputs already described, the tests in this chapter reflect several important assumptions about input variables that could also be based on time-series data. These assumptions are exhibited in Table V-3. The first column of the table shows the input variable that would normally change in response to conditions outside the Financial Sector. The second column shows how the variable is treated for testing purposes.

Table V-3
ASSUMPTIONS ABOUT SELECTED INPUTS TO THE FINANCIAL SECTOR

<u>Model Variable</u>	<u>Assumption</u>
1. Inflow of savings ISAV	Based on normal growth and interest rate feedback
2. Default fraction on accounts DFA(FF) (default fraction on loans in test gen.)	Constant (= NDFAN = 0.01)
3. Risk and cost premiums on Treasury bills, government bonds, loans, and savings deposits RCPTB, RCPGB, RCPL(L), RCPSD(L)	Constant parameters based on year-end data for 1967-70.
4. Desired ratio of currency to money DRCM	Constant (= 0.2)
5. Return on savings deposits RSD(L)	Variable without ceilings
6. Tax of lending institution TLI and operating costs of lending institution OCLI	= 0

The first, and most important, assumption concerns the manner in which new savings enter the Financial Sector. Unlike the other inputs to the sector, savings respond to activity within the sector, rather than entering exogenously as independent time-series data. In other words, for the purpose of time-series testing, the boundary of the sector has been extended to include the savings decision, by making the flow of savings dependent on interest rates in the model relative to interest rates from data. This procedure represents a simplification of the theoretically more correct link that would run from interest rates to wealth (which changes with variations in returns) and from wealth to savings and consumption. Most economists of both Keynesian or monetarist persuasion would reject a direct link between available

financial returns and real consumption or savings.

Figure V-1 shows the structure of savings in the test generator for time-series testing.

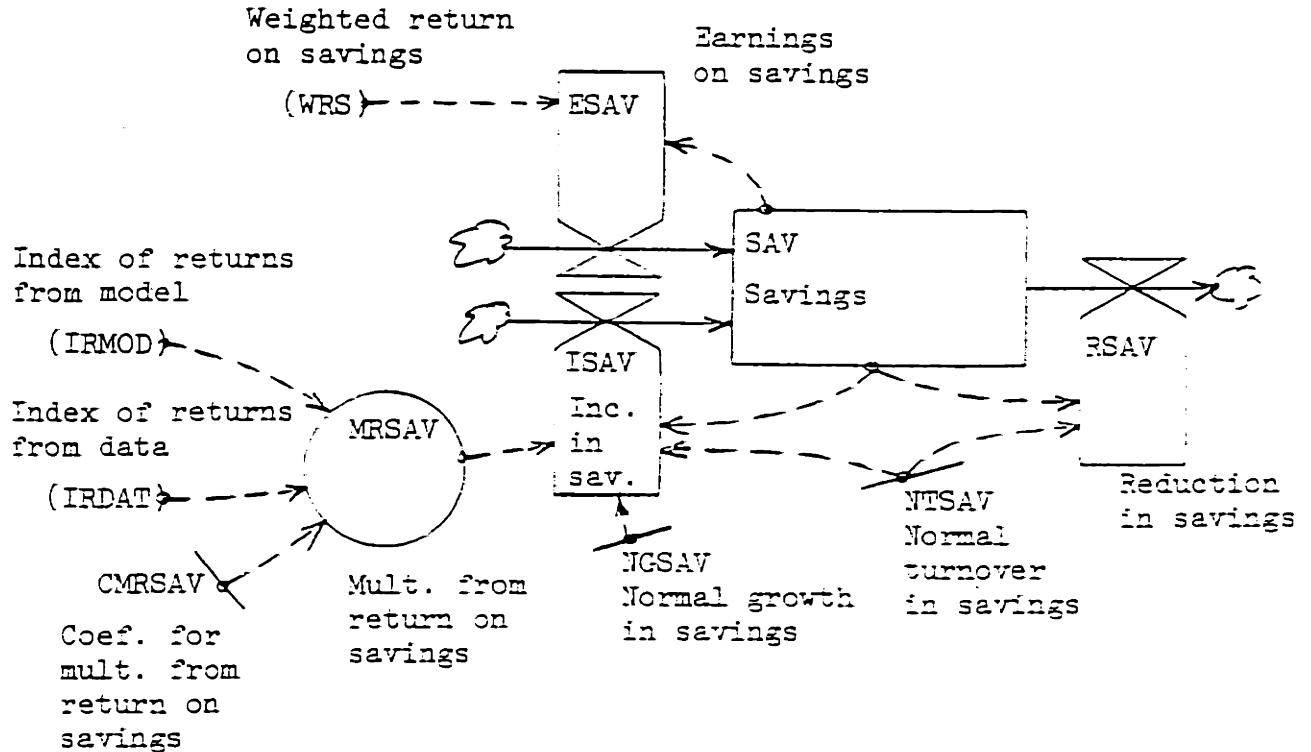


Figure V-1. The Savings Structure for Time-Series Testing

The increase in savings includes earnings accrued on assets of the Savings Investor (earnings on savings ESAV) plus a separate inflow of savings ISAV that replaces savings that are drawn down at a normal turnover rate (NTSAV), causes savings to grow at a normal growth rate (NGSAV) in addition to that obtained from earnings accrual, and responds to interest rates. Thus, if the index of returns from the model IRMOD equals the index of returns from data IRDAT, the inflow of savings $ISAV = SAV \cdot (NTSAV + NGSAV) \cdot f(IRMOD/IRDAT) = SAV \cdot (0.3 + 0.025) \cdot 1$. The change in savings ΔSAV , then, equals earnings + inflow - reduction =

$WRS \cdot SAV + (NTSAV + NGS AV) \cdot SAV - NTSAV \cdot SAV = (WRS + NGS AV) \cdot SAV$, where WRS is the weighted return on savings. If $IRMOD > IRDAT$, savings increase at a faster pace, while $IRMOD < IRDAT$ produces slower growth in savings.

Extending the boundary of the Financial Sector in this way seems appropriate for at least three reasons. First, inputs to the Financial Sector are in several cases very large relative to the levels within the sector that they influence. For example, the initial levels of liquid assets of lending institutions range from 2% to 4% of the flows of savings that directly affect liquid assets. Thus, if the exogenous inputs only approximate real flows, because of measurement error or faulty aggregation, then the smaller levels of liquidity will deviate from their correct paths and thereby force interest rates and other variables off course.

Combined with the first consideration is the fact that the time-series test does not capture the controlling feedback relationships that actually exist in the full economy. Thus, if the system deviates from its correct time-path, due to discrepancies in the inputs or faulty or neglected structural elements, feedbacks, such as the relation between interest rates and demand, do not exist to pull the system back on course. Therefore, interest rates, which can float to any level in response to supply and demand, can almost be expected to deviate from

historical paths when the system is driven by a set of independent, and imperfect, inputs.*10*

As a third justification for introducing feedback from the model to the inflow of savings, we can compare the savings that result from this procedure with the level of savings based on time-series data. Despite the importance of feedback in generating a reasonable historical fit (especially in interest rates), the change in the amount of funds

*10*I made several unsuccessful attempts to generate savings independently of interest-rate feedback. In one case, I tried to adjust savings SAV to a desired level through the inflow of savings ISAV, where the desired savings DSAV were derived from data. I discovered that the resulting total inflow of funds to the Financial Sector, consisting of earnings receipts on total loans and government securities plus new inflows of savings, deviated significantly from the outflow of funds in the form of private and public credit over the test period. Given reasonable adjustments in liquidity levels within the sector, this finding suggested that the available data on savings and credit were inconsistent with the requirements of conserved money flows and, therefore, reflected imperfect measurement.

actually produced by the feedback is rather small, resulting in a close fit between model-generated and actual savings ($R^2 = .952$).^{*11*}

Compared with the treatment of savings in the time-series test, the other important assumptions about input variables are less controversial. For example, the default fraction on loans, as well as the risk and cost premiums on all assets, are held constant rather than being allowed to vary as they did over the 1960-1975 period. Both concepts probably will require refinement in future model versions. Likewise, the desired ratio of currency to money is fixed at a value of 0.2, even though the actual ratio varied slightly during the 15-year period.

Although legal ceilings were imposed on time and savings deposits of commercial banks and mortgage lenders during most of the test period, they are not active in the time-series test. However, except for the last year of the run, the returns on savings deposits RSD

^{*11*}The R^2 is based on annual comparisons. Data-based savings requires some explanation. From the Flow of Funds, one can extract total household savings (= total financial assets, less demand deposits and currency, investment company shares and other corporate stock) and business savings (= credit market instruments plus time deposits). These savings together grew at the following annual percentage rates (starting with 1961 over 1960): 7.17 / 6.78 / 8.57 / 8.44 / 8.06 / 6.28 / 8.37 / 8.60 / 5.89 / 6.87 / 10.33 / 11.35 / 5.96 / 7.58. The volume of household and business savings at 12/60 was about 10% higher than the total amount of assets in the Savings Investor, because of inconsistencies in the data and because certain miscellaneous types of foreign and domestic credit are not accounted for in the Financial Sector. To generate the comparison, therefore, I set the data-based savings amount at 12/60 equal to total savings TSAV in the model (in turn based on data on outstanding credit) and then applied the annual growth rates shown above to generate a 15-year series.

for both the Bank and Mortgage Lender stay below the actual ceilings.

Finally, as a simplifying assumption for model testing, tax payments and operating costs of the lending institutions equal 0. This assumption distorts the calculation for return on assets in the model, where the "acceptable" level is simply assumed to be its initial value. For example, the Bank's initial return on assets is considerably higher than the return that would reflect taxes and non-interest operating costs. Since relative, rather than actual, return on assets affects decisions in the Financial Sector, however, no effort is made to generate realistic absolute values.

Initial values of the system levels remain as a category of data-based inputs. All levels are initialized to reflect real values. Some of these values, such as some interest rates and bank asset holdings, are directly available from the data and pose no problems. Some of the initial values, however, are less straightforward. Balance-sheet items for the Corporate Lender, for example, are approximate, since the Corporate Lender, as we have seen, represents a function (extension of long-term corporate credit) more than a distinct institutional category.*12* The initial "savings deposits" of the Corporate Lender simply equal all of the assets (which are based on 1960 IV data) less the equity portion (= an assumed 7% of total assets). The return on savings deposits RSD is initialized roughly in

*12*The Corporate Lender includes those parts of insurance companies, banks, pension funds, etc., that make long-term corporate loans.

accord with data for large deposits of banks (RSD(1)) and deposits of savings and loan associations (RSD(3)) (both = 0.025). For the Corporate Lender, RSD(2) also is initialized at 0.025. Apart from initial values, the Financial Sector model tested here, including all parameter values, is identical to the structure tested in Chapter IV.

4. Statistical Measures of Fit

The primary statistical measure employed in this chapter is the coefficient of determination (R^2). Before presenting the results of the test, an interpretation of the R^2 statistic used here is appropriate. As shown in most introductory texts (for example, Wonnacott and Wonnacott 1970, Chapter 5), the R^2 statistic is used in connection with regression analysis to show the proportion of total variation in the data that is explained by fitting a linear regression equation of the form $\hat{Y} = a + bX$, where the observed Y_i are regressed against the observed X_i . The Y_i and X_i can be taken from time-series or cross-sectional data. The \hat{Y} line constitutes a model designed to relate one variable to another so as to minimize the sum of squares of the residuals between the actual Y_i and and linear model (\hat{Y}).

For comparing time-series outputs of a simulation model with time-series data from the real system, however, the R^2 coefficient has a different interpretation. Now the "model" is not a line designed to minimize the sum of squares of residuals on a Y-X plane, but the time path of a variable, generated through model simulation, which is to be compared with the time path of a variable taken from data. The

parameters of the underlying model in this case are selected independently (perhaps informally) rather than being forced by the regression to equal specific values. As Runge states (Runge 1976, p. 355), the R^2 computation here is not bounded, as it would be in least-squares regression, by 0 and 1. For the test performed here and in Runge's work, one version of R^2 is defined below. As can be seen in the figure that follows, this definition of R^2 (called R^2_a here) has no lower bound and an upper bound of 1.

$$R^2_a = 1 - \frac{\sum_{i=1}^n (Y_i - \hat{Y}_i)^2}{\sum_{i=1}^n (Y_i - \bar{Y})^2}$$

where \hat{Y} is the model-generated variable, Y is from real-world data, and \bar{Y} is the mean of the data.

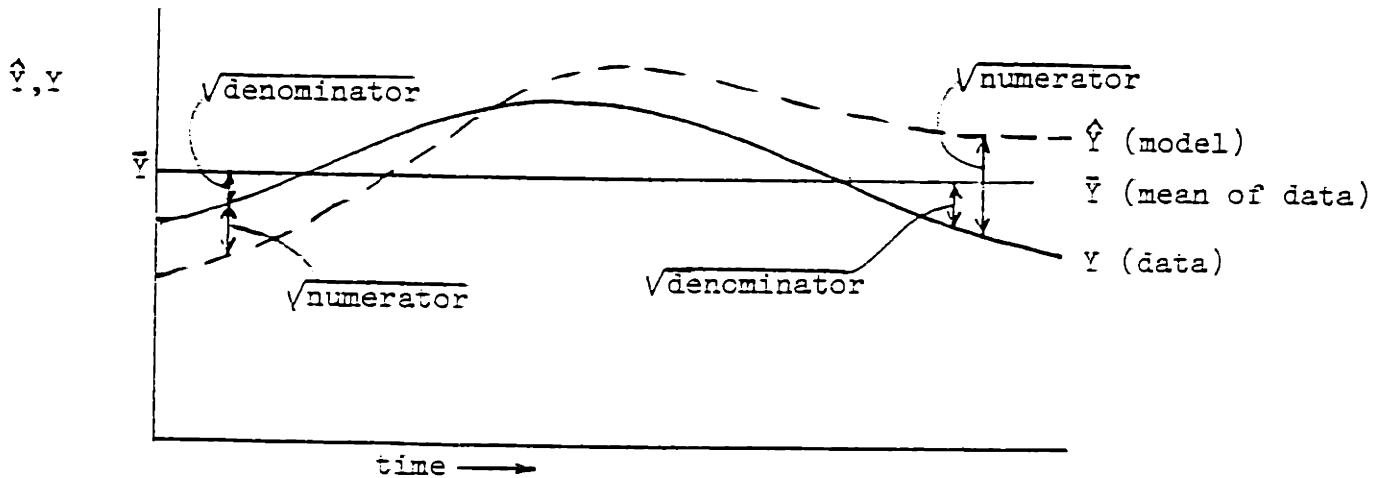


Figure V-2. Comparison of Model-Based Time-Series with Data-Based Time-Series.

Because most of the parameters in a system dynamics model are chosen informally, another measure of fit may also be considered and appears in the table of results as R^2b . With the first measure (R^2a), close qualitative agreement between the behavior of a model variable and its real-world counterpart could still exhibit a poor fit if biases were present. The alternative measure, however, would reflect the qualitative correspondence. This measure is based on a linear regression model that relates model variables \hat{Y}_i to the data Y_i . Now R^2b measures the proportion of total variation in the data. As shown in Figure V-3, a comparison of model time series and data time series (Panel 1) can exhibit a good qualitative "fit" while producing a

poor R^2 : while a regression of the same \hat{Y} on Y (Panel 2) can produce a good R^2 .^{*13*} As we shall see, this difference occurs for one of the comparisons in the next section. Note that a perfect fit, where the lines in Panel 1 coincide, would appear in Panel 2 as a 45-degree line passing through the origin (in $\hat{Y} = a + bY$, $a = 0$, $b = 1$).^{*14*}

^{*13*}A more familiar procedure would be to derive \hat{R}^2_a from the first difference terms, which would permit one to ignore the intercept term and, thereby, any important differences that might show up here between R^2_a and R^2_b .

^{*14*}Nothing has been said here about the possibility of close behavioral agreement which would still produce a poor R^2_a or R^2_b . For example, Forrester briefly describes the case of identical cyclical behavior in two variables which, because they are out of phase, are poorly correlated in any normal statistical sense (see Forrester 1961, Chapter 13, "Judging Model Validity").

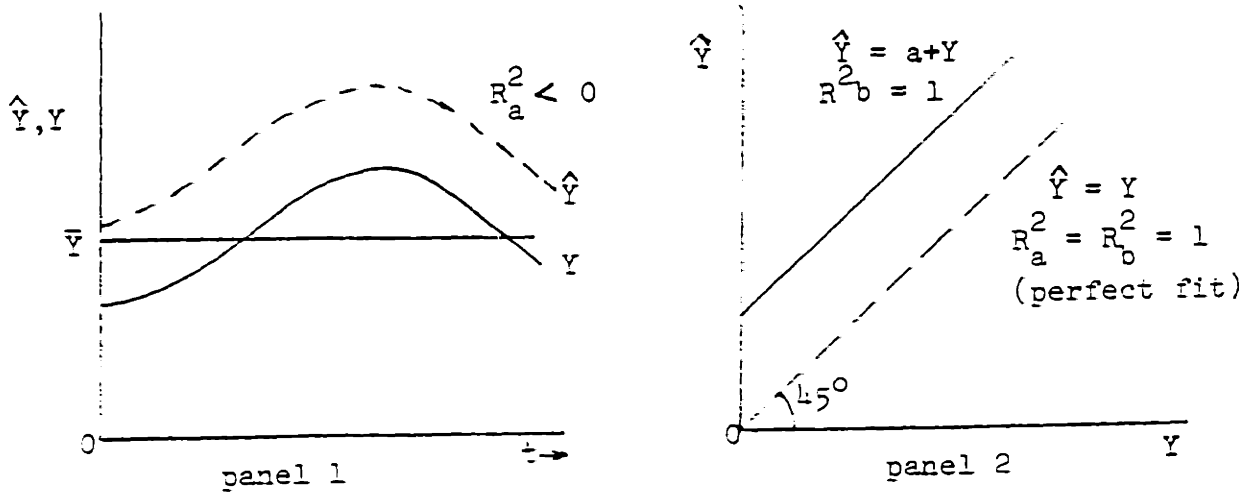


Figure V-3. Two Comparisons of Time-Series Data

Apart from the R^2 coefficient, very little attention is paid in this chapter to the Durbin-Watson statistic, which indicates the degree of autocorrelation in the residuals. In the case of least-squares regression, the D-W statistic can imply misspecification in the model. But in a model with informally-selected parameters (that is, parameters that are not forced by the least-squares criterion), very little can be implied by the D-W number. As Runge shows in more detail (Runge 1976, pp. 356-358), a perfectly specified model with informally selected parameters can generate very poor D-W statistics. Of course, a poorly specified model can do the same. We are left, in the case of a

system dynamics model, with a number that, apart from indicating autocorrelation, tells us little about model specification.*15*

C. Results

1. Time-Series Test of the Basic Model

This section presents results of testing the Financial Sector model with time-series inputs. Some of the results are satisfactory and require limited analysis. Other features of the test are not as satisfying and will require analysis of model behavior and structure. Some features of the model, including elements that are missing in the current version, will be considered.

Table V-4 summarizes the statistical results of the time-series tests. The first column lists the twelve model variables that are compared with data. The next two columns present the two measures of R^2 that were discussed in the previous section. The last column gives the Durbin-Watson statistic. As stated previously, low D-W values do not necessarily imply structural misspecification. Each of the comparisons will be discussed in more detail following the table.

*15*The equation for the D-W statistic is:

$$DW = \frac{\sum_{i=2}^n (e_i - e_{i-1})^2}{\sum_{i=1}^n (e_i^2)}$$

where $e = Y_i - \hat{Y}_i$.

Table V-4
STATISTICAL RESULTS OF TIME-SERIES TEST

<u>Model Variable</u>	<u>R²a</u>	<u>R²b</u>	<u>D-W</u>
1. Loans outstanding of Bank LO(1)	.988	.995	0.291
2. Loans outstanding of Corporate Lender LO(2)	.999	.999	0.200
3. Loans outstanding of Mortgage Lender LO(3)	.998	.998	0.113
4. Quarterly loan extension rate of Bank LER(1)	.917	.946	2.031
5. Quarterly loan extension rate of Corporate Lender LER(2)	.965	.965	0.872
6. Quarterly loan extension rate of Mortgage Lender LER(3)	.880	.880	0.845
7. Return on loans outstanding of Bank RLO(1)	.789	.827	0.281
8. Return on loans outstanding of Corporate Lender RLO(2)	.736	.828	0.252
9. Return on loans outstanding of Mortgage Lender RLO(3)	-.768	.858	0.760
10. Return on Treasury bills RTB	.463	.602	.263
11. Return on government bonds RGB	.688	.802	0.249
12. Return on Federal funds RFF	-.983	.196	0.066

Figure V-4 compares the behavior of the three levels of loans outstanding in the model with their real-world counterparts. In all three cases, loan levels rise steadily throughout the entire 14-year sampling period and track the data very closely. As we saw earlier, the input time series for desired loans was a leading value of the actual level. Therefore, one should expect close correspondence between data and model. Meeting that expectation does not provide a strong validation of the model, but at least the model passes the minimum test. Low R² for the loan levels would probably signal some basic structural problems.

The D-W statistics for all three variables indicate substantial positive autocorrelation in the residuals. But, because the parameters in the model were selected informally rather than by

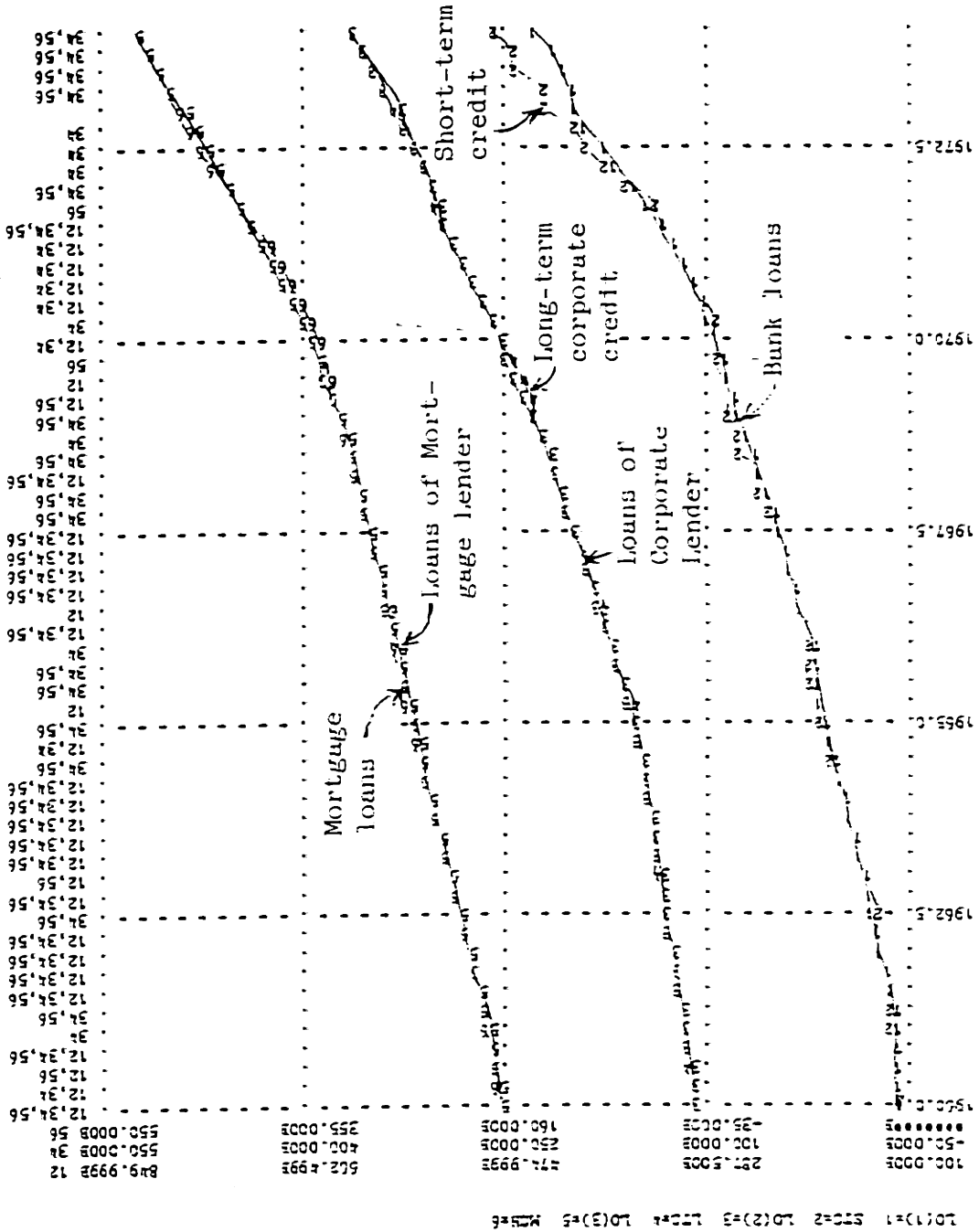


Figure V-4. Time-Series Comparisons of Outstanding Primary Credit

statistical fit, "bad" D-W values do not necessarily imply faulty structure. Moreover, as Runge shows (Runge 1976, p. 327), the steadily rising trajectory for the data on loans invites positive autocorrelation in the residuals for any variables attempting to track them.

Bank lending rates are compared in Figure V-5. As stated in a previous footnote, actual commercial bank loan data is available on a quarterly basis, without seasonal adjustment, which explains why the data path fluctuates over short periods more than the (quarterly) loan extension rate from the model. The model does not purport to capture seasonal patterns, however, so we should not be concerned with this part of the unexplained variance. Otherwise, the fit is fairly good, with Bank lending in the model usually remaining within the range of the fluctuating real-life data.

Lending by the Corporate Lender does a slightly better job at tracking the data, as shown in Figure V-6. One troublesome feature that stands out, however, is the short-term fluctuations in the model variable compared with the smoother path in actual lending. The short-term oscillations in lending of long-term lenders were mentioned in the test of the Mortgage Lender, Bank, and Savings Investor described in Chapter IV. There, the cause of the instability was tentatively attributed to the effective time constant for adjusting a small pool of liquid assets with a large flow of savings deposits. Even a minute fractional change in purchases of deposits by the Savings Investor in the model can have a significant impact on liquidity, especially for the

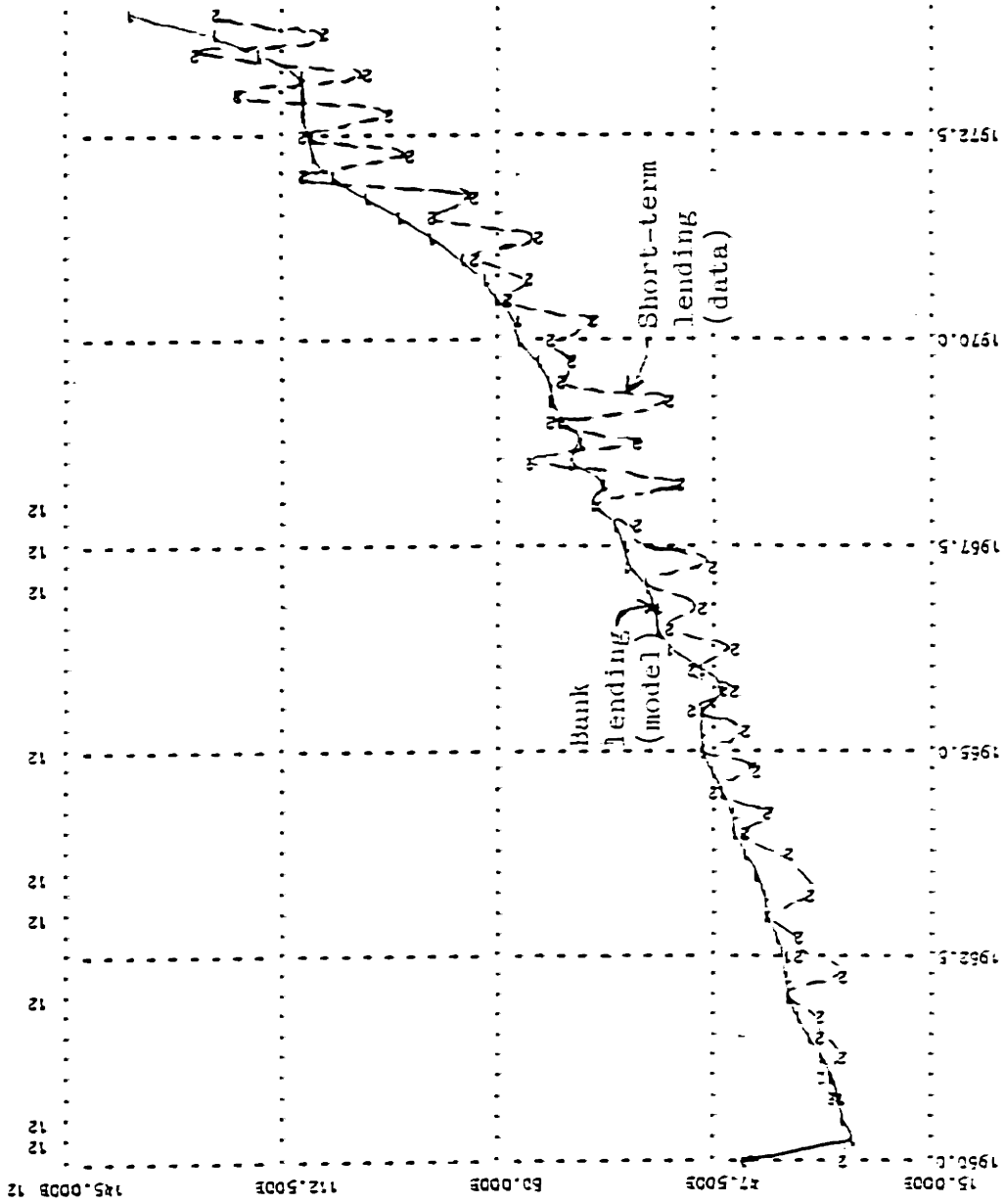


Figure V-5. Time-Series Comparison of Short-Term Lending (in dollars/quarter)

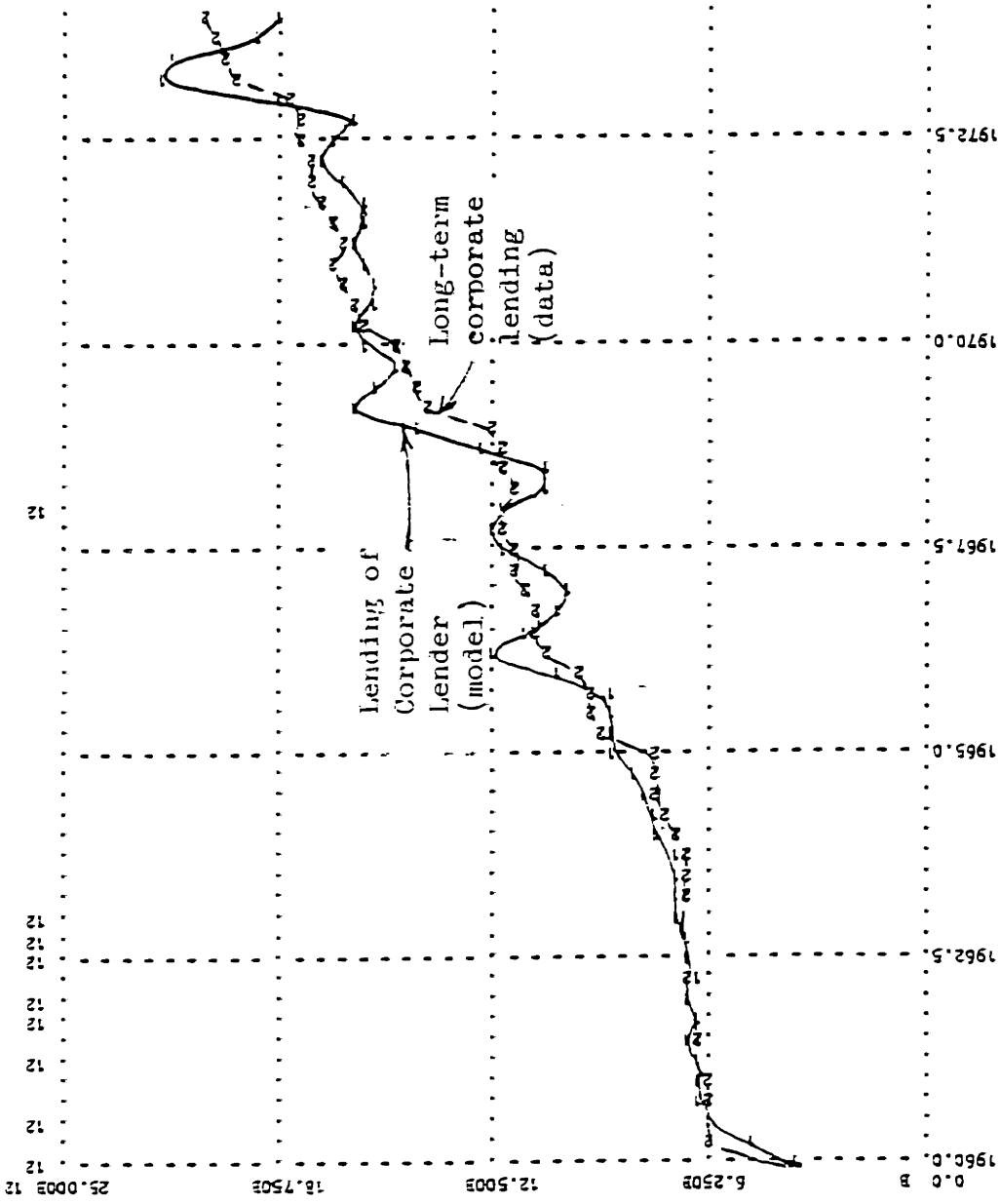


Figure V-6. Time-Series Comparison of Long-Term Lending to Business (dollars/quarter)

long-term lenders which rely almost solely on deposits to expand credit. As we shall see in the next section, however, a slower, more realistic turnover in savings deposits (which reduces the large difference between normal deposit flows and liquidity levels) eliminates these rapid fluctuations and invites modification in the structure of the Savings Investor's response to changing deposit rates.*16*

Another feature of the comparison is the manner in which the model coincides with the data during the sharp expansion of long-term corporate credit that occurred during late 1969 and early 1970. Although the model should do fairly well on the loan levels and lending rates, because of the nature of the test input for loan demand, the overall fit in lending rates, both here and in the next section, supports the way lending institutions in the model capture the management of assets and liabilities.

The extension of mortgage credit produces a lower, but still acceptable, R^2 statistic, As shown in Figure V-7, the rapid growth during the first two years, followed by five years of slower growth, is reproduced nicely by the model. The model demonstrates wider short-term changes than before, but again this form of instability is eliminated in the second time-series test described later.

*16*As stated in Chapter IV, a shorter DT was necessary in the noise test of the entire sector in order to avoid spurious behavior. The same DT (= 0.015) was used for the time-series test as well, although the difference in output resulting from using a larger DT (= 0.03) was not significant.

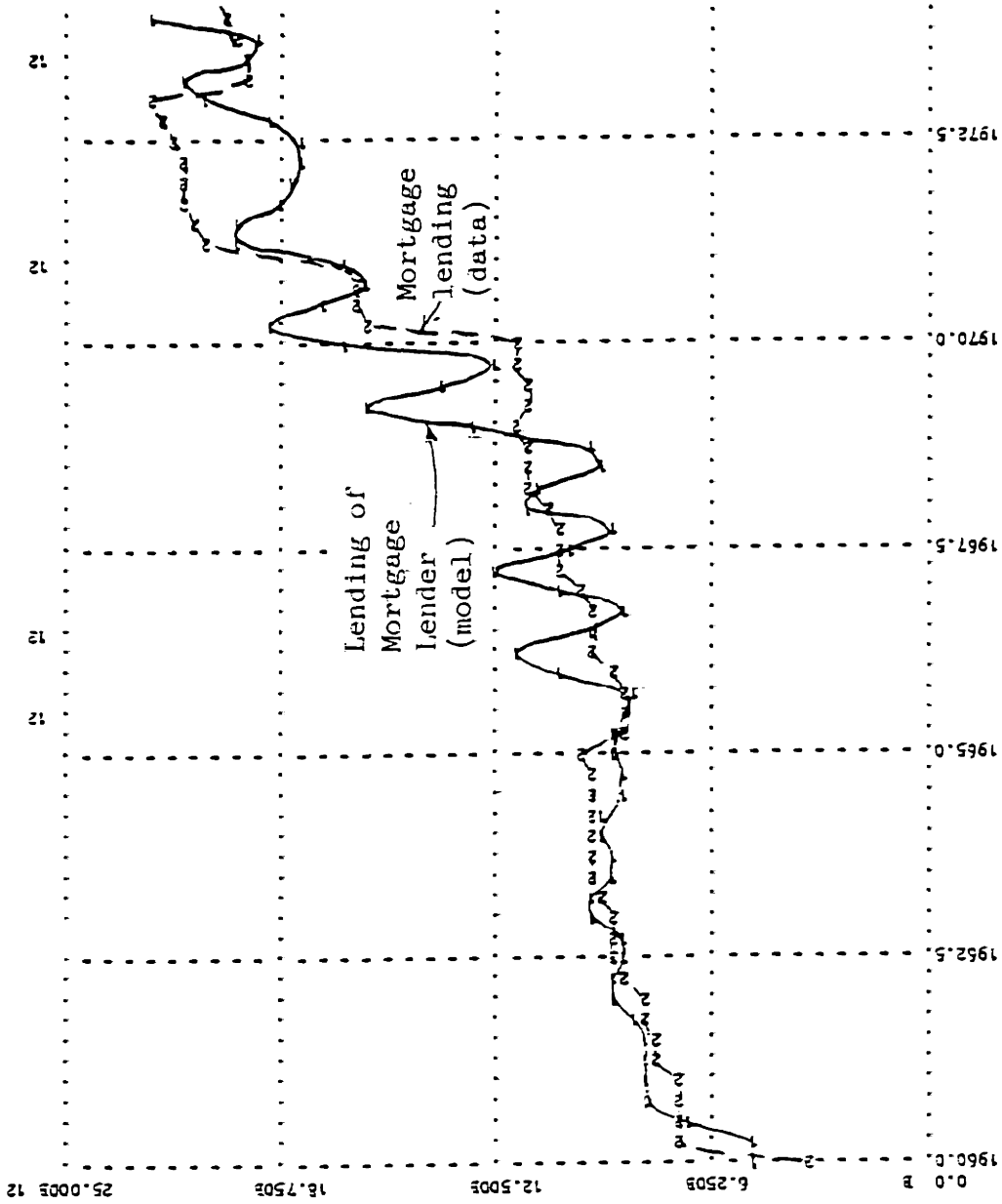


Figure V-7. Time-Series Comparison of Mortgage Lending (dollars/quarter)

The behavior of interest rates in the model provides more interesting, if less accurate, comparisons with actual data. Unlike loans and lending, which respond directly to data-based inputs, interest rates in the model respond to conditions prescribed within the model boundary and are affected only indirectly by the time-series inputs. The return on loans, for example, depends on market conditions, as revealed by the relative loan extension delay LED, the spread between asset yields and return on savings deposits, and relative profitability. If any of these forces gets out of line, the whole structure of interacting interest rates is affected. In light of these considerations, then, the behavior of model-generated yields compares quite well with the data, both statistically and qualitatively. As we shall see, however, yields on government securities exhibit an apparent lag with respect to data that may suggest the need for future model refinement. The fit of the federal funds rate, which as of now affects nothing else in the model, is poor.

Figure V-8 traces the return on loans outstanding for the Bank RLO(1) and the actual return on commercial bank loans drawn on a quarterly basis. During the first seven years of relatively stable rates, the model tracks the data well. The differences that do occur reflect some of the forces that affect lending and, thereby, the return on loans. For example, because Treasury bill rates start off at an unusually low level at the end of 1960 ($= 2.5\%$), the relative return on loans is high and encourages expanded lending. This, in turn, keeps the

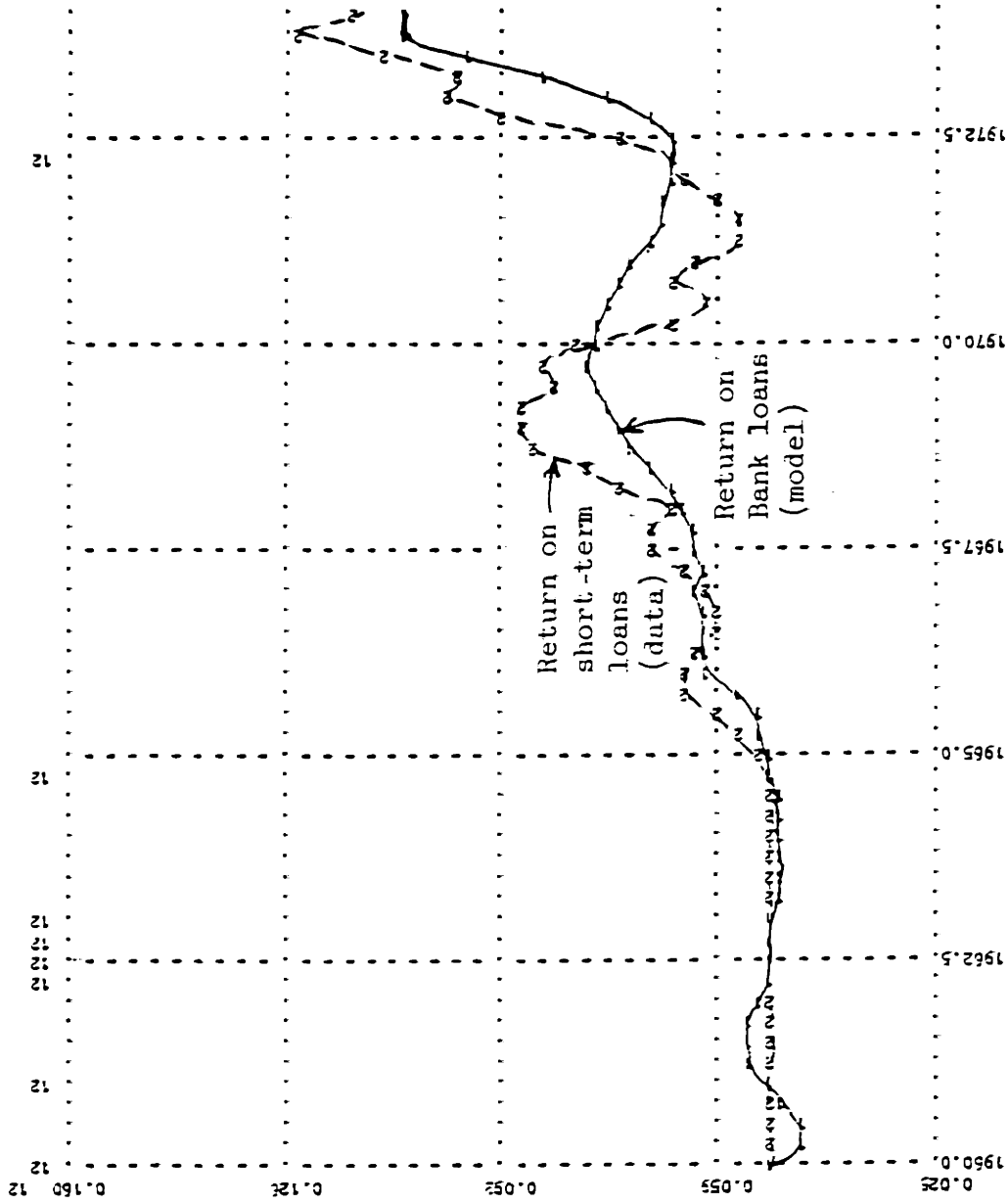


Figure V-8. Time-Series Comparison of Return on Short-Term Loans

loan extension delay below its normal value for over 6 months, thereby forcing the return on loans below the actual value. Subsequently, the bill yield rises sharply in the model, making loan yield somewhat less attractive and restraining lending. (The multiplier from relative return on lending MRRL falls from 1.2 to 0.9 within one year.) The restrained lending causes loan extension delay to rise above normal and thereby pushes the loan yield slightly above its actual value. These considerations, and similar forces that prevail during the rest of the simulation, reflect a complex structure underlying the establishment of interest rates.

During the last seven years of the comparison in Figure V-8, the model-generated return compares qualitatively to the data, in terms of the pattern and amplitude of excursion. The fit would be better, however, if the slight apparent lag in turning points were corrected. The lag seems to reflect primarily the relationship between loan yields and available yields on government securities which, in the model, constitute the other source of bank earnings. As we shall see, the returns on both bills and bonds display a six- to nine-month lag in turning points, for reasons to be discussed later. The return on loans is basically driven by the average return on assets ARA, which reflects the opportunity cost of holding loans relative to other assets. As two of the three components of ARA in the model, namely yields on bills and bonds, lag the actual values, we should expect some difference in phasing in loan yields as well.

The return on loans by the Corporate Lender (RLO(2)) also exhibits a fair statistical fit, but does better qualitatively, in that the turning points coincide more closely in time. As shown in Figure V-9, however, the model-generated yield swings more widely, above the actual peak and below the actual trough. The divergence is greatest at the end of the run, when the return in the model rises sharply to a level about 25% above the actual rate.

The return produced by the model immediately rises and then parallels the movement of its counterpart with about a 10-15% gap during most of the first ten years. The initial rise in the model yield reflects the pressure of expanding loan demand*17* as well as an early squeeze on profits (arising from the attempt to attract funds by raising the return on savings deposits). Pressure on loan yields from profitability is more significant for the Corporate Lender and Mortgage Lender than for the Bank, because the long-term lenders incur the current cost in savings deposits for all outstanding deposits, while interest earnings on outstanding loans and securities accrue only at yields prevailing, on average, well in the past. Thus, during periods of rising returns, the growing cost of attracting and holding deposits encourages higher loan yields. In 1969-70, for example, the multiplier from profitability on return on loans MPRL(2) rises even higher than the multiplier from demand (MDRL(2)), peaking in 1970 at about 1.3. During

*17*The backlog of loans in test generator BLTG is initialized in equilibrium and, therefore, does not reflect the initial growth trend in loan demand.

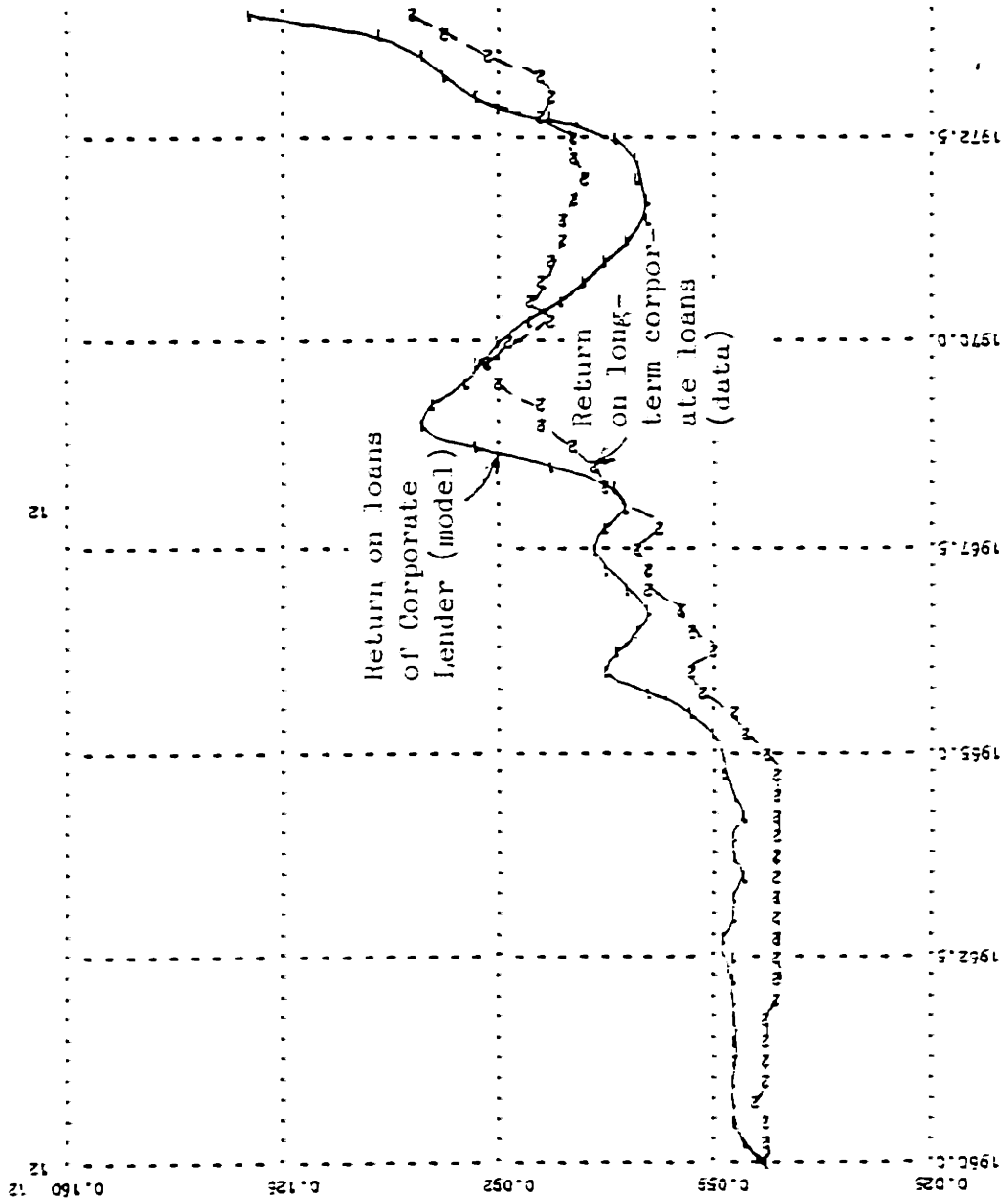


Figure V-9. Time-Series Comparison of Return on Long-Term Corporate Loans

the next year, the influence of demand falls sharply as corporate credit needs are realized, and the interest rate falls. During 1974, both demand and profitability combine in the model to force the return on loans to unrealistically high levels. The upward pressure of demand abates near the end, however, and would show a peak in 1975 if permitted to run out further.

The return on mortgage loans, exhibited in Figure V-10, moves in a pattern similar to the return on long-term corporate loans. The fit is closer during the early years, however, because the initial return on loans outstanding $RLO(3)$ is high relative to other available returns, thereby encouraging expanded lending at the outset and causing an initial loan extension delay $LED(3)$ considerably below the normal level.*18* Later, as interest rates rise, the force of eroded profitability that comes from paying out a rising return on deposits causes the model yield to rise considerably higher than the actual yield, both in 1969-70 and in 1974. It should be noted here that loans by the FHLB to savings and loan associations during these years enabled actual mortgage lenders to keep loan (and deposit) yields down at relatively (and artificially) low levels.

In the case of mortgage loans, the first measure of fit, R^2a ,

*18*At $t = 0$, the multiplier from relative returns on lending $MRRL(3)$ equals 1.4, causing lending to exceed the indicated rate and producing an initial loan extension delay of 0.17 (versus a "normal" 0.25). The influence of a lower loan extension delay offsets the upward pressures that develop from declining profits.

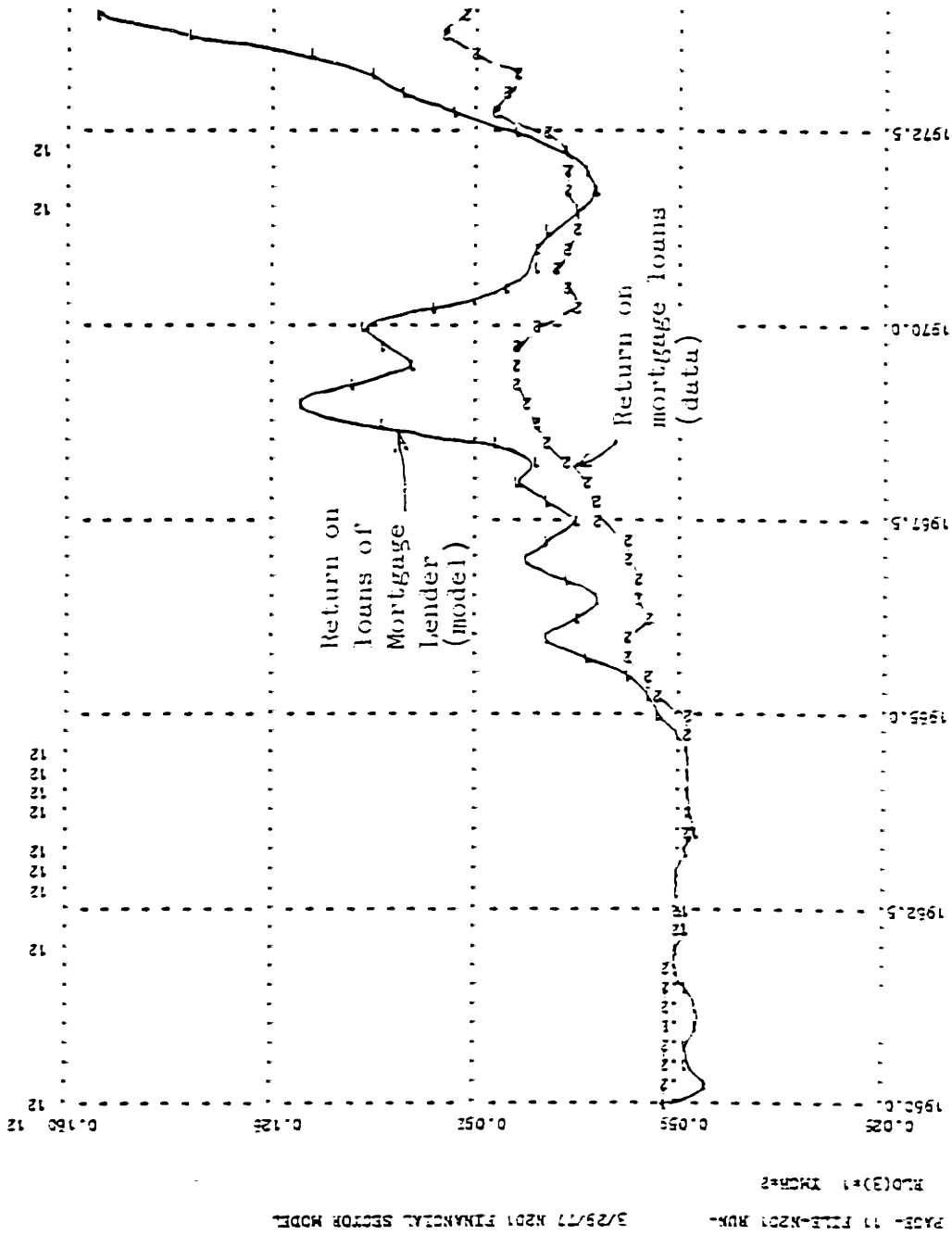


Figure V-10. Time-Series Comparison of Return on Mortgage Loans

is poor; but the second measure, R^2_b , is not bad. The low R^2_a reveals substantial point-by-point discrepancies, while the high R^2_b reflects a more acceptable qualitative pattern over the 14-year period. Nevertheless, the volatility that appeared in mortgage lending also occurs here, and the overall increases during 1968-70 and 1972-74 are much too large. The rapid fluctuations will disappear in the test described later, but the force of upward movement during years of tight credit suggest the need for further examination of the mechanisms for setting long-term interest rates.

Yields on the two categories of government securities are less satisfactory than the returns on primary credit. Figure V-11 exhibits the return on Treasury bills, which is qualitatively similar to the actual yield, but is less volatile, remains in a narrower range, and lags the turning points by six to nine months. At the very beginning, the model's return jumps sharply above the actual yield because the relatively low return on bills with respect to other assets encourages net sales.*19* From then on, the return in the model moves basically upward, like the real yield, and peaks in 1970 before declining again during the next two years. The first major peak follows the actual high

*19*During 1960 the bill rate dropped by almost 50% to 0.025. Given the data-based parameter, risk and cost premium on Treasury bills RCPTB, which appears in the equation that relates the (risk-adjusted) bill yield to the average return on assets ARA, this low bill yield constitutes a substantial deterrent in the model to buying bills.

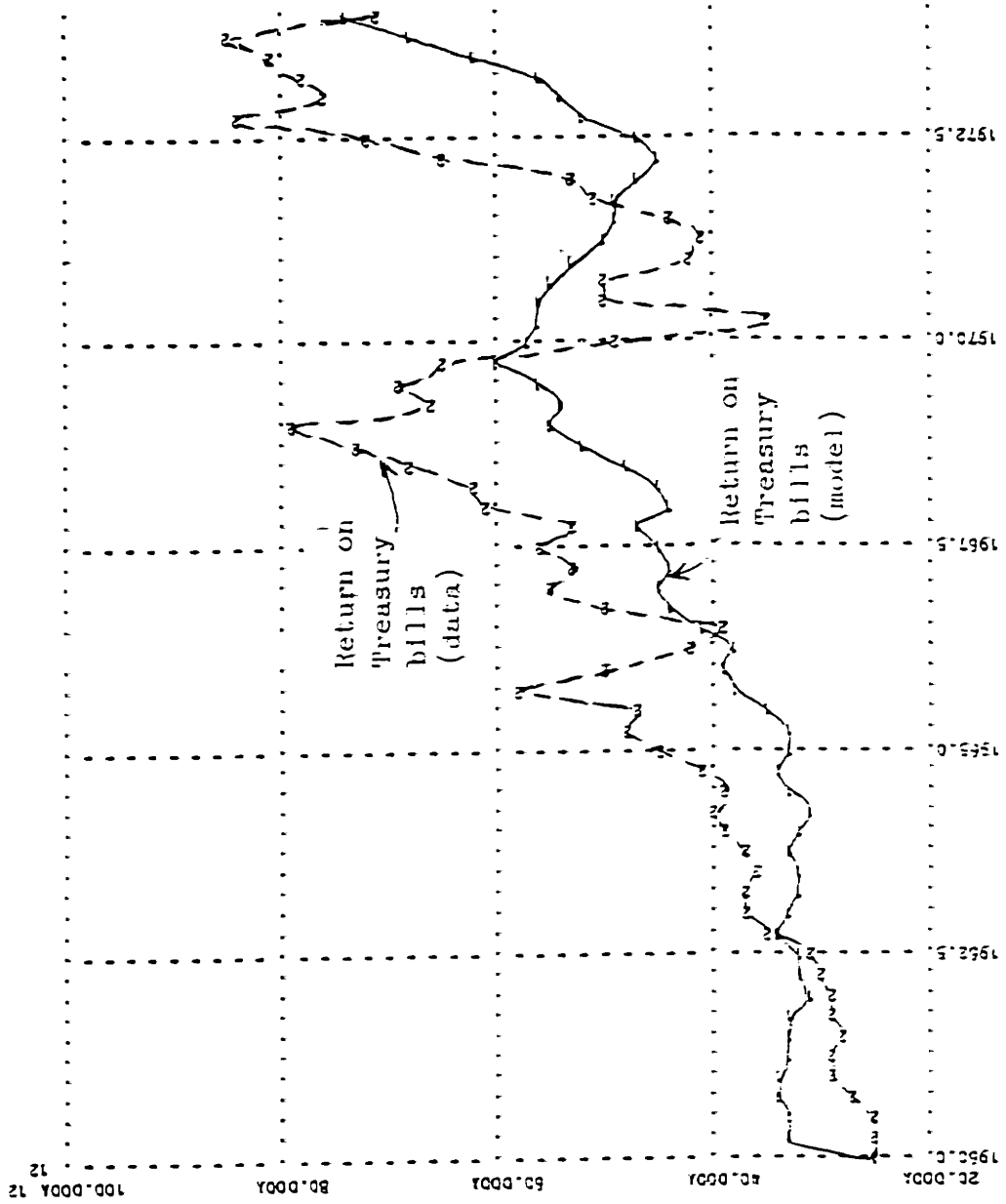


Figure V-11. Time-Series Comparison of Return on Treasury Bills

point and reaches only 6% (versus 8% for the real return). The subsequent rise, though also lagging the data, advances by almost the same amount as the real return.

The lag in bill rates elicits more significant questions about model structure than the failure of the model-generated return to rise as high in 1969-70 as the data. Unlike primary loans in the model, the demand and supply of credit to the government is represented as flow rates (desired sales and desired purchase rates) rather than as levels (liquid asset "inventory" and a demand "backlog"), for reasons described in Chapter III and Appendix 1. Thus the influence of market conditions on government security interest rates is reflected by flows which, unlike system states, cannot actually be observed and which are allocated instantaneously among potential purchasers in the model. Whereas an indicator of future lending exists for primary loans in the form of a backlog, no such information about future needs exists in the model for government debt; therefore, the relevant market-based yields cannot anticipate future activity.

Another form of present information about future needs is also lacking for most types of credit in the model--namely expectations about future rates that might cause more volatile and more anticipatory behavior in Treasury bill yields. Apart from the bond market, which contains a weak extrapolation pressure (see Appendix 1), none of the asset returns directly reflects the influence of expected future yields. The dynamic tests of the Financial Sector in isolation failed to provide

solid evidence for or against changes in the current structure of securities transactions, but the time-series test raises the possibility of future modifications.

The return on government bonds in the model exhibits a better statistical fit and a fair qualitative fit. The amplitude of change, as well as the pattern of behavior, more closely resembles the data. As Figure V-12 reveals, though, the return on bonds in the model declines during 1964 while the actual rate rose or stayed constant. Later, the return moves in the correct manner, except for a lag similar to the phasing of the bill rate. During each period of rapid rise, lenders in the model attempt to unload bonds so as to obtain liquidity to meet rising loan demand, while the Savings Investor augments its holdings at a slower pace to make room for higher-yielding assets. Again, the underlying model structure, as revealed in the behavior of variables cited but not shown in this chapter, appears to respond properly to conditions that prevailed during the comparison period.

The fit between the return on federal funds in the model and the actual yield, is very poor and is not exhibited here. It is tempting to ignore the poor results for several reasons. First, although the federal funds rate is considered a primary input to short-term Federal Reserve decisions, it is probably not as important to the longer-term control policies as other interest rates represented in the model. Moreover, the levels of excess and borrowed bank reserves in the model, to which the funds rate responds (see Equations 140 and 141 in Appendix 1) are not controlled in these simulations as they would be

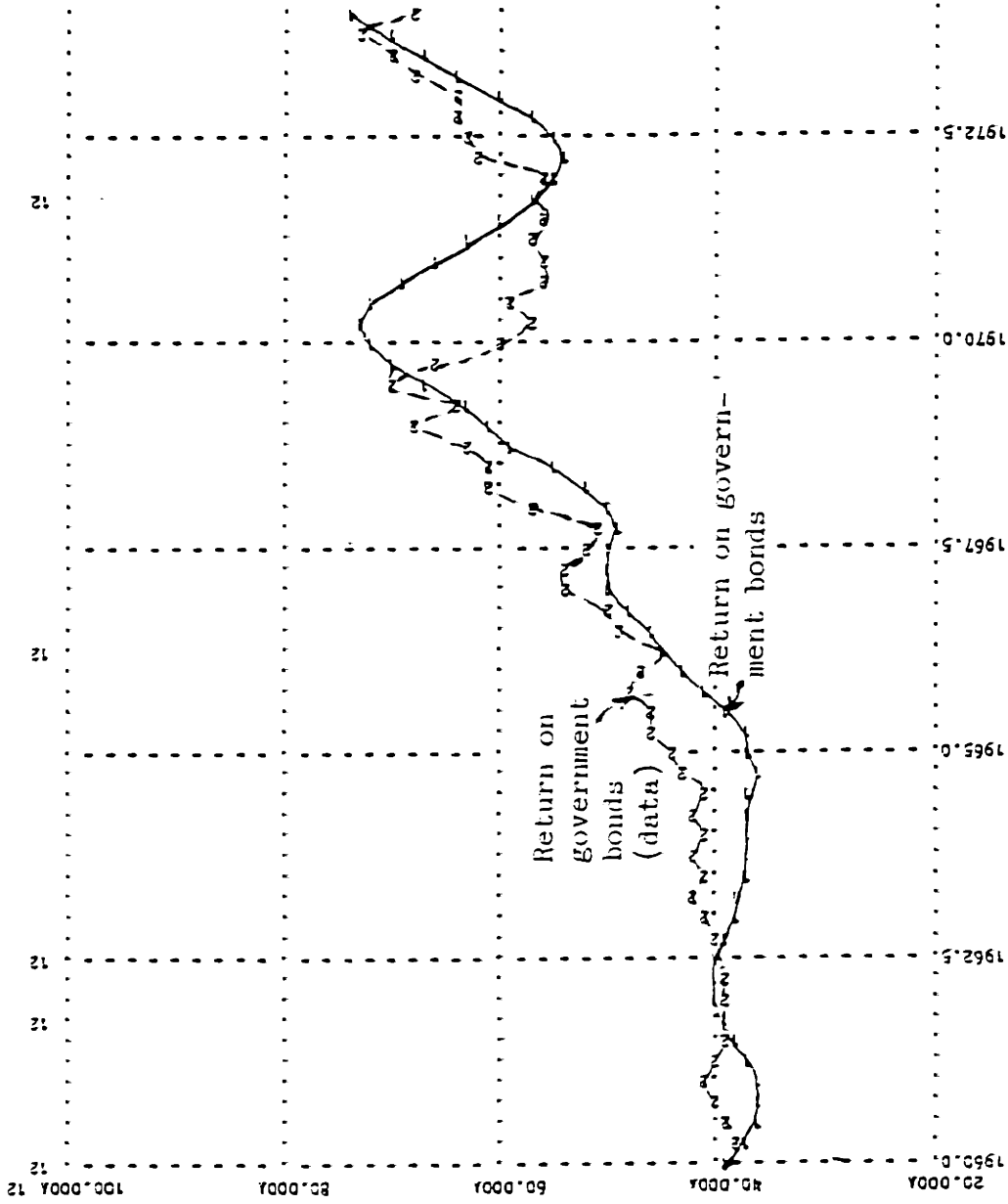


Figure V-12. Time-Series Comparison of Return on Government Bonds

when the Financial Sector is linked with the Monetary Authority.*20* Therefore, there is little to prevent wide swings in borrowed funds and, therefore, in the funds rate. Despite the temptation to neglect the funds rate in the National Model, however, its apparent importance as an indicator of short-term money-market conditions probably warrants a more careful treatment than has been attempted in the current version of the Financial Sector.

2. Time-Series Test with Slower Turnover in Savings Deposits

Combining the long-term lenders with each other or with the Bank has produced what appears to be excessive instability in model behavior. This volatility appeared in the last two simulations described in Chapter IV (see footnotes on pages 223 and 224) and was especially noticeable in the time-series comparisons of long-term lending to business (Figure V-6) and mortgage lending to households (Figure V-7). The instability apparently arises from the interaction of large flows of savings deposits in the model with small pools of liquidity. These interactions are complex, but may be traced briefly in the following example: a decline in liquid assets of the Mortgage Lender encourages a higher return on savings deposits. The higher return raises the value of the multiplier from return on savings

*20*The multiplier from borrowed funds on lending MBFL is neutralized here, because the level of "acceptable" borrowed reserves, to which the actual amount would be compared, is determined through feedback mechanisms with the Monetary Authority and is not entered as an exogenous time-series input for this test.

deposits $MRSD(3)$, thereby causing deposit purchases to rise and restoring liquidity of the Mortgage Lender. In all of the model simulations described so far, savings deposits have been assumed to turn over every 6 months (the average life of savings deposits $ALSD = 0.5$), on the theory that aggregate deposits can be liquidated that fast. In reality, however, savings deposits exhibit a much slower turnover, on the order of 3 to 4 years in the case of savings and loan associations (USL 1974, p. 69).

In Chapter VI, certain structural changes are proposed to distinguish between the slow average turnover of savings deposits and the rapid potential liquidation of deposits during periods of stress. While these changes have not been adopted here, one can test the impact of a slower, more realistic deposit turnover on model stability by changing the value of $ALSD$ from 0.5 to 3 (years). Increasing this parameter also implies that a given change in the deposit yield produces a smaller effect on deposits and liquidity, because the average flow-through in deposits, which is modified by the multiplier from return on savings deposits $MRSD$, is now reduced by a factor of 6. The results of this change are presented in this section and tend to support the structural modifications proposed in the next chapter.

The next three figures exhibit a significant improvement in model stability resulting from this one parameter change. Figure V-13, for example, which plots lending of the Corporate Lender against the data, should be compared with Figure V-6. Figure V-13 does not show the oscillatory behavior in the model that was generated previously.

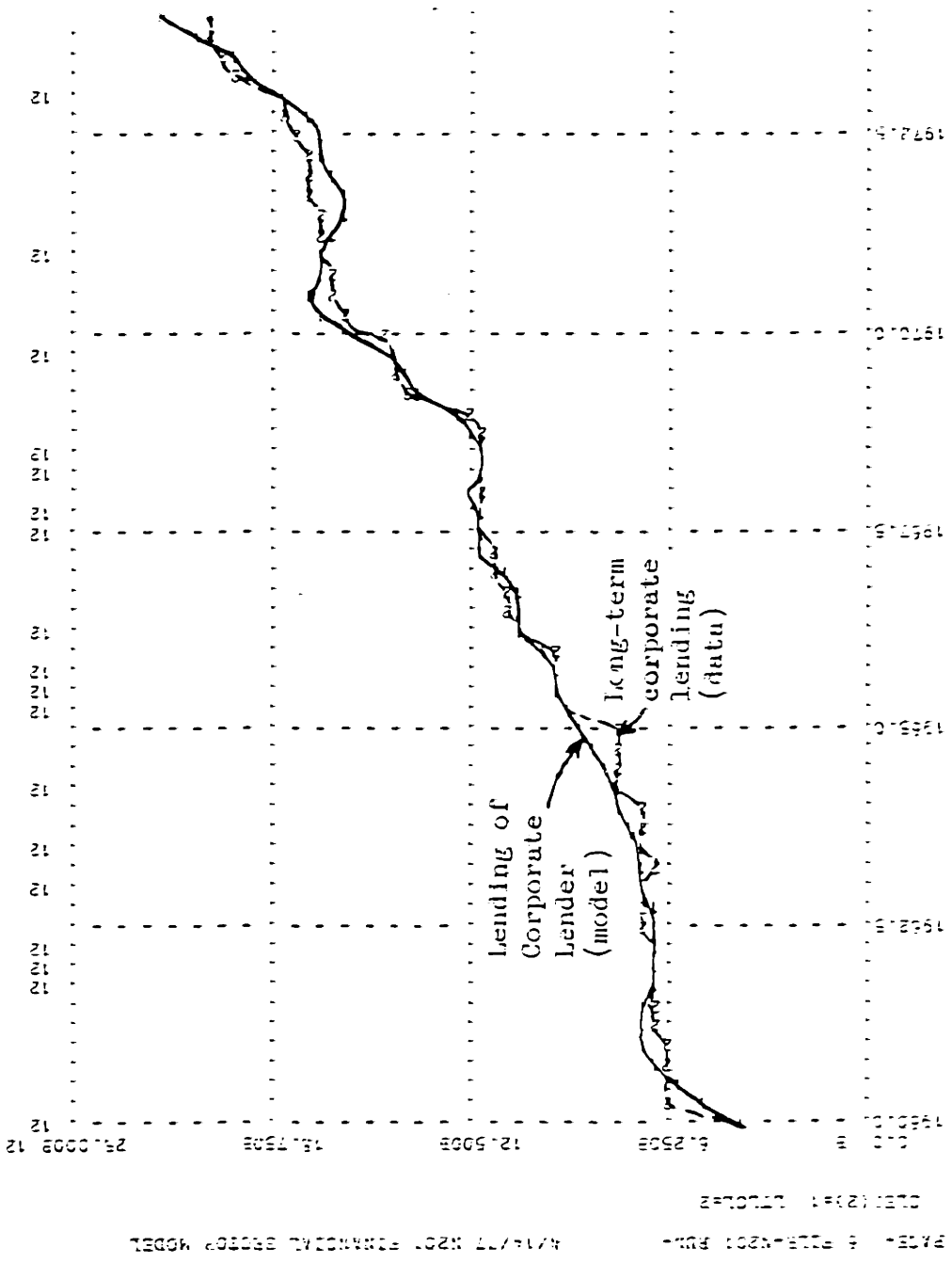


Figure V-13. Time-Series Comparison of Long-term Lending to Business, with Slower Turnover in Savings Deposits (dollars/quarter)

Figure V-14, which relates mortgage lending in the model to time-series data, portrays the improvement in model stability more vividly. Compared with the first time-series test (see Figure V-7), the change in ALSD eliminates the 1-year fluctuations in lending and improves the fit. Finally, observe Figure V-15, which relates the return on mortgage loans from the data with the model-based yield. The fit is not improved, which again invites a reexamination of the speed and intensity of adjustment in long-term interest rates. But the oscillations that are visible in Figure V-10 now are eliminated, as is the dramatic divergence in interest rates that occurred previously during the last year of the simulation.

The behavioral difference exhibited in all three figures reveals the importance of the relatively slow response among savers in real life (portrayed by the Savings Investor) to changes in savings deposit rates. If people responded more rapidly than they actually do, the mismatching of long-term loan maturities relative to the more rapid turnover in deposits would produce troublesome instability similar to that observed in the first time-series test.

While the system's adjustment to the higher value of ALSD will not be pursued here in depth, the main effects can be observed in the behavior of the two multipliers that influence the return on savings deposits (not plotted here). The higher value of ALSD reduces the rapidity with which the Savings Investor's response to changing deposit yields affects liquidity. Therefore, the multiplier from liquidity on

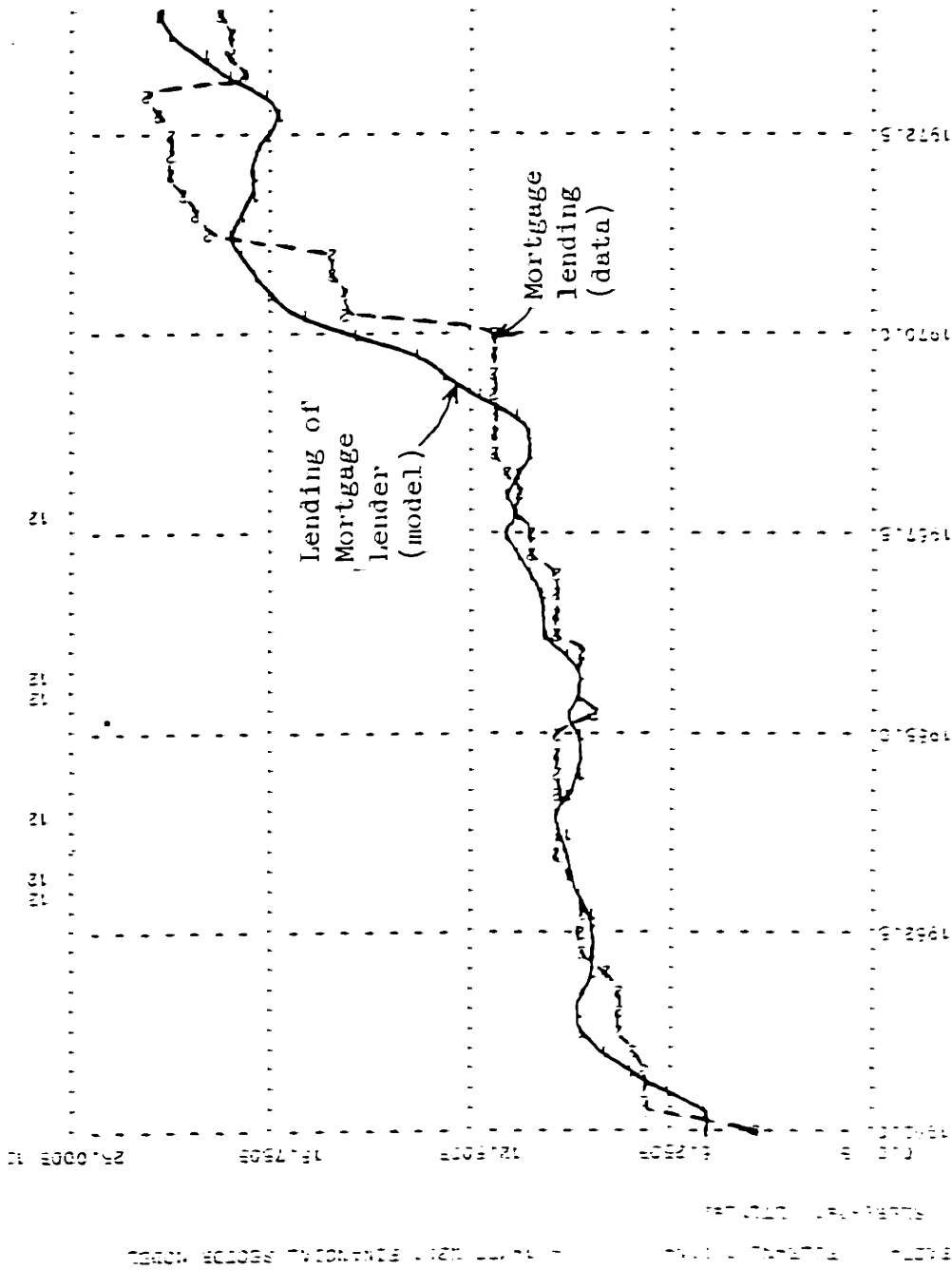


Figure V-14. Time-Series Comparison of Mortgage Lending, with Slower Turnover in Savings Deposits (dollars/quarter)

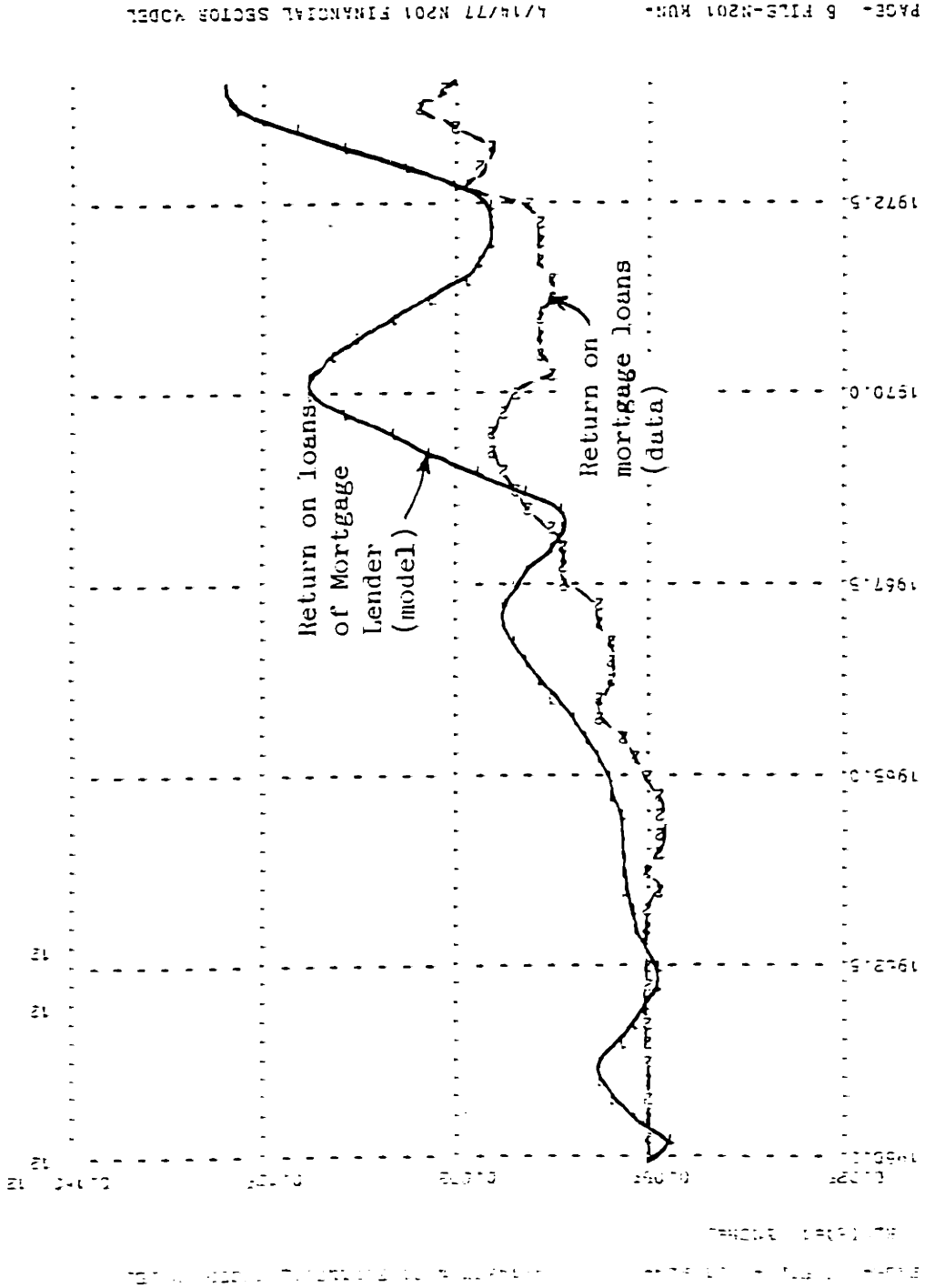


Figure V-15. Time-Series Comparison of Return on Mortgage Loans, with Slower Turnover in Savings Deposits

return on deposits MLRD, which exhibited rapid fluctuations before, now moves much more smoothly. Because liquidity now jumps around less, lending also changes less rapidly. More stable lending, in turn, produces greater stability in the loan extension delay, which directly influences the change in the return on loans. At the same time, the multiplier from profitability on return on deposits MPRD, which showed very little change before, now moves over a somewhat wider range, reflecting the need to vary deposit yields by more to obtain a given change in liquid assets. In effect, the parameter change reduces the strength of the loop relating liquidity and deposit return and increases the importance of the loop that relates profit and deposit return. Model behavior, thereby, improves, because the rapid fluctuations are eliminated; but the overall changes in amplitude and other qualitative measures of behavior are not greatly affected.

Statistical measures for the second time-series test also exhibit little change; although, on balance, the fit between model and data is slightly improved. Table V-5, which summarizes the difference in terms of R^2 values, shows this improvement, which appears mainly in lending rates and the return on government bonds.

Table V-5
 COMPARISON OF R^2 FOR TWO TIME-SERIES TESTS, *21*
 WITH ALTERNATIVE VALUES FOR THE AVERAGE LIFE OF SAVINGS DEPOSITS
 (ALSD = 0.5 year and 3 years)

<u>Model Variable</u>	<u>ALSD=0.5</u>	<u>ALSD=3</u>
1. Loans outstanding of Bank LO(1)	.988	.993
2. Loans outstanding of Corporate Lender LO(2)	.999	1.000
3. Loans outstanding of Mortgage Lender LO(3)	.998	.998
4. Quarterly loan extension rate of Bank LER(1)	.917	.912
5. Quarterly loan extension rate of Corporate Lender LER(2)	.965	.989
6. Quarterly loan extension rate of Mortgage Lender LER(3)	.880	.911
7. Return on loans outstanding of Bank RLO(1)	.789	.764
8. Return on loans outstanding of Corporate Lender RLO(2)	.736	.673
9. Return on loans outstanding of Mortgage Lender RLO(3)	-.768 (.858)	-.821 (.786)
10. Return on Treasury bills RTB	.463	.421
11. Return on government bonds RGB	.688	.784
12. Return on Federal funds RFF	-.983	-1.063

D. Conclusions

To summarize the time-series comparisons of selected financial variables, the model on the whole tracks time-series data fairly well and provides some limited support for the underlying structure. With respect to market yields, which provide the most interesting comparisons, returns on primary loans exhibit proper qualitative behavior and timing, if somewhat unrealistic excursions in the case of long-term credit. Government securities rates are less satisfactory because of an apparent phase shift between model and real returns.

*21*The values shown are for R^2 a. The two values in parentheses are for \bar{r}^2 b.

As an exercise in model development, the time-series testing proved useful for several reasons. First, the test process resulted in several changes in parameters that helped to generate more realistic responsiveness to market and institutional conditions.*22* Secondly, the testing process raised questions about the structure of government security markets and interest rates that should be pursued in future research. Finally, one aspect of developing part of a larger model is the lack of a clear "problem statement" or reference mode that usually guides a system dynamics modeling effort.*23* The 14-year time-series data, in this case, provided a useful, if partial, reference mode for testing the behavior of the Financial Sector in isolation.

*22*Namely, the time to adjust return on loans TARLO was shortened during the testing process from an intuitively derived 0.75 year to 0.30, thereby producing a wider, more realistic range in interest rate fluctuations, as well as more proper phasing between real and simulated variables. However, further experimentation could lead to different adjustment times for different lenders, as both long-term rates in the time-series test seem to respond too vigorously to changing market conditions. Also, to obtain a better fit with data, the slope of the table for fractional change in return TFCR (governing the change in return on both kinds of government securities) was raised as a result of the testing process.

*23*See Randers 1973, Chapter 2, for a discussion of reference modes in model development.

APPENDIX V-1

RERUN CONDITIONS FOR THE FIRST TIME-SERIES TEST*24*

ORIGINAL DT	31.250A				
PRESENT DT	15.625A				
ORIGINAL LENGTH	10.000				
PRESENT LENGTH	1.975T				
ORIGINAL INBLA	0.0	5.143B	4.500B		
PRESENT INBLA	0.0	6.000B	6.000B		
ORIGINAL IRLO	63.000A	69.000A	66.000A		
PRESENT IRLO	49.900A	51.000A	59.800A		
ORIGINAL ITB	15.190B	1.286B	1.125B	40.000B	
PRESENT ITB	19.000B	2.000B	2.000B	38.900B	
ORIGINAL IRTB	50.000A				
PRESENT IRTB	25.000A				
ORIGINAL IGB	40.000B	30.000B	10.000B	70.000B	
PRESENT IGB	74.800B	9.000B	9.000B	79.400B	
ORIGINAL IRGB	49.000A				
PRESENT IRGB	38.800A				
ORIGINAL ISD	65.000B	126.300B	153.550B		
PRESENT ISD	67.700B	110.400B	160.500B		
ORIGINAL CWESD	1.000				
PRESENT CWESD	0.0				
ORIGINAL TDFSD	0.400	100.000A	20.000A	1.000A	0.500A
PRESENT TDFSD	0.500A	0.500A	0.500A	0.500A	0.500A
ORIGINAL IRSD	45.000A	45.000A	45.000A		
PRESENT IRSD	25.000A	25.000A	25.000A		
ORIGINAL IERB	429.893M				
PRESENT IERB	756.000M				
ORIGINAL CVCS	10.000B				
PRESENT CVCS	0.0				
ORIGINAL CBCTG	1.000				
PRESENT CBCTG	0.0				
ORIGINAL SWTS	1.000				
PRESENT SWTS	0.0				
ORIGINAL ILOTG	148.485B	100.000B	150.000B		
PRESENT ILOTG	109.100B	107.700B	161.600B		
ORIGINAL IMTG	187.093B				
PRESENT IMTG	117.500B				
ORIGINAL ILASI	397.850B				
PRESENT ILASI	392.500B				
ORIGINAL NTSAV	0.0				
PRESENT NTSAV	0.300				
ORIGINAL NGSAV	0.0				
PRESENT NGSAV	25.000A				
ORIGINAL CMRSV	0.0				
PRESENT CMRSV	1.000				
ORIGINAL ITEM	18.000B				
PRESENT ITEM	15.200B				
ORIGINAL IGBM	3.000B				
PRESENT IGBM	12.200B				
			ORIGINAL TCGB	0.750	
			PRESENT TCGB	2.000	
			ORIGINAL ITIME	0.0	
			PRESENT ITIME	1.960T	
			ORIGINAL LDGBO	0.750	
			PRESENT LDGBO	2.000	
			ORIGINAL INT	0.0	
			PRESENT INT	0.250	
			ORIGINAL PLTS1	0.0	
			PRESENT PLTS1	1.960T	
			ORIGINAL PLTS2	999.000	
			PRESENT PLTS2	1.974T	

*24*The second time-series test is based on the same rerun conditions, except that ALSD = 3 (versus 0.5).

CHAPTER VI. LOOSE ENDS AND ISSUES

The model development and testing described in this study constitute the first phase of an ongoing process. Despite the Financial Sector's comprehensive scope, numerous loose ends remain. Some of these can be identified now and will be outlined in the first part of this chapter. Other loose ends will become more apparent as testing of the sort described in Chapter IV continues and as the model undergoes outside scrutiny and criticism. The purpose of the modeling effort, of course, goes beyond representation and includes important monetary policy issues. The second part of Chapter VI, therefore, will consider a selection of these issues, none of which can be explored fully without complete representation of borrowing and saving functions. Again, perhaps the most significant issues for further investigation will emerge only as the Financial Sector is linked with the rest of the National Model and as the model and the testing process receive continued external review.

A. Structural Loose Ends

Four of the incomplete or weaker elements in the Financial Sector model will be considered here. Most importantly, the model virtually ignores the valuation and impact of common stock ownership. The treatment of common stock, then, constitutes the longest section of Part A. Other loose ends relate to the nature of aggregation in the sector, the manner in which the lenders obtain non-financial factors of production, and the treatment of the computation interval for simulating the sector.

1. The Treatment of Common Stock

As of now, the Financial Sector deals mainly with contractual, interest-bearing assets (government securities, loans, savings deposits). An asset called "value of common stock" VCS appears on the balance sheet of the Savings Investor, but the value is held constant and simply entitles the Savings Investor to collect dividends from the three lending institutions. When the Financial Sector is linked with the rest of the National Model, the Savings Investor will receive dividends from each production sector and will be responsible for supplying equity funds, as well as interest-bearing credit, to the different sectors.

Business firms in reality finance most of their operations through the retention of earnings, and hardly any of their requirements by issuing new common stock.*1* To accommodate this self-financing, owners of equity are willing to forego dividend receipts if they think

*1*The following figures, which appear in Sametz 1970 (p. 267), show the importance of internal funds relative to new equity issues as sources of corporate finance:

	<u>1962-1966</u>
Internal sources	67%
- Retained profits	23%
- Depreciation	44%
External sources	33%
- Stocks (new equity issues)	1%
- Bonds and mortgages	11%
- Short-term	21%

that the company can earn an acceptable return by reinvesting its profits. Otherwise, the investor prefers to receive dividends and place them in more profitable ventures of the same risk category. It seems appropriate, therefore, to model all equity financing by modulating the flow of dividend payments to the Savings Investor, and ignoring the explicit flow of new equity issues.

In this scheme, dividends would be influenced by pressures generated within the paying sector (production sectors and lending institutions) and within the receiving sector (Savings Investor). As portrayed currently, dividend payments in the Financial Sector reflect primarily internal pressures and are based on:

- (1) traditional dividend payments
- (2) average profit after tax
- (3) desired debt-equity ratio
- (4) adequacy of money.

The pressures from the Savings Investor could include:

- (1) relative expected return
- (2) risk
- (3) liquidity
- (4) relative cash.

Relative return would be treated like other relative returns in the Financial Sector. That is, each return is compared on a risk-adjusted basis with the average return on assets ARA, which in the case of the Savings Investor equals the sum of the returns on bills, bonds, and three kinds of savings deposits, divided by 5. When equity investments are added, ARA would include the expected returns on each of the equity possibilities. Suppose, for example, that there are two production

sectors. Then the Savings Investor would hold equity in the two production sectors and in the three lenders for a total of five equity possibilities. ARA would include the sum of the five currently available returns plus five risk-adjusted returns on equities. The expected yield that enters each relative return computation could equal an exponentially averaged return on the book value of equity (that is, net profits of a production sector divided by the equity account on its balance sheet), modified by expected growth.*2*

Risk, the second influence from the investor's side on the payment on dividends, would appear in a variable risk and cost premium, based on past volatility of earnings. For example, a cyclical industry such as machine tools shows greater variation in earnings (and return on equity) than consumer services and, thereby, would generate a higher risk and cost premium on that category of common stock. A higher premium would require a higher expected return to make that investment category as attractive as the equity of other, less cyclical production sectors. If the expected return were not high enough, dividend payments from the cyclical sector would be encouraged so as to provide funds for investment in more attractive industries.

The last two influences (relative liquidity and relative cash funds) enter into the Savings Investor's decision to buy other non-liquid

*2*The reason for using this calculation will become clearer in the discussion that follows.

assets*3* and, for symmetry, should influence the effective flow of equity funds. Thus, if relative liquid assets or cash funds were low, dividend payments would expand, thereby producing an effective divestiture of equities, just as these two influences would produce pressures to limit bond holdings.

To summarize, each production sector would pay out dividends in response to its needs (traditional dividends, profits, debt-equity ratio, and money adequacy) and the needs of the Savings Investor (expected return, risk, liquidity, and cash). Thus the effective purchase of equities responds to the same influences as the purchase of other assets by the Savings Investor. However, the "purchase" of equities is accomplished through the flow of dividend payments rather than, in the case of other assets, by investing at a rate based on replacements. In this way we need not assume some average "lifetime" of equities which, for actual healthy firms, is infinite.

The valuation of equity and its effects on the consumption-versus-savings decisions of households still has to be specified. In the current Financial Sector model, total assets of the Savings Investor equal total savings TSAV at all times. To maintain this equality, the weighted return on savings WRS (expressed as a

*3*Equities, along with bonds, are considered non-liquid in the current model. While it is true that a large volume of common stock trades in public markets, a large portion of equity ownership cannot be transferred easily. Also, except for speculators, investors generally view common stocks as less readily transferrable into cash without loss than other assets and are viewed as a repository of savings rather than as transactions balances.

fraction per year) is transmitted to each household and production sector so that each level of savings can expand at the same rate that earnings flow or accrue to the Savings Investor.

This procedure would still work when equities are included among the Savings Investor's assets if we treat equity in the same fashion as savings deposits. That is, for savings deposits, the Savings Investor can either withdraw earnings as they are credited or let the earnings accrue. In the first case, cash increases by the amount of the earnings, and in the second case the value of savings deposits rises. Either way, total assets of the Savings Investor expand and, because earnings (paid out by the lender or not paid out) are reflected in the weighted return on savings WRS, savings expand by the same amount.

For equities, the payment of dividends (like earnings on deposits) may account for only part of the total return. The other part consists of the expected return on retained earnings. Savings in each sector must reflect the value of these equity holdings on which some, but not all, of the return involves a flow of funds (dividend payments). In the extreme, if no earnings are distributed to shareholders, the value of savings still rises even though funds do not flow to the Savings Investor. Perhaps the easiest way to account for these holdings would be to carry the book value of equity in each production sector as an asset of the Savings Investor. The book value of equity, now called "net worth" NW in the production sector, is simply a residual item on the production sector balance sheet (modeled like equity of lending institution ELI in the Financial Sector) that accounts for the

difference between total assets and total accounts payable. Thus, as earnings accrue in a production sector and are not paid out as dividends, new worth rises. The value of common stock VCS on the books of the Savings Investor could simply reflect the sum of all the net worth accounts in the system. Thus, the retention of earnings in a production sector would cause VCS to rise, and the payout of dividends would cause liquid assets of the Savings Investor LA(SI) to rise.

While the assets of the Savings Investor would reflect the book value of common stock holdings, we need to transmit that value back to the original savers, so that their total savings will equal total assets of the Savings Investor. This can be accomplished by taking total profits net of taxes (whether distributed or not) into the computation for total earnings on savings TES and calculating the weighted return accordingly:

$$\begin{aligned} \text{WRS} &= \text{TES} / \text{TSAV} \\ \text{TES} &= \text{RITB}(\text{SI}) + \text{RIGB}(\text{SI}) + \sum_L \text{ESD} + \sum_L \text{PLI} + \sum_S \text{NI} \end{aligned}$$

- WRS - WEIGHTED RETURN ON SAVINGS (FRACTION/YEAR)
- TES - TOTAL EARNINGS ON SAVINGS (DOLLARS/YEAR)
- TSAV - TOTAL SAVINGS (DOLLARS)
- RITB - RECEIPT OF INTEREST ON TREASURY BILLS (DOLLARS/YEAR)
- RIGB - RECEIPT OF INTEREST ON GOVERNMENT BONDS (DOLLARS/YEAR)
- ESD - EARNINGS ON SAVINGS DEPOSITS (DOLLARS/YEAR)
- PLI - PROFIT OF LENDING INSTITUTION (DOLLARS/YEAR)
- NI - NET INCOME (DOLLARS/YEAR)

- \sum_L - SUMMATION OVER ALL LENDING INSTITUTIONS
- \sum_S - SUMMATION OVER ALL PRODUCTION SECTORS

In this manner the book value of equity in the production sectors (and in the lending institutions) is reflected simultaneously in

the assets of the Savings Investor and in the savings of the household and production sectors (distributed in proportion to the size of the different savings pools).

The level of savings, as calculated here, represents book value, which may or may not reflect what people think their savings are actually worth. When people try to withdraw their funds, however, they may be disappointed, in that the Savings Investor may not have sufficient cash to meet withdrawals. This procedure seems reasonable, as people cannot liquidate immediately their accumulated savings. In the model, the reduction of savings RSAV in each household and production sector would be influenced by the relative cash and liquidity of the Savings Investor. As withdrawals continue, inadequate cash and liquidity force the Savings Investor to liquidate its assets, and the process of liquidation filters through the various levels of credit in the system.

Nothing has been said here about the market value of common stock, which does not necessarily equal the book value. It may be, however, that the proposed structure is sufficient to generate the correct impact of stock prices on savings and consumption. In the National Model, the change in savings is considered a function of weighted available returns on savings. The savings decision, in turn, affects consumption. As proposed here, the weighted return is based on a computation of savings that reflects book value rather than market value. In either case, a high relative return would attract more savings and, thereby, reduce consumption. In the widely-accepted

life-cycle hypothesis of consumption behavior (see Modigliani and Ando 1963), a high relative return on savings reflects a relatively low price (value) of financial assets which, in turn, restrains consumption and encourages savings. The mechanisms described above may differ from modern consumption theory, but should produce consistent results. More research, therefore, should be devoted to equity valuation in the National Model.

2. Aggregation in the Financial Sector

The degree of aggregation in a model can be considered appropriate only with reference to the model purpose. For most purposes, the asset categories in the financial model appear to be appropriate, but several aspects of the aggregation may be pointed out here. Savings deposits of the three lending institutions consist of a wide range of yield-bearing deposit categories, varying according to size, maturity, and owner. For the Bank, the aggregation of all time and savings deposits into one category obscures the basic differences between household-type deposits, which are extremely stable, and business-owned deposits (mainly CD's), which are volatile and highly sensitive to money-market conditions. Combining the two types of deposits has several implications. First, the channels for controlling one type of deposit over the other (via the Federal Reserve's Regulation Q) cannot be tested in the model. Second, the investment preferences of business savers are assumed to parallel those of household savers, when, in fact, they are quite different. To make the

separation explicit would require two Savings Investors, one for corporations and one for households, each with different interest rate and liquidity preferences. The DYNAMO III compiler would permit this replication rather easily, although the need does not seem obvious at present.

The government bond category in the model is another case of combining rather dissimilar elements into one aggregation. Although state and local bonds are combined with U.S. government bonds, the risk characteristics differ. The aggregation seems justified for most purposes, in that both kinds of bonds serve as a residual investment that can be liquidated if necessary to support primary lending. To explore urban issues in the context of the National Model, however, one could fairly easily add an "urban sector" in addition to the government sector, whose debt requirements would carry higher risk and whose tax status could be manipulated in policy design.

The manner in which urban or other government demands for credit are structured should also be investigated. In the model, the demand for government funds takes the form of a desired sales rate that is transmitted directly to the securities markets, rather than, as for primary credit, a flow of orders that accumulates in backlog. This difference in structure seemed appropriate for allocating government securities, where one source of demand seeks funds from several sources of supply rather than, as with primary credit, where one supplier tries to meet several sources of demand. As we saw in Chapter V, however, public demand for credit might be structured more appropriately like

private demand, which would add symmetry with the rest of the model, though probably require a somewhat different allocation mechanism.

3. The Acquisition of Non-Money Factors of Production

Currently, the only direct cost that enters the calculations of lending firms is the cost of acquiring deposits. However, other factors, such as labor, buildings, and energy, are also required by financial institutions. To avoid repeating the whole set of ordering equations that form a large part of the standard production sector, one way to represent factor acquisition in the Financial Sector is to establish a stream of orders for services from the service sector, which in turn uses the necessary labor and other factors of production. The order stream could be generated in proportion to both average transactions activity and size, just as (temporary) Equation #135 now determines operating costs of lending institution OCLI. These standard orders would be modified by the "backlog" of orders for services and the "inventory" (or flow?) of services available to the sector. In addition, the availability of services would have to affect the activity of lenders, perhaps through a multiplier on the loan extension rate. Finally, operating costs (OCLI) and actual cash payments to the service sector might be considered equivalent so as to avoid setting up the usual accounts payable and other accounting structures used in the standard production sector.

4. The Computation Interval

As noted in previous chapters, the Financial Sector model requires a relatively small computation interval (DT), in terms of the modes of behavior to be investigated and in contrast to the much longer DT that suffices for the rest of the National Model. Underlying the need for a short DT is the feedback in the model between small pools of cash and liquid assets and large monetary flows. For example, cash funds in the Bank constitute a very small fraction of the loan extension rate (about 1% initially). Lending depletes cash and depleted cash restrains lending, a logical negative feedback relationship, but one that can create technical problems if, as a result, the net change in cash occurs too fast. That is, the flows that influence cash funds may produce an effective time constant for adjusting cash that is too short relative to the DT and, thereby, distorts behavior.

Another source of the DT problem is the large flows of savings deposits relative to the levels of liquidity they affect. The relative difference is particularly marked for the long-term lenders; the Mortgage Lender, for example, typically holds liquid assets equal to 2% of the flow through the level of savings deposits. The liquid asset pool, in turn, influences lending and bond purchases but does not have much impact on deposit withdrawals except under extreme conditions. It is at extreme illiquidity, however, where the DT problem is especially acute. In the case of deposits, moreover, another link between small pools and large flows exists, as purchases of deposits by the Savings Investor are directly affected by its level of cash funds, which

initially equal about 4% of the flow. Again, the technical problem does not produce distortion if the time derivative of the small levels changes slowly relative to the DT; but as previous simulations have indicated, this condition cannot be guaranteed.

Some causes of the computation problem can be eliminated through model refinement (or even by means of parameter changes). For instance, the normal flow of deposits now equals twice the level, as the "average life" of savings deposits is assumed to be one-half year. This parameter (ALSD = 0.5) is based, however, not on the normal turnover of private savings, which would be more like several years, but on how fast one could liquidate deposits if desired. Thus, savings deposits usually constitute liquid assets which, nevertheless, have a slower turnover in reality (longer "average lifetime") than some types of assets that are usually considered illiquid. The model could capture this characteristic of savings deposits by specifying a longer average life of savings deposits ALSD, perhaps 3 years, and separately modifying withdrawals of deposits by Savings Investor WDSI to permit faster desired liquidation under certain conditions. These conditions could reflect runs on banks and other lending institutions, which, in turn, would activate the normally neutral influence of internal liquidity on deposit withdrawals.

The proposed modification would retain the standard format for asset purchases based on replacements of normal maturities. The change would also reduce by a factor of 6 the discrepancy between lender liquidity, or cash in the Savings Investor, and normal deposit flows.

Moreover, we saw in the second time-series test in Chapter V that a longer average life, equivalent to a slower turnover in deposits, reduces the instability that arose from the interaction between large deposit flows and small liquidity levels.

The small cash pools within each lending institution would also be affected by changing the structure of deposit purchases and withdrawals. In effect, cash funds would be much larger relative to the flows that influence them. However, cash pools would still be small, especially for the Bank. It appears necessary to maintain separate accounting of money in the model, because of the required calculation of various bank reserve categories and because of the impact of cash funds on Treasury bills and bill rates. So ignoring cash funds by having only an undifferentiated liquid assets level seems inappropriate. One might assume larger cash pools than actually exist, a procedure that would involve unrealistic parameter values (e.g., for normal cash fraction of liquid assets NCFLA) but probably no significant changes in dynamic behavior. At any rate, the problem of choosing a suitable computation interval does not appear to be irresolvable, but does require further study.

B. Financial Issues and the National Model

This section considers a selection of issues that can be addressed with the aid of the Financial Sector. In most respects, meaningful conclusions about the issues cannot be drawn from the Financial Sector in isolation and will require the combination of

financial and other sectors of the National Model. Although such combinations are beyond the scope of this study, a delineation of certain issues may support the choice of variables and the level of aggregation described in previous chapters.

1. The Importance of Money

For years economists have debated the importance of the money supply to real economic activity. Although the focus and content of debate shifts constantly, one can distinguish a basic "Keynesian" or "fiscalist" position from the "monetarist" position. Arguing from the famous IS-LM construction of Hicks (Hicks 1937), the fiscalist says that the demand for money is a function of both transactions requirements and interest rates and that the supply of money is controlled by the monetary authority. The monetary authority can influence interest rates directly and indirectly by changing the supply of money. For example, restraining the money supply causes an excess transactions demand for money, which raises interest rates. Higher interest rates not only directly influence the demand for money but also suppress investment. Reduced investment, in turn, operates through the multiplier-accelerator interaction (Samuelson 1939) to restrain economic activity.

Most monetarists argue from the classical quantity theory of money, based on the identity $MV = PT$ (where money M times velocity V equals price P times real transactions T). Since PT equals total expenditures, velocity by definition is the amount of spending divided by money ($V = PT/M$). The monetarist asserts that velocity is fairly

constant (or predictable), since people generally want to hold money balances equal to some proportion of their expenditures. Therefore, changes in the money supply are the crucial determinant of spending. Proponents of the money supply school draw support from the historical relationship between cycles in money and cycles in general business activity. Friedman and Schwartz, for example, show that over a 100-year period every cycle in business activity has been associated with a cycle in the rate of growth of the money supply, and generally leads general production activity by 20 to 30 months. (Friedman and Schwartz 1963, pp. 34-38).

Although Friedman and others have suggested a causal relationship between money and business activity, it is clear that chronological leads do not necessarily imply causation. It is perfectly possible, for example, to construct economic models in which money has no influence on business and yet generate the observed lead-lag relationship (Tobin 1969). Cyclical behavior has also been observed in the rate of inflation, which some economists attribute to the rate of growth in monetary aggregates. Again, however, inflation may not uniquely relate to the money supply but reflect other, more important causes.

In the real economy, strong non-monetary forces appear to contribute to instability and inflation. Some of these forces reflect basic business activity, such as the management of inventories and productive factors, quite apart from monetary flows. In reviewing our lack of understanding about economic instability, Sommers writes,

"...[T]he identification and treatment of sources of inflation in the system not inherently related to the behavior of monetary aggregates would be a useful pursuit in the effort to avoid the deepening cyclical experience of the last decade." (Sommers and Blau 1975), p. 28).

The National Model contains sufficient detail at the operating level of business, banking, and monetary policy-making to explore with some precision these non-monetary sources of instability. By providing the detail contained in the Financial Sector, for example, we may be able to identify not only causal factors emanating from the productive sectors, but also the important reverse influences exerted by the business cycle on the monetary cycle itself. As Davis reveals, we should examine "the feedback from business conditions to policy decisions and thence from policy to the money supply." (Davis 1968, p. 69). In fact, the extensive detail contained in the Financial and Monetary Authority sectors may lead eventually to the conclusion that many of the financial decisions we take as important are really secondary to non-monetary factors. By constructing a detailed financial model first, we may develop convincing reasons to reduce its complexity later.

2. Monetary Policy

The money-business interaction would be of only academic interest were it not for its policy implications. Given their view about the importance of money, monetarists argue that the stock of money, rather than the interest rate, is the best target and guide for

monetary policy. While "Keynesians" believe the interest rate to be an important determinant of real output, most monetarists treat interest rates as a reflection of other aspects of economic activity. Trying to keep interest rates low by expanding the money supply, they claim, is usually futile and leads to greater inflation rather than expanded real output (Friedman 1968).

The suitable target for policy relates, of course, to one's view of the important causal relationships. Clearly, interest rates and money supply both affect and are affected by economic decisions in many spheres. To emphasize either interest rates or money supply at the expense of the other may ignore the feedbacks that cause these variables to be part of the same dynamic system. Moreover, an interest rate target might be quite suitable for influencing certain modes of behavior, such as long-term capital-related cycles, and inappropriate for controlling short-term instability related more to inventory and labor management (see Mass 1975 for the underlying distinctions). The integrated systems perspective that the National Model provides may help to focus academic arguments on these points.

Even if some people claim to have identified the appropriate policy targets, they disagree about how fast they should respond to changes in target variables. Fiscalists are more inclined to "fine-tune" the economy to continuously changing conditions, while the monetarists favor slowly changing policy rules, such as maintaining a steady growth rate in money supply. One argument against fine-tuning is that the lags between policy and economic behavior are fairly long and

variable and may cause monetary decisions to have maximum impact at the most inopportune times (Warburton 1971). Another argument cites the instability in financial markets that results from frequent changes in Federal Reserve policy. Attempts to fine-tune result in highly variable market rates, upsetting spending plans, and reducing financial liquidity (McCracken 1975).

Questions relating to the appropriate response time in monetary control will be examined with the aid of the Financial Sector model. As shown earlier, the Monetary Authority in the model operates in the securities market to influence both bank reserves and interest rates. The short-term effect on Bank lending capacity will vary, and will be determined in part by the Bank's liquidity position, defined in the model as the sum of excess reserves and Treasury bills. Moreover, the Bank may be able to reduce the direct predictability of monetary controls, by selling time deposits to other investors (represented in the Savings Investor) and thereby continuing to extend credit in the face of tight money policies.

3. Fragile Financial Structures

Minsky writes that our financial system has become increasingly vulnerable to unexpected shocks or poorly conceived policy decisions (Minsky 1975). Contributing to this fragile system is the invention of new investments (such as CD's) designed to create credit by tapping pools of liquidity. Liability management, as a result, has enabled banks to operate on a smaller pool of liquid assets, eroding the

capital base of financial institutions and other stable sources of operating funds. "However, underlying the greater reliance upon debt financing of investment and positions in the stock of capital assets is a belief that the debt-validating income of business, households, and state and local government will grow, so that the cash flows required to fulfill financial obligations will be forthcoming. Once expectations of unbounded growth are abandoned, an inherited debt structure can become untenable." (Minsky 1975, pp. 11-12).

Minsky's observations are especially relevant if we believe that the economy is capable of generating long-term as well as short-term modes of activity. The National model contains non-financial structures that produce the controversial long wave, or 50-year Kondratieff cycle in economic activity. If the economy is now near the peak of such a long wave, as overbuilt capital and other signs suggest (see Forrester 1975, pp. 14-19), then the bouyant expectations that have produced fragility in the financial system may become increasingly disappointed. Unrealized expectations, in turn, can lead to financial crisis. To mitigate the crisis, Minsky prescribes reduced investment activity (Minsky, p. 13). This alternative coincides with the view that capital is already overbuilt and, if expanded further, could produce a more severe readjustment in the future. At the same time, however, some level of inflation, perhaps fueled by continued government deficits, may be necessary to destroy the value of old debts in a more palatable manner than multiple defaults.

These issues combine both long-term and short-term

perspectives that can be studied through simulation of the National Model. Expectations in the borrowing sectors of the model govern the acquisition of financial capital and other productive factors. Expectations also lead to assessments of creditworthiness that, over an extended period of growth, can produce eroding standards and increased vulnerability to changing conditions.*4* In this climate, the "control" exerted by the Federal Reserve as lender of last resort turns to crisis avoidance (as in 1966, 1970, and 1972), which may simply reinforce the trend toward more fragile finance. The feedbacks from underlying economic activity to public policy may exert more force than the "control" that public institutions are said to exercise.

4. The Inflation Component of Interest Rates

An unresolved question in monetary economics is the manner in which expected price inflation affects interest rates. Following Irving Fisher's early work on interest rates, many observers claim that the nominal interest rate actually contains a real rate and an expected price inflation (or deflation) component. In theory, lenders expecting a future decline in purchasing power through price inflation require compensation in the form of higher interest rates for holding financial assets rather than goods. Borrowers, also expecting continued inflation, benefit from the depreciation of their liabilities and,

*4*See Carruth 1975 for an interesting review of how eroded bank standards relative to construction lending recently led to disastrous losses and foreclosures.

therefore, are willing to pay a higher interest rate to obtain credit.

The impact of inflationary expectations on interest rates has been explored empirically with uncertain results (see Yohe and Karnovsky, 1969). Some studies suggest a lag of about one year between price changes and their appearance in interest rates, while others suggest lags of up to twenty years. The monetarist view supports a shorter lag. Monetarists argue that an expansive monetary policy aiming to reduce interest rates affects mainly prices and inflationary expectations, thereby eventually causing rates to rise, rather than fall.

In the Financial Sector model, interest rates respond to the supply and demand for funds. No explicit inflationary expectations component enters the supply (investor's) side. Rather, the investing institutions are assumed to respond to the various sectoral demands, where one of the influences affecting the need for funds is the expected rate of inflation in the cost of factor inputs. Higher inflationary expectations cause the borrowing sectors to seek more financing, thereby tending to raise interest rates. At the same time, as the different sectors face a growing need for funds, partly induced by inflationary expectations, they start to withdraw savings from the Savings Investor, thereby reducing the supply of credit and also raising rates. Tests that relate inflation to interest rates cannot be performed with the Financial Sector alone, but will be attempted as an extension of the work described here.

5. The Term Structure of Interest Rates

Much has been written about the relationship between interest rates and the average life to maturity for securities in equal risk classes. The typical yield curve on government securities, for example, is upward sloping, revealing that longer-term bonds generally yield a higher return than short-term securities. However, at cyclical peaks, Treasury securities generally exhibit a hump and downward slope (Kessel 1965). Most theories that attempt to explain the term structure focus on the asset preferences of investors rather than the interaction of the supply and demand for funds. The major inputs from the supply side are investor's expectations about future short-term rates and the aversion of investors to the risk of capital depreciation that results from rising interest rates. Most macroeconomic models of financial activity contain some sort of reduced-form equation intended to explain the term structure.

In contrast to the usual approach, Benjamin Friedman proposes a structural model of the corporate bond markets that reflects the influence of both supply and demand for corporate bonds on long-term rates (B. Friedman 1975). His approach is closer to that of the financial model developed in this study. But Friedman focuses on the investor's portfolio decision, simply adding an exogenous demand for funds as a constraint on total transactions. Yet it is the feedback between investor and borrower decisions, as well as among buyers and sellers of securities in the secondary markets, that determine the term structure. In the National Model the production sector borrowing

equations will relate short- and long-term financing to working capital and factor input decisions. It is quite possible that the observed yield/maturity relationship is generated more by sector ordering decisions (in turn affected by expectations) than by investors' portfolio allocations. This possibility can be tested in the National Model only when financial and production sectors are linked together.

Numerous financial issues have been outlined in this chapter. A complete program of research would have to probe deeply into the details and would require considerable effort. This study, together with the rest of the National Model structures developed to date, constitutes only the beginning of an ambitious investigation into the financial processes that contribute to observed economic behavior.

APPENDIX 1
DESCRIPTION OF EQUATIONS FOR THE FINANCIAL SECTOR
OF THE SYSTEM DYNAMICS NATIONAL MODEL

A. INTRODUCTION

This appendix describes the equations that comprise the Financial Sector of the System Dynamics National Model. Appendix 2 provides additional equations that are designed to test the Financial Sector and will be eliminated or otherwise modified when the sector is combined with other parts of the National Model. For example, Appendix 2 specifies a separate set of test equations used to represent loan demand. These test equations will be eliminated when the Financial Sector is linked to one or more production sectors. Equations required to couple the Financial Sector with the rest of the model will remain, but their form will depend on the particular configuration of the overall model.

The sector is organized by institutions and functions. As explained in Chapter III, the model contains four institutions, many of whose functions overlap. Three of the four institutions collect deposits, extend credit, and invest in government securities. The Bank, for example, makes short-term loans to business and household sectors. The Corporate Lender extends long-term credit to business sectors. The Mortgage Lender provides residential mortgage credits to household sectors. A fourth, non-lending institution, the Savings Investor, accumulates the savings of all business and household sectors and

invests these savings in government securities (Treasury bills and long-term bonds), yield-bearing deposits of the three aggregate lenders, and common stock.*1*

The Bank, Corporate Lender, and Mortgage Lender represent composites of real-life, profit-making institutions, with capital accounts (equity liabilities) owned by private investors. The Savings Investor, on the other hand, portrays an allocation function rather than an identifiable, profit-making institution. The Savings Investor holds all of the financial assets that in reality are owned directly by individuals; its liabilities consist entirely of the accumulated savings of the various private sectors.

Table A-1 divides the functional organization of the Financial Sector model into 8 blocks of equations. Page numbers in parentheses indicate where in the appendix each block is described. The equations are portrayed by flow diagrams displayed at the end of the appendices. A better understanding of the formulations will be gained by referring to the relevant diagram while reading each section of the equation descriptions.

*1*In the current model version, the Savings Investor carries common stock as an asset with a fixed value. This asset entitles the Savings Investor to receive dividends paid by the three lending institutions, but no attempt is made in this thesis to portray the market's valuation of equity or common stock transactions.

Table A-1
 ORGANIZATION OF FINANCIAL SECTOR EQUATIONS

BLOCK OF EQUATIONS	FUNCTION
(Appendix 1):	
1. Primary lending (pp. A5-A28)	Extends short-term and long-term credit to business and households on the basis of demand, liquidity, relative returns, and borrowed funds.
2. Return on loans (pp. A28-A43)	Establishes interest rates on primary loans in response to demand, profitability, and interest-rate spreads.
3. Investment in Treasury bills (pp. A43-A58)	Sets desired and actual transactions in Treasury bills, and determines the return.
4. Investment in government bonds (pp. A59-A72)	Sets desired and actual transactions in government bonds and determines the return.
5. Liabilities--savings deposits (pp. A72-A86)	Determines the amount of savings deposits and interest rates on deposits.
6. Liabilities--equity (pp. A86-A94)	Defines equity levels and dividends
7. Bank reserves and currency (pp. A94-A108)	Manages bank reserves, borrowing from the Monetary Authority, and currency deposits and withdrawals.
8. Temporary equations (pp. A109-A115)	Provides temporary values for certain Financial Sector variables that will require fuller treatment.
(Appendix 2):	
9. Test generators (pp. A116-A144)	Represents loan demand, and desired securities transactions of the Treasury and Monetary Authority.
10. Coupling equations (pp. A144-A151)	Links test generators with Financial Sector.

Many of the Financial Sector equations are used to represent more than one variable in the model. The DYNAMO III compiler permits this efficiency in writing and simulating equations by manipulating vectors or matrices in addition to single-valued equations. For example, a number of variables in the model carry the subscript "FI," which ranges over four different types of financial institutions. Government bonds GB is one of these variables and represents bonds held by the Bank (FI = 1), the Corporate Lender (FI = 2), the Mortgage Lender (FI = 3), and the Savings Investor (FI = 4). The equation for government bonds GB, however, is written only once:

$$L \quad GB.K(FI) = GB.J(FI) + (DT)(PGB.J(FI) - MGB.J(FI))$$

GB - GOVERNMENT BONDS (DOLLARS/YEAR)
PGB - PURCHASE OF GOVERNMENT BONDS (DOLLARS/YEAR)
MGB - MATURITY OF GOVERNMENT BONDS (DOLLARS/YEAR)
FI - INDEX THAT INDICATES FINANCIAL INSTITUTIONS
DT - COMPUTATION INTERVAL (YEARS)

All variables that have the "FI" subscript are dimensioned "TFI" = 4, which means that such variables really stand for four separate quantities, each one changing independently over time. Many variables in the model carry subscripts other than FI. Each of these indices indicates a subset of the four financial institutions, so that the reader can immediately associate a subscripted variable with one or more institutions. This scheme entails five subscripts for the Financial Sector, plus one additional index ("FF") for the test generator.

The subscripts and the institutions to which they apply are shown in Table A-2. To demonstrate how this arrangement operates,

consider the equation for equity of lending institution ELI, an auxiliary variable that defines the equity liability of each of the three lenders. While ELI is dimensioned $TL = 3$, it is defined by two equations (see Equations 100 and 101). One equation is subscripted "BK" for Bank, and shows that Bank equity equals total assets minus savings deposits, demand deposits and borrowed reserves. A second equation is subscripted "NBL" for non-Bank lender, which ranges from 2 to $TL = 3$. As non-Bank lenders have no demand deposits or borrowed reserves, $ELI(NBL)$ simply equals total assets minus savings deposits.

Table A-2
SUBSCRIPTS IN FINANCIAL SECTOR

FINANCIAL INSTITUTIONS				SUBSCRIPT
BANK	CORPORATE LENDER	MORTGAGE LENDER	SAVINGS INVESTOR	
x				BK - Bank
x	x	x		L - Lender
	x	x		NBL - Non-Bank Lender
x	x	x	x	FI - Financial Institution
			x	SI - Savings Investor

B. PRIMARY LENDING (F-57)

The three primary lending institutions extend loans to business and household sectors. These primary credits, as distinguished from financial assets purchased in government securities markets, result

from negotiations with each client sector and represent the primary business of the three lending institutions. The lending equations, described in this section and portrayed in Flow Diagram #F-57, respond to loan demand, relative returns, the lender's cash and overall liquidity, and (for the Bank) the level of debt to the Monetary Authority.

As explained more fully in Chapter III, the lending equations resemble the formulation for shipments in the standard production sector. That is, the demand for loans, like the demand for factors of production, is represented by a backlog level that accumulates orders (loan requests). The backlog determines a desired shipping (loan extension) rate which, together with the sector's product inventory (liquid assets), generates an actual shipping (loan extension) rate. The backlog of loan requests divided by the loan extension rate defines a loan extension delay which, when transmitted to each ordering sector, determines the flow of loans to each sector.

Equation 1 defines the loan extension delay LED as the backlog of loan requests BLR divided by the loan extension rate LER. This "delivery delay" for loans passes to the borrowing sectors in the National Model to determine the actual flow of funds to each sector. Each sector receives the fraction of credit represented by the proportion of its backlog to the sum of all the backlogs of loan requests. When credit is rationed, therefore, the rationing affects all sectors proportionally rather than favoring or discriminating against particular industries or household categories. As explained before, the

subscript "L" indicates that the equation generates a separate loan extension delay LED for each of the three lending institutions in the model. Thus, LED(1) refers to the Bank, LED(2) to the Corporate Lender, and LED(3) to the Mortgage Lender.

$$\text{LED.K(L)} = \text{BLR.K(L)} / \text{LER.K(L)} \quad 1, A$$

LED - LOAN EXTENSION DELAY (YEARS)
L - INDEX FOR LENDERS
BLR - BACKLOG OF LOAN REQUESTS (DOLLARS)
LER - LOAN EXTENSION RATE (DOLLARS/YEAR)

The loan extension rate LER, defined in Equation 2, represents the impact of demand, as well as the lender's relative liquidity, relative cash funds, borrowed reserves (for the Bank only), and relative returns. The influence of loan demand is captured in the indicated loan extension rate ILER which is explained in Equation 3. The other influences on lending are expressed in the multiplier on loan extension rate MLER. When the multiplier equals 1, the loan extension rate matches the indicated rate. However, inadequate cash or overall liquidity, excessive borrowing by the Bank, or relatively high yields on assets that compete with loans will restrain lending.

$$\text{LER.K(L)} = \text{ILER.K(L)} * \text{MLER.K(L)} \quad 2, A$$

LER - LOAN EXTENSION RATE (DOLLARS/YEAR)
L - INDEX FOR LENDERS
ILER - INDICATED LOAN EXTENSION RATE (DOLLARS/YEAR)
MLER - MULTIPLIER ON LOAN EXTENSION RATE (DIMENSIONLESS)

The indicated loan extension rate ILER in Equation 3 reflects the flow of lending that would maintain the normal loan extension delay NLED. Here NLED equals 0.25 years. That is, an average of 3 months

passes between the time initial contact is made between lenders and potential borrowers and the time that funds are actually drawn down. For some long-term corporate credit, involving private placements with insurance companies, or for public underwritings, 3 months may be short. For routine residential mortgages and lines of credit established with well-known companies, this delay would be rather long.

$$ILER.K(L) = BLR.K(L) / NLED(L) \quad 3, A$$

ILER - INDICATED LOAN EXTENSION RATE (DOLLARS/
YEAR)
L - INDEX FOR LENDERS
BLR - BACKLOG OF LOAN REQUESTS (DOLLARS)
NLED - NORMAL LOAN EXTENSION DELAY (YEARS)
ILER - INDICATED LOAN EXTENSION RATE (DOLLARS/
YEAR)

In Equation 4, the product of four multipliers determines the multiplier on loan extension rate MLER. The coefficient for testing Financial Sector CTFS that appears here and in several other equations permits one to test different subsets of the four financial institutions without changing the model (see Chapter IV). When CTFS = 1, the multiplier can diverge from 1. When CTFS = 0, the multiplier equals 1 and lending, thereby, equals the indicated rate (proportional to backlog) at all times. In all cases CTFS = 1 unless otherwise stated.

$$MLER.K(L) = MLAL.K(L) * MCFL.K(L) * MBFL.K(L) * MRRL.K(L) * 4, A \\ CTFS(L) + (1 - CTFS(L))$$

- MLER - MULTIPLIER ON LOAN EXTENSION RATE
(DIMENSIONLESS)
- L - INDEX FOR LENDERS
- MLAL - MULTIPLIER FROM LIQUID ASSETS ON LENDING
(DIMENSIONLESS)
- MCFL - MULTIPLIER FROM CASH FUNDS ON LENDING
(DIMENSIONLESS)
- MBFL - MULTIPLIER FROM BORROWED FUNDS ON LENDING
(DIMENSIONLESS)
- MRRL - MULTIPLIER FROM RELATIVE RETURN ON LENDING
(DIMENSIONLESS)
- CTFS - COEFFICIENT FOR TESTING FINANCIAL SECTOR
(DIMENSIONLESS)

The multiplier from liquid assets on lending MLAL, defined in Equation 5, expresses the impact of lending capacity on the loan extension rate. Loan capacity for a bank or other lending institution is an amorphous term which could be debated extensively. The notion of capacity contained in the model reflects a fairly close analogy between the inventory of available output in a production firm and the "inventory" of liquid assets in a lending firm. For both production and lending institutions, "capacity" denotes the direct, short-term ability to meet desired shipments, rather than some longer-term concept of borrowing power or potential utilization of productive resources.

The multiplier is expressed as an exponential function of the liquid assets ratio LAR, which measures lending capacity by relating current liquid assets LA to desired liquid assets DLA (see Equation 6). The DYNAMO compiler defines an exponential function of the sort $Y = LAR^e$ as the equivalent $Y = \exp(e * \ln LAR)$. Here, "e" is called the exponent for multiplier from liquid assets on lending $EMLAL = 0.25$, and "ln" is the natural logarithm function. The equation form implies several

important features that relate "inventory" to lending. When liquid assets relative to the desired amount are adequate, for example, lending equals the indicated rate. The loan extension delay LED, therefore, remains constant. As relative liquidity approaches zero, however, the multiplier restrains the loan extension rate LER to some quantity below the indicated amount, and LED rises. An "inventory" of liquid assets equal to zero would indicate that the lender has no capacity to make loans. The multiplier in this situation equals zero and shuts off lending completely, no matter how alluring loan demand or interest rates might be. On the other hand, excess liquidity permits a lender to offer more attractive terms and, thereby, to lend at a rate higher than the indicated loan extension rate ILER. The low exponent, however, reflects a decreasing willingness of lending institutions to soften their terms as liquidity rises above the desired amount.

$$MLAL.K(L) = \text{EXP}(EMLAL * \text{LOGN}(LAR.K(L))) \quad 5, A$$

MLAL - MULTIPLIER FROM LIQUID ASSETS ON LENDING
(DIMENSIONLESS)
L - INDEX FOR LENDERS
EMLAL - EXPONENT FOR MULTIPLIER FROM LIQUID ASSETS
ON LENDING (DIMENSIONLESS)
LAR - LIQUID ASSETS RATIO (DIMENSIONLESS)

Equation 6 defines the liquid assets ratio LAR as the ratio of liquid assets LA to desired liquid assets DLA.

$$LAR.K(L) = LA.K(L) / DLA.K(L) \quad 6, A$$

LAR - LIQUID ASSETS RATIO (DIMENSIONLESS)
L - INDEX FOR LENDERS
LA - LIQUID ASSETS (DOLLARS) •
DLA - DESIRED LIQUID ASSETS (DOLLARS)

The spending and savings decisions of individuals and business firms depend more on the concept of liquidity than on the narrower concept of money (defined as currency plus demand deposits). However, the definition of liquid assets is different for banks than for non-bank institutions because, unlike other institutions, bank "cash" includes reserves (mainly deposits in the Federal Reserve) rather than money (mainly demand deposit liabilities of banks). Equation 7, therefore, defines liquid assets LA for the Bank LA(BK) as a multiple of excess reserves of bank ERB plus Treasury bills TB, which can be liquidated easily when necessary.

Excess reserves, like money, are depleted by expenditures and augmented by revenue flows. But the impact of a bank loan, for example, on excess reserves is only a fraction of the impact of a loan by some non-bank lender on its money holdings. The primary effect of a bank loan of \$1000 on the banking system is to reduce excess reserves by \$1000 times the reserve ratio required on demand deposits;*2* while a \$1000 loan by an insurance company reduces the company's money pool by the full amount.

In a similar fashion, when the Bank in the model purchases a Treasury bill for \$1000, the Treasury's demand deposits go up (in the

*2*Note that the impact of a loan on reserves is also affected by the public's desired ratio of currency to money. For a new loan increases demand deposits, which changes the composition of the money supply. Adjustments of the composition, in turn, will produce secondary effects on Bank reserves. An example of these effects is discussed in the first simulation of Chapter IV.

first instance) by \$1000, while excess reserves of the Bank ERB decline by only a fraction of \$1000. For non-Bank institutions, however, an exchange between bills and cash has no impact on the total of the two and, therefore, has no impact on the activities influenced by the combination of money and bill holdings (which is the way non-bank liquidity is defined). While it seems reasonable to define liquidity for non-Banks as money plus bills, it seems unreasonable to define liquidity for the Bank as excess reserves (which is in some ways analogous to money) plus bills; for the sum of excess reserves and Treasury bills in the banking system is affected when banks exchange bills for reserves, while the sum of money and bills for non-banks is not changed by such a transaction.*3*

For the banking system as a whole, in fact, excess reserves are worth more in terms of liquidity than their direct cash value, because they can be converted into bills worth several times that amount (depending on reserve requirements and other factors considered below). For any individual bank, excess reserves still are usually worth more in terms of liquidity than their cash value, depending on the bank's size and the likelihood that the money used to buy a bill remains as a demand deposit or is withdrawn for deposit in another bank. Over time, the

*3*If Bank liquid assets were defined as excess reserves of Bank ERB plus Treasury bills TB, a \$1000 purchase of bills, in the first instance, would increase liquidity by $\$1000 - 1000 \cdot RRDD$, where RRDD is the reserve ratio on demand deposits. If $RRDD = 0.2$, liquid assets defined in this manner would rise by \$800.

average impact of bill transactions on individual, on-going banks would be to change reserves by considerably less than they would change the stock of bills. Equation 7, therefore, multiplies excess reserves by the conversion factor for reserves of Bank CFRB (defined in Equation 8) in order to produce Bank liquidity. Bank liquidity defined in this fashion is not affected when the Bank exchanges bills for excess reserves.

$$LA.K(BK) = CFRB.K * ERB.K + TB.K(BK) \quad 7, A$$

LA - LIQUID ASSETS (DOLLARS)
BK - INDEX FOR BANK
CFRB - CONVERSION FACTOR FOR RESERVES OF BANK
(DIMENSIONLESS)
ERB - EXCESS RESERVES OF BANK (DOLLARS)
TB - TREASURY BILLS (DOLLARS)

Equation 8 defines the conversion factor for reserves of Bank CFRD. As we have seen, excess reserves are worth more in terms of the assets they can support than their immediate cash value. For example, the aggregate banking system can support \$1000 in new assets (e.g., loans) on the basis of \$200 in excess reserves if the reserve requirement equals 0.2 and if the money stock consists entirely of demand deposits. If the money stock includes currency, however, a certain amount of the newly-created demand deposits will be withdrawn so as to maintain the public's desired ratio of currency to money DRCM. Now the \$200 in excess reserves is still worth more than \$200 in new assets but less than \$1000. Let us suppose, for example, that DRCM = 0.25 and that the banking system increases loans by \$100. Demand deposits rise in the first instance by \$100 and excess reserves fall by $RRDD * 100 = \$20$. But with the addition of \$100 to demand deposits the

ratio of currency to money is now lower than before the new loan, and in order to restore currency to its desired amount, a portion ($= \text{DRCM} * \$100 = \25) will be withdrawn. Finally, this withdrawal of \$25 in deposits reduces required reserves, and increases excess reserves by $\text{RRDD} * 25 = \$5$. The net impact of the \$100 loan, therefore, is to reduce excess reserves by $(\text{RRDD} + \text{DRCM} - \text{RRDD} * \text{DRCM}) * 100 = 0.4 * 100 = \40 . This leaves \$160 in excess reserves remaining for additional new lending. By the process of a geometric series, continued rounds of lending bring excess reserves down to zero and new loans up to $[1 / (\text{RRDD} + \text{DRCM} - \text{RRDD} * \text{DRCM})] * 200 = \500 . The conversion factor is the expression in brackets, which in the above example equals 2.5.

$$\text{CFRB.K} = 1 / (\text{RRDD.K} + \text{DRCM.K} - \text{RRDD.K} * \text{DRCM.K}) \quad 8, A$$

CFRB - CONVERSION FACTOR FOR RESERVES OF BANK
(DIMENSIONLESS)
RRDD - RESERVE RATIO ON DEMAND DEPOSITS (FRACTION)
DRCM - DESIRED RATIO OF CURRENCY TO MONEY
(DIMENSIONLESS)

Liquid assets for non-bank lending institutions are specified in Equation 9 as non-bank liquid assets NBLA, a level defined in the next equation.

$$\text{LA.K(NBL)} = \text{NBLA.K(NBL)} \quad 9, A$$

LA - LIQUID ASSETS (DOLLARS)
NBL - INDEX FOR NON-BANK LENDERS
NBLA - NON-BANK LIQUID ASSETS (DOLLARS)

Equation 10 defines non-bank liquid assets NBLA with the subscript NBL, indicating that the level variable applies only to non-Bank lenders. As shown above, Bank liquidity involves excess reserves of bank ERB, which is an algebraic computation depending on the

amount of demand deposits and bank time deposits in the system, and on the reserve requirements for both kinds of deposits. Therefore, liquid assets of the Bank (LA(BK)) is an auxiliary variable. Liquid assets for the other financial institutions, on the other hand, must be represented as a level variable (NBLA) to accumulate all the monetary flows related to asset transactions, earnings, and operating costs. These same flows also affect bank liquidity, but only through their impact on the money supply and, thereby, on excess reserves of Bank ERB.*4*

NBLA.K(NBL)=NBLA.J(NBL)+(DT)(INBL.J(NBL)-RNBL.J(NBL))	10, L
NBLA(L)=INBLA(L)	10.1, N
NBLA	- NON-BANK LIQUID ASSETS (DOLLARS)
NBL	- INDEX FOR NON-BANK LENDERS
DT	- TIME STEP FOR INTEGRATION (YEARS)
INBL	- INCREASE IN NON-BANK LIQUIDITY (DOLLARS/ YEAR)
RNBL	- REDUCTION IN NON-BANK LIQUIDITY (DOLLARS/ YEAR)
L	- INDEX FOR LENDERS
INBLA	- INITIAL NON-BANK LIQUID ASSETS (DOLLARS)

For non-bank lenders, the increase in non-bank liquidity reflects the receipt of interest on loans, bills, and bonds; repayments (maturities) on loans and bonds; and purchases of savings deposits by the Savings Investor. The definition of INBL with the subscript NBL

*4*Initial values for NBLA are calculated to be consistent with the data-based parameter, normal liquidity coverage for lending NLCL (discussed in connection with Equation 13) and with an initial equilibrium. The DYNAMO compiler requires an initial value for NBLA(1), even though we are only interested in the values subscripted with NBL (= 2,3). The initial values are INBLA(1) = 0, INBLA(2) = 5.14E9, and INBLA(3) = 4.5E9.

appears in Equation 11. Because non-bank liquid assets NBLA consist of both money and Treasury bills, the purchase and maturity of bills has no impact on the level and, therefore, does not appear in the associated rates of flow.*5*

$$\text{INBL.K(NBL)} = \text{RILO.K(NBL)} + \text{RITB.K(NBL)} + \text{RIGB.K(NBL)} + \text{RPYL.K(NBL)} + \text{MGB.K(NBL)} + \text{PDSI.K(NBL)} \quad 11, A$$

INBL - INCREASE IN NON-BANK LIQUIDITY (DOLLARS/YEAR)

NBL - INDEX FOR NON-BANK LENDERS

RILO - RECEIPT OF INTEREST ON LOANS OUTSTANDING (DOLLARS/YEAR)

RITB - RECEIPT OF INTEREST ON TREASURY BILLS (DOLLARS/YEAR)

RIGB - RECEIPT OF INTEREST ON GOVERNMENT BONDS (DOLLARS/YEAR)

RPYL - REPAYMENT OF LOANS (DOLLARS/YEAR)

MGB - MATURITY OF GOVERNMENT BONDS (DOLLARS/YEAR)

PDSI - PURCHASE OF DEPOSITS BY SAVINGS INVESTOR (DOLLARS/YEAR)

Like the increase in non-bank liquidity INBL, the reduction in non-bank liquidity RNBL is defined for non-bank lenders separately and equals the sum of loan extensions, bond purchases, the withdrawal of deposits by the Savings Investor, operating costs, total dividend receipts, and the withdrawal of earnings on savings deposits.

*5*The DYNAMO compiler requires values for NBLA(1) even though the term does not apply to non-Bank lenders. Therefore, an initial value equation in the parameters for this block of the model sets $\text{INBL}(1) = 0$. In like manner, the equation for RNBL (defined in Equation 12) must also be specified as $\text{RNBL}(1) = 0$.

$$RNBL.K(NBL) = LER.K(NBL) + PGB.K(NBL) + WDSI.K(NBL) + OCLI.K(NBL) + PDLI.K(NBL) + TLI.K(NBL) \quad 12, A$$

- RNBL - REDUCTION IN NON-BANK LIQUIDITY (DOLLARS/YEAR)
- NBL - INDEX FOR NON-BANK LENDERS
- LER - LOAN EXTENSION RATE (DOLLARS/YEAR)
- PGB - PURCHASE OF GOVERNMENT BONDS (DOLLARS/YEAR)
- WDSI - WITHDRAWAL OF DEPOSITS BY SAVINGS INVESTOR (DOLLARS/YEAR)
- OCLI - OPERATING COSTS OF LENDING INSTITUTION (DOLLARS/YEAR)
- PDLI - PAYMENT OF DIVIDENDS BY LENDING INSTITUTION (DOLLARS/YEAR)
- TLI - TAX ON LENDING INSTITUTION (DOLLARS/YEAR)

Desired liquid assets DLA appears in Equation 13 as the amount of liquid assets inventory necessary to permit the indicated loan extension rate ILER. The normal liquidity coverage for lending NLCL denotes the fraction of a year's worth of indicated lending activity that each aggregate institution wants to hold in liquid form. Like other "normal" values in the financial model, the value of NLCL reflects relationships that have prevailed over recent years. In the case of the Bank, for example, NLCL is computed from commercial bank holdings of excess reserves and Treasury bills at year-end for the period 1967-1970. For the Corporate Lender, the parameter is not accessible from real data and is assumed to equal the value for the Mortgage Lender. For the Mortgage Lender, NLCL reflects year-end money and bill holdings of

savings and loan associations.*6* The three values for NLCL are 0.11, 0.36, and 0.36.

DLA.K(L)=NLCL(L)*ILER.K(L) 13, A
DLA - DESIRED LIQUID ASSETS (DOLLARS)
L - INDEX FOR LENDERS
NLCL - NORMAL LIQUIDITY COVERAGE FOR LENDING
(YEARS)
ILER - INDICATED LOAN EXTENSION RATE (DOLLARS/
YEAR)

As we shall see throughout this appendix, all asset purchases in the model are influenced by the availability of cash funds, represented by the variable, relative cash funds RCF. Like the liquid assets ratio LAR, which affects only the purchase of non-liquid assets, relative cash funds RCF relates the actual level to the desired level. The desired amount, in turn, is proportional to the indicated loan extension rate ILER. Simulations of the model in Chapter IV show that relative cash funds and relative liquidity do not necessarily move together. The force of changing relative returns, for example, could

*6*As shown in Equation 7, liquid assets of the Bank (LA(1)) = conversion factor * excess reserves + Treasury bills. For each of the 4 years this quantity is divided by (bank loans outstanding LO at year-end)/(the one-year normal average life of loans NALL):

$$\frac{LA(1)}{LO(1)/NALL(1)} .$$

NLCL(1), then, equals the mean of these 4 values. Similarly, NLCL for the Mortgage Lender is based on money and bill holdings, divided by outstanding residential mortgage loans over the assumed 12-year average life of mortgage loans. Data for the three values of NLCL came from various issues of the Federal Reserve Bulletin and Flow of Funds Accounts.

encourage the purchase of a non-liquid asset (e.g., bonds) and discourage the purchase of a liquid asset (e.g., bills). As a result, liquidity might be inadequate as defined above, while cash funds might be excessive. The multiplier from cash funds on lending, which is computed in Equation 14, would encourage lending in this case, thereby offsetting to some extent the restraining impact of insufficient liquidity on lending. Figure A-1 relates relative cash funds RCF to lending. As with the impact of relative liquidity, the loan extension rate is not influenced when RCF equals one. But as cash funds decline toward zero, lending is increasingly restrained. When RCF equals zero (i.e., the lender has no money or excess reserves), further lending becomes impossible. Excessive cash, on the other hand, encourages loan extensions, but with decreasing force. The table, in fact, saturates at a fairly low level ($= 1.16$), so that a great deal of excess cash still has a limited impact on lending. As relative cash funds influences all of the asset purchase rates in the model, excessive money or reserve pools will be adjusted quickly back to desired levels (assuming other

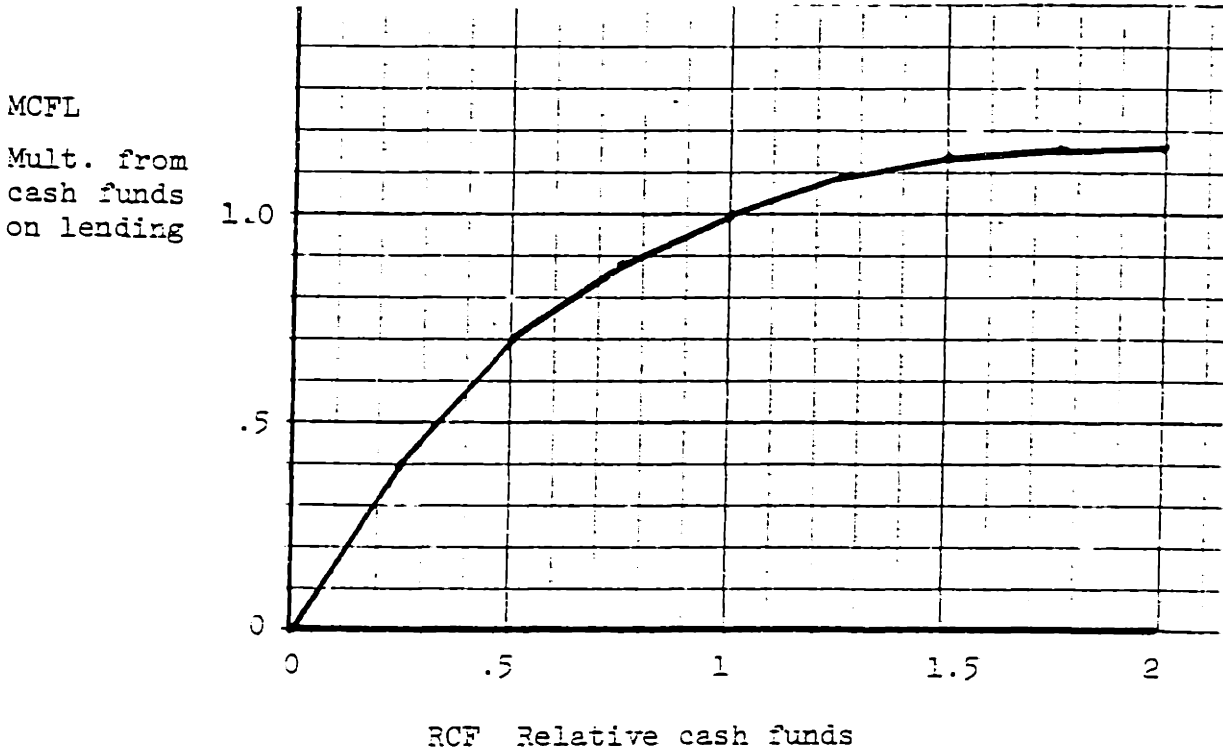


Figure A-1.
TABLE FOR MULTIPLIER FROM CASH FUNDS ON LENDING

influences are neutral). *7* Relative cash funds RCF is defined later (see Equation 45).

*7*For example, the total initial flow of asset purchases by the Bank (bills, bonds, loans) approximates \$185 billion, while initial cash funds equal \$1.2 billion. If RCF rises to two, MCFL equals 1.16 and total desired purchases would increase by 29.6 billion to 214.6 billion. Thus, the \$1.2 billion in excess cash would be eliminated within about 0.04 year ($= 1.2/29.6$), which is small relative to the computation interval used in the model ($DT = 0.03125$ for the simulations in Chapter IV). Although no computational problem has arisen as a result, this short effective time constant could raise problems that might lead to model refinements in the future. Note that the effective time constants for adjusting cash (at least initially with the given initial values) are longer for the other two lenders and the Savings Investor.

MCFL.K(L)=TABLE(TMCFL,RCF.K(L),0,2,.25) 14, A
MCFL - MULTIPLIER FROM CASH FUNDS ON LENDING
(DIMENSIONLESS)
L - INDEX FOR LENDERS
TMCFL - TABLE FOR MULTIPLIER FROM CASH FUNDS ON
LENDING
RCF - RELATIVE CASH FUNDS (DIMENSIONLESS)

Equation 15 and Figure A-2 express the impact of borrowed funds on lending. Whereas the influence of capacity on loan extensions arises directly from the internal management of liquidity, the influence of borrowed funds is externally imposed. For banks, this external control is imposed by the Federal Reserve System, which applies increasing pressure on banks to reduce their lending as their dependence on borrowed funds from the Federal Reserve increases.

As shown in Behrens (1975), the Monetary Authority in the model establishes a level of "acceptable" borrowed reserves. If Bank borrowing is higher than the acceptable level, then the monetary authorities work, mainly through persuasion and other informal means, to suppress loan extensions. As shown in Figure A-2 (and in the definition of the correction for borrowed funds CBF), excessive borrowing increasingly restrains lending, while a relatively low level of debt to the Monetary Authority provides a limited incentive to expand loans. The nonlinearity of the curve reflects the fact that the Federal Reserve can restrain bank credit more easily (by persuading borrowers or even implicitly threatening member banks with removal from the Federal Reserve System) than it can encourage lending (by making it easy to borrow). Banks will lend more freely if the Federal Reserve welcomes

borrowers, but this force alone saturates at a fairly low level (at 1.12 in the table).

$MBFL.K(L) = TABLE(TMBFL, CBF.K(L)/ILER.K(L), -.2, .2, .1) 15, A$
MBFL - MULTIPLIER FROM BORROWED FUNDS ON LENDING (DIMENSIONLESS)
L - INDEX FOR LENDERS
TMBFL - TABLE FOR MULTIPLIER FROM BORROWED FUNDS ON LENDING
CBF - CORRECTION IN BORROWED FUNDS (DOLLARS/YEAR)
ILER - INDICATED LOAN EXTENSION RATE (DOLLARS/YEAR)

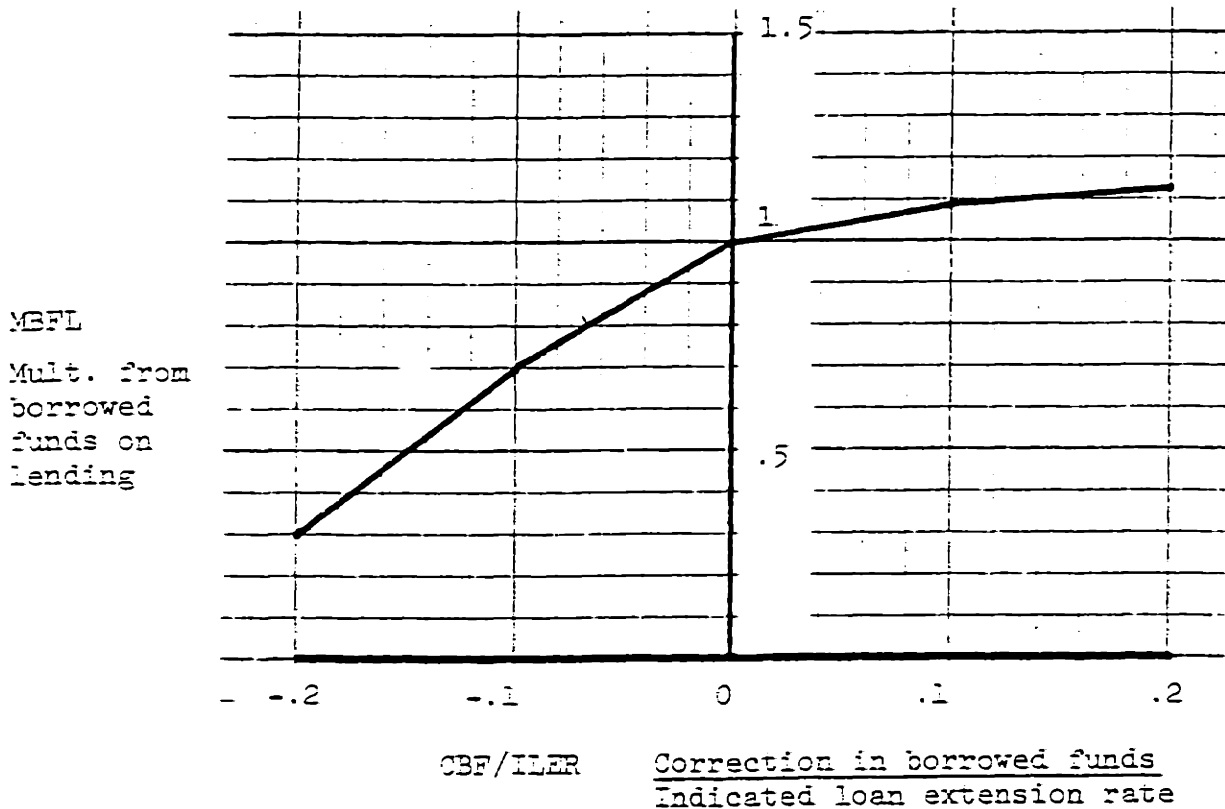


Figure A-2
TABLE FOR MULTIPLIER FROM BORROWED FUNDS ON LENDING

Only the Bank in the model can borrow from some outside agency to meet short-term cash deficiencies. Therefore, Equation 16 defines correction in borrowed funds CBF (subscripted "BK" for Bank) in terms of

other variables in the model, while Equation 17 sets CBF (subscripted "NBL" for Non-Bank Lender) at zero.*8* For the Bank, the correction in borrowed funds CBF is defined as the difference between acceptable and actual borrowed reserves divided by a normal time to adjust borrowed funds NTABF and multiplied by the conversion factor for reserves of bank CFRB. Since individual banks are prevented from incurring sustained debts to the Federal Reserve, the normal time to adjust borrowed funds NTABF is rather short for the aggregate banking system (= 0.25 years, or 3 months).

$$CBF.K(BK) = ((ABR.K - BRB.K) / NTABF) * CFRB.K \quad 16, A$$

CBF - CORRECTION IN BORROWED FUNDS (DOLLARS/YEAR)
BK - INDEX FOR BANK
ABR - ACCEPTABLE BORROWED RESERVES (DOLLARS)
BRB - BORROWED RESERVES OF BANK (DOLLARS)
NTABF - NORMAL TIME TO ADJUST BORROWED FUNDS (YEARS)
CFRB - CONVERSION FACTOR FOR RESERVES OF BANK (DIMENSIONLESS)

$$CBF.K(NBL) = 0 \quad 17, A$$

CBF - CORRECTION IN BORROWED FUNDS (DOLLARS/YEAR)
NBL - INDEX FOR NON-BANK LENDERS

Equation 18 defines the multiplier from relative returns on lending MRRL as a positive function of the relative return on loans RRL. In general, a bank or other lending institution is in business primarily

*8*In reality, non-Bank lenders can also borrow from official institutions. For example, savings and loan banks can borrow from Federal Home Loan banks (FHLB) to meet liquidity needs. However, the FHLB does not appear in the National Model at this time. Equation 17 is necessary, because MCFL, which depends on CBF, has the subscript "L", which means that CBF(NBL) must be defined for the compiler to operate.

to meet the credit demands of its customers, even if investment securities temporarily provide better (risk-adjusted) returns. As we shall see later, rising loan demand encourages lenders to raise the rates they charge on loans, thereby tending to bring demand and supply into balance. However, if interest rates on primary credit were constrained, officially or otherwise, or if bills or bonds provided better yields than loans, lending would be curtailed by MRRL. On the other hand, high relative returns on loans work to encourage more than the usual volume of lending.

As shown in Figure A-3, the multiplier*9* equals zero at the extreme point where aggregate loans yield a zero return, thereby indicating that, all other things being equal, a zero return on loans or any other assets that are less liquid and more risky than money makes non-money assets totally unattractive. The table rises with an increasing slope to express the increasing attractiveness of rising yields. If the loan yield is no different from other returns, of course, no pressure is exerted on lending by relative returns.

MRRL.K(L)=TABLE(TMRR,RRL.K(L),0,3,.5) 18, A
MRRL - MULTIPLIER FROM RELATIVE RETURN ON LENDING
(DIMENSIONLESS)
L - INDEX FOR LENDERS
TMRR - TABLE FOR MULTIPLIER FROM RELATIVE RETURNS
RRL - RELATIVE RETURN ON LOANS (DIMENSIONLESS)

*9*The same table (TMRR) is used elsewhere in the model to express the impact of relative returns on other asset transactions, namely the purchase of Treasury bills, government bonds, and savings deposits.

TMRR
Table for
multiplier
from
relative
returns

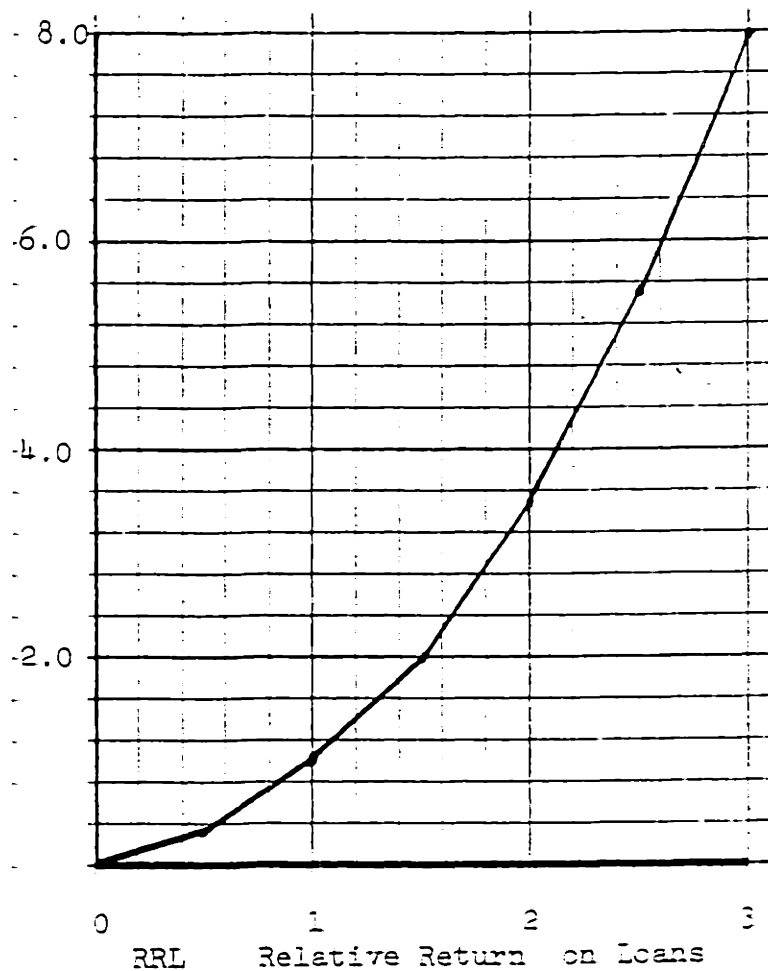


Figure A-3.
TABLE FOR MULTIPLIER FROM RELATIVE RETURNS

The formulation of the relative return on loans RRL (Equation 19) is similar to the equations for other relative return relationships in the model. In each case, the return on the asset in question (e.g., loans, bills, bonds), after adjusting for current defaults and other types of risk, is compared with the average return on assets ARA available to each lender. The Bank, for example, compares

the risk-adjusted return on (Bank) loans outstanding RLO with an average return computed from the returns on Bank loans, bills, and bonds.

The effective return, as shown later, reflects current default experience. The risk and cost premium on loans RCPL represents risks other than the risk of defaults (e.g., the risk associated with having to liquidate a long-term bond at a capital loss because the return has risen since the bond was purchased), as well as the administrative costs involved, say, in monitoring and collecting repayments on small loans. The risk and cost premium on loans is expressed as a constant, although over long periods of time the premium would change in response to variations in perceived risk and in administrative technology. It is in large part due to the spread between what a lender pays for money (e.g., in the form of time and savings deposits) and what it charges on loans that an adequate return on stockholders' equity can be sustained.

The values chosen for RCPL were derived from year-end data for

the period 1967-1970.*10* These values are (rounded) 0.002, 0.006, and 0.04 for the Bank, Corporate Lender, and Mortgage Lender, respectively. For example, if Bank loans yield 0.06 after a normal default fraction (see Equations 20 and 21), and the average return on (Bank) assets $ARA(1)$ equals 0.06 less $RCPL(1)$, then $MRR(1)$ equals one and relative returns have a neutral impact on Bank lending.

$$RRL.K(L) = (ERLO.K(L) - RCPL(L)) / ARA.K(L) \quad 19, A$$

RRL - RELATIVE RETURN ON LOANS (DIMENSIONLESS)
L - INDEX FOR LENDERS
ERLO - EFFECTIVE RETURN ON LOANS OUTSTANDING
(FRACTION/YEAR)
RCPL - RISK AND COST PREMIUM ON LOANS (FRACTION/
YEAR)
ARA - AVERAGE RETURN ON ASSETS (FRACTION/YEAR)

The effective return on loans outstanding ERLO is given by Equation 20 as the difference between the nominal return and the default fraction on loans. If defaults suddenly rise, say because of a spate of business failures, the effective return on loans outstanding ERLO will

*10*The data used includes interest rates on Treasury bills, government bonds, and three kinds of loans (short-term business loans of banks, Baa corporate bonds, and the FHA and HUD series for contracted interest rates on new-home first mortgages). From the return on loans outstanding RLO we subtract an assumed default fraction on loans of 0.01 to derive an "effective" return on loans. Taking the simple average of the bill rate, the bond rate, and the effective interest rate on bank loans provides the average return on (Bank) assets ARA (defined in Equation 22). In like manner, the average return on assets ARA for the Corporate Lender and Mortgage Lender are derived from interest rates on bills, bonds, and the return on the relevant loan category. The risk and cost premium on loans RCPL is then derived by taking the four-year average of the differences between the rate on loans and the computed available return on assets ARA.

decline and, thereby, make loans, relative to safer government securities, less attractive than they were before the rash of defaults. Note that the impact of defaults affects lending through this channel only on a short-term basis, as a return to normal conditions will make loans relatively more attractive again. In addition to influencing lending activities via relative returns (and through the impact on liquidity), a period of high defaults has a longer lasting impact on the willingness of lenders to take risks. This influence, which can linger for decades, is specified in the equations that determine loan requests within each borrowing sector and are not within the boundaries of the Financial Sector as defined here.

$$\text{ERLO.K(L)} = \text{RLO.K(L)} - \text{DFL.K(L)} \quad 20, A$$

ERLO - EFFECTIVE RETURN ON LOANS OUTSTANDING (FRACTION/YEAR)
L - INDEX FOR LENDERS
RLO - RETURN ON LOANS OUTSTANDING (FRACTION/YEAR)
DFL - DEFAULT FRACTION ON LOANS (FRACTION/YEAR)

Equation 21 specifies the default fraction on loans DFL as the ratio of defaults on (total) loans over the level of loans outstanding.

$$\text{DFL.K(L)} = \text{DLO.K(L)} / \text{LO.K(L)} \quad 21, A$$

DFL - DEFAULT FRACTION ON LOANS (FRACTION/YEAR)
L - INDEX FOR LENDERS
DLO - DEFAULTS ON LOANS OUTSTANDING (DOLLARS/YEAR)
LO - LOANS OUTSTANDING (DOLLARS)

Equation 22 defines the average return on assets ARA for lenders as the mean of the yields on available assets. For loans, the effective, rather than nominal, return is used in the calculation in order to account for loan defaults. In the case of government bonds,

the effective return takes into account the return expected in the near future, as explained in connection with the equation for relative return on government bonds (Equation 72). For lenders, there are three (yield-bearing) asset categories in financial institution ACFI.

$$\text{ARA.K(L)} = (\text{ERLO.K(L)} + \text{RTB.K} + \text{ERGB.K}) / \text{ACFI(L)} \quad 22, \text{ A}$$

ARA - AVERAGE RETURN ON ASSETS (FRACTION/YEAR)
L - INDEX FOR LENDERS
ERLO - EFFECTIVE RETURN ON LOANS OUTSTANDING
(FRACTION/YEAR)
RTB - RETURN ON TREASURY BILLS (FRACTION/YEAR)
ERGB - EFFECTIVE RETURN ON GOVERNMENT BONDS
(FRACTION/YEAR)
ACFI - ASSET CATEGORIES IN FINANCIAL INSTITUTION
(DIMENSIONLESS)

C. RETURN ON LOANS OUTSTANDING (F-58)

Interest costs on outstanding loans reflect the maturity of loans on the books, the interest rates prevailing when loans were granted, and the extent to which lenders charge front-end fees (as on mortgage loans) or can change the interest charges on outstanding loans to reflect current market conditions (as on a large proportion of bank loans). In the National Model, borrowing sectors calculate the payment of interest on loans on the basis of total loans and exponentially averaged interest rates. Thus, rather than using the current return on loans, the borrowing sectors need to know the average return on loans outstanding ARLO, which is defined in Equation 23. The averaging time for return on loans outstanding ATRLO reflects, on aggregate, the factors listed above that affect current costs. As an approximation, ATRLO equals half of the average life of loans in each category--that

is, $ATRLO(1) = 0.5$, $ATRLO(2) = 3.5$, $ATRLO(3) = 6$.^{*11*}

$ARLO.K(L) = ARLO.J(L) + (DT/ATRLO(L))(RLO.J(L) - ARLO.J(L))$ 23, L
 $ARLO(L) = RLO(L)$ 23.1, N
ARLO - AVERAGE RETURN ON LOANS OUTSTANDING (FRACTION/YEAR)
L - INDEX FOR LENDERS
DT - TIME STEP FOR INTEGRATION (YEARS)
ATRLO - ADJUSTMENT TIME FOR RETURN ON LOANS OUTSTANDING (YEARS)
RLO - RETURN ON LOANS OUTSTANDING (FRACTION/YEAR)

The return on loans outstanding is defined by Equation 24 as the minimum of two quantities, the "standard" return that responds to pressures established within the lending institution, and a "permissible" return imposed by official regulation. In most cases an effective ceiling is not imposed, but the formulation permits one to test the effect of regulated rates when the financial sector is linked with borrowing sectors of the National Model.

^{*11*}ATRLO is defined as an initial value equation:

$$N \quad ATRLO(L) = CATRL(L) * NALL(L)$$

where $CATRL = 0.5$ and is the coefficient for averaging time for return on loans, and $NALL$ is normal average life of loans. One can vary $CATRL$ for experimental purposes.

$RLO.K(L) = \min(SRLO.K(L), PRLO.K(L))$ 24, A
RLO - RETURN ON LOANS OUTSTANDING (FRACTION/YEAR)
L - INDEX FOR LENDERS
MIN - FUNCTION FOR MINIMUM VALUE
SRLO - STANDARD RETURN ON LOANS OUTSTANDING
(FRACTION/YEAR)
PRLO - PERMISSIBLE RETURN ON LOANS OUTSTANDING
(FRACTION/YEAR)

The standard return on loans outstanding SRLO, determined by Equation 25, is expressed as a level that changes over time in response to a variety of pressures. As with other levels in the model, the initial values are chosen to yield an initial equilibrium for testing purposes.*12*

$SRLO.K(L) = SRLO.J(L) + (DT)(CRLO.JK(L))$ 25, L
 $SRLO(L) = IRLO(L)$ 25.1, N
SRLO - STANDARD RETURN ON LOANS OUTSTANDING
(FRACTION/YEAR)
L - INDEX FOR LENDERS
DT - TIME STEP FOR INTEGRATION (YEARS)
CRLO - CHANGE IN RETURN ON LOANS OUTSTANDING
(FRACTION/YEAR/YEAR)
IRLO - INITIAL RETURN ON LOANS OUTSTANDING
(FRACTION/YEAR)

12 A previous footnote explained the derivation of the risk and cost premium on loans RCPL for each of three loan categories. As we shall see later, the risk and cost premium for Treasury bills and government bonds can also be calculated from data for the 1967-1970 period. To find initial values for interest rates, I first assumed a return of 5% for bills and added the risk and cost "premium" on Treasury bills RCPTB to derive an initial average return on assets ARA for each lender. Adding RCPL to ARA yields an initial return on loans outstanding IRLO for each lender: IRLO(1) = 0.063, IRLO(2) = 0.069, IRLO(3) = 0.066.

The change in the return on loans outstanding CRLO is expressed in Equation 26 as the difference between a desired, or indicated, return and the current return, over the time to adjust return on loans outstanding TARLO. In the model, TARLO equals 0.3 for each lender,*13* meaning that the current return is adjusted to a desired level over an appreciable amount of time. Banks and other lenders, in fact, are reluctant to change prices very rapidly because of the need to maintain orderly markets and to protect their customers from sudden and frequent price changes. Frequently, therefore, the loan markets fail to clear by means of the price mechanism alone.

Using level variables for interest rates permits an explicit dynamic adjustment process and allows interest rates to "float" in response to various pressures, seeking levels that are not dependent on initial or "normal" values. For example, suppose that the return on loans initially starts in equilibrium and then, because of excess demand for credit, is pushed upward until demand is brought back into balance. If no other influences are active, and if higher interest rates fail to discourage borrowing, then the return on loans outstanding RLO will settle at a new (higher) equilibrium value.

*13*TARLO equals one value for all three lenders but can be changed to permit one to test differences in the speed of adjustment to changes in demand. It has been argued that Mortgage Lenders, for example, adjust their rates more slowly than banks, partly because of political, social, and legal pressures to keep mortgage rates down. In this case, TARLO(3) could be set above 0.3 to capture the relatively slow rate of adjustment by mortgage lenders.

$$CRLO.K(L) = CTFS(L) * (DRLO.K(L) - SRLO.K(L)) / TARLO(L) \quad 26, R$$

CRLO - CHANGE IN RETURN ON LOANS OUTSTANDING
(FRACTION/YEAR/YEAR)

L - INDEX FOR LENDERS

CTFS - COEFFICIENT FOR TESTING FINANCIAL SECTOR
(DIMENSIONLESS)

DRLO - DESIRED RETURN ON LOANS OUTSTANDING
(FRACTION/YEAR)

SRLO - STANDARD RETURN ON LOANS OUTSTANDING
(FRACTION/YEAR)

TARLO - TIME TO ADJUST RETURN ON LOANS OUTSTANDING
(YEARS)

Equation 27 defines the desired return on loans outstanding DRLO, to which actual returns adjust. The desired return responds to five variable influences: (1) the average return on assets ARA, which represents the overall returns available on yield-bearing assets; (2) the current default fraction on loans DFL; (3) the demand for loans, expressed by the relative loan extension delay; (4) relative profitability, measured by the return on assets; and (5) the current spread between average return on assets ARA and the return on savings deposits. Equation 27 shows that, in the absence of other pressures, the return will adjust to the average return plus the (now constant) risk and cost premium on loans RCPL plus the default fraction. The average return essentially reflects the opportunity cost of investing in loans relative to other assets. If ARA rises, for example because of rising government security yields, the lender tends to raise the rate charged on loans. The lender also tries to raise rates to recoup what is lost through defaults. A more refined model would express this influence as the effect of expected defaults on current rate-setting, but for now the lender simply adjusts for the

current default fraction itself. The other influences on loan yields are contained in multipliers which will be described below.

$$DRLO.K(L) = (ARA.K(L) + RCPL(L) + DFL.K(L)) * MDRL.K(L) * MPRL.K(L) * MSRL.K(L) \quad 27, A$$

DRLO - DESIRED RETURN ON LOANS OUTSTANDING (FRACTION/YEAR)
L - INDEX FOR LENDERS
ARA - AVERAGE RETURN ON ASSETS (FRACTION/YEAR)
RCPL - RISK AND COST PREMIUM ON LOANS (FRACTION/YEAR)
DFL - DEFAULT FRACTION ON LOANS (FRACTION/YEAR)
MDRL - MULTIPLIER FROM DEMAND ON RETURN ON LOANS (DIMENSIONLESS)
MPRL - MULTIPLIER FROM PROFIT ON RETURN ON LOANS (DIMENSIONLESS)
MSRL - MULTIPLIER FROM SPREAD ON RETURN ON LOANS (DIMENSIONLESS)

The first multiplier, multiplier from demand on return on loans MDRL, appears in Equation 28. A good indication of demand conditions is "delivery delay," called the loan extension delay LED in the Financial Sector. A high "delivery delay," defined as backlog divided by shipments (loan extension rate), reveals a buildup of unsatisfied demand in backlog and a restrained lending rate. When current demand is satisfied--that is, when the loan extension delay LED equals its normal value--relative loan demand produces no incentive to move interest rates up or down.

As shown in Figure A-4, however, excess demand ($LED > NLED$) forces the desired return on loans to rise as market conditions become increasingly tight. If the loan extension delay were at twice its normal value, for example, the desired return would equal 1.7 times the quantity (ARA + RCPL + DFL) and actual return would rise toward the

desired level over the 3.6-month adjustment time. Still tighter conditions cause rates to rise faster. The slope of the curve in Figure A-4 declines, however, to indicate that bankers are also concerned about orderly markets and usually wish to avoid an explosion in interest rates even when demand is extremely high. On the other hand, when demand is slack relative to lending capacity, the return on loans tends to move down. For example, if the loan extension delay is only half its normal value, then the multiplier from demand on return on loans equals 0.6.

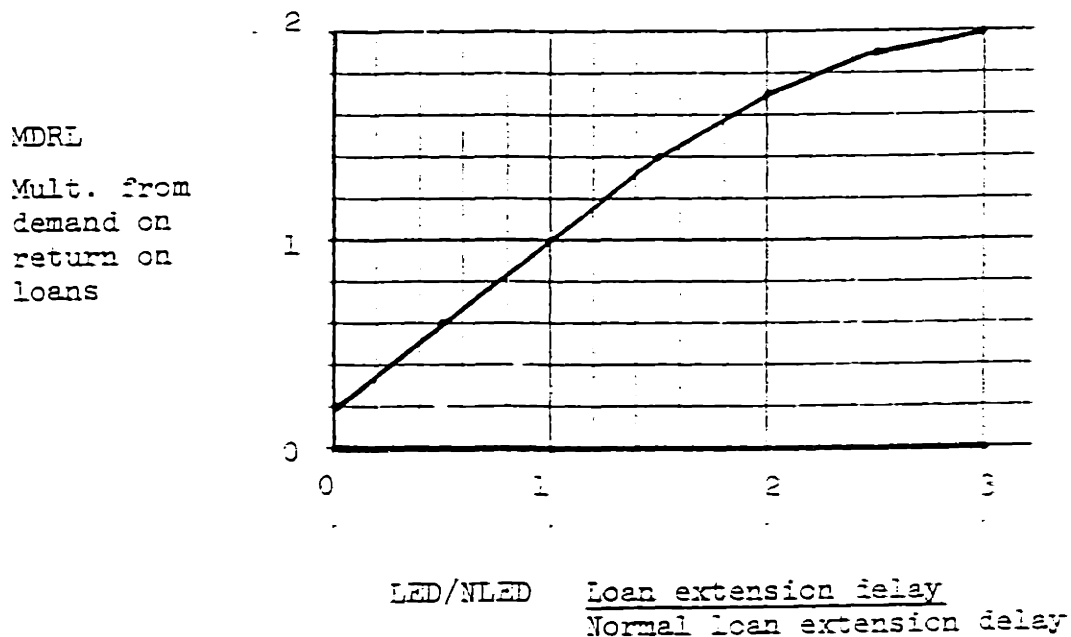


Figure A-4.
TABLE FOR MULTIPLIER FROM DEMAND ON RETURN ON LOANS

MDRL.K(L)=TABLE(TMDRL,LED.K(L)/NLED(L),0,3,.5) 28, A
MDRL - MULTIPLIER FROM DEMAND ON RETURN ON LOANS
(DIMENSIONLESS)
L - INDEX FOR LENDERS
TMDRL - TABLE FOR MULTIPLIER FROM DEMAND ON RETURN
ON LOANS
LED - LOAN EXTENSION DELAY (YEARS)
NLED - NORMAL LOAN EXTENSION DELAY (YEARS)

Equation 29 relates profitability to the return on loans. Most bankers contend that their interest rates respond mainly to market pressures and that lenders have little freedom to "set" rates in response to other forces. However, as in the establishment of prices in other industries, profitability, together with demand, affects the willingness with which lenders adjust price.

The multiplier from profit on return on loans relates the impact of relative profitability of lending institution RPLI to the return on loans, through the table function displayed in Figure A-5. Other things being equal, relatively low profitability causes rates to rise, slowly at first but more rapidly as profits decline below zero. High profits exert downward pressure on interest rates. The impact is relatively weak, however, suggesting that in times of high profits lenders would temper, but not strongly resist, a rise in rates resulting from excess demand.

MPRL.K(L)=TABLE(TMPRL,RPLI.K(L),-1,3,1) 29, A
MPRL - MULTIPLIER FROM PROFIT ON RETURN ON LOANS
(DIMENSIONLESS)
L - INDEX FOR LENDERS
TMPRL - TABLE FOR MULTIPLIER FROM PROFIT ON RETURN
ON LOANS
RPLI - RELATIVE PROFIT OF LENDING INSTITUTION
(DIMENSIONLESS)

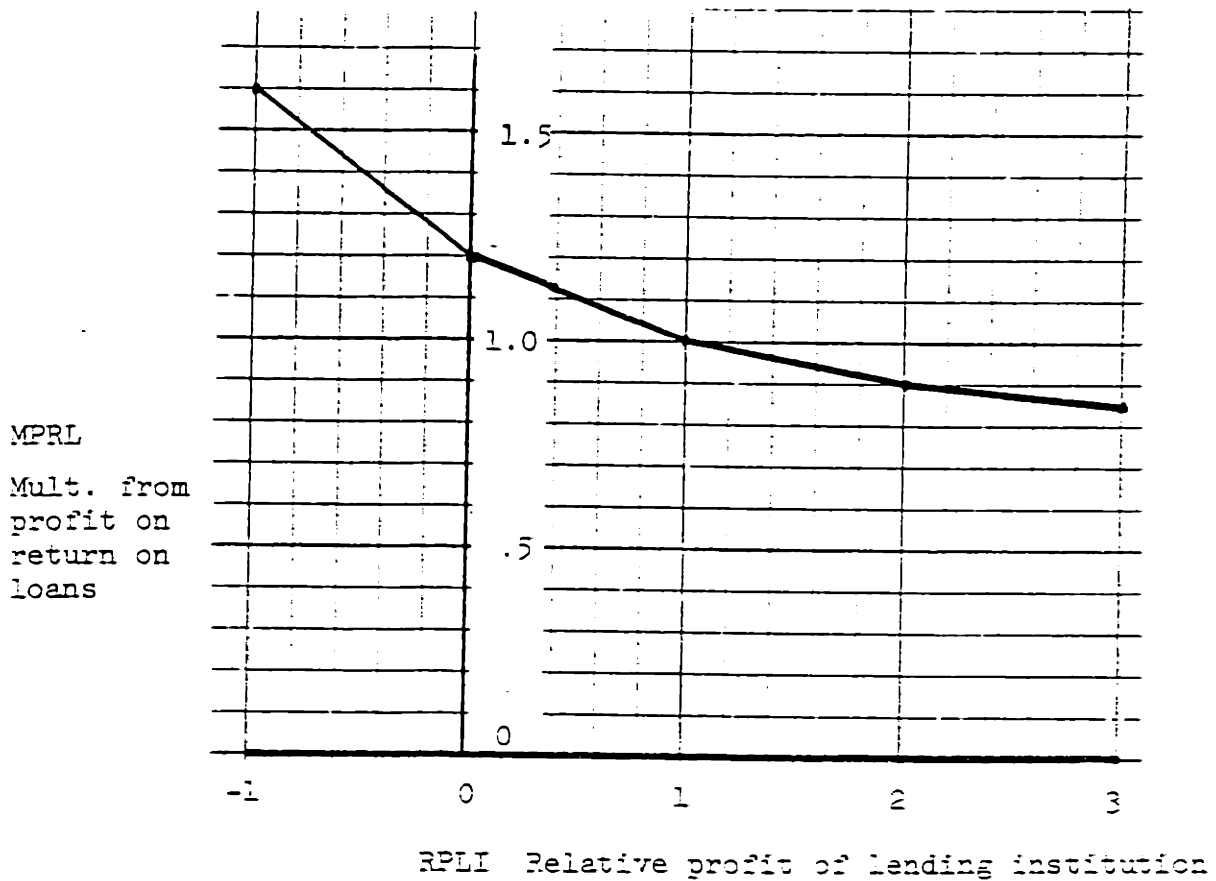


Figure A-5
TABLE FOR MULTIPLIER FROM PROFIT ON RETURN ON LOANS

Relative profitability of lending institution RPLI, in Equation 30, represents the ratio of the actual return on assets of lending institution RALI to the required return on assets RRA. This relationship, and its impact on interest rates, reflects the concern of management to meet internal standards as well as the ultimate profitability requirements of creditors and shareholders (represented in the model by the Savings Investor).

$$RPLI.K(L) = RALI.K(L) / RRA.K(L) \quad 30, A$$

RPLI - RELATIVE PROFIT OF LENDING INSTITUTION
(DIMENSIONLESS)
L - INDEX FOR LENDERS
RALI - RETURN ON ASSETS OF LENDING INSTITUTION
(FRACTION/YEAR)
RRA - REQUIRED RETURN ON ASSETS (FRACTION/YEAR)

The return on assets of lending institution RALI, expressed in Equation 31, represents the ratio of (after-tax) profits to total assets, a common performance index used by financial analysts.

$$RALI.K(L) = PLI.K(L) / TALI.K(L) \quad 31, A$$

RALI - RETURN ON ASSETS OF LENDING INSTITUTION
(FRACTION/YEAR)
L - INDEX FOR LENDERS
PLI - PROFIT OF LENDING INSTITUTION (DOLLARS/
YEAR)
TALI - TOTAL ASSETS OF LENDING INSTITUTION
(DOLLARS)

Equation 32 expresses profit of lending institution PLI as the difference between operating revenues and costs, less current taxes and defaults. Operating revenues of lending institutions consist of earnings received on yield-bearing assets, which in the model includes three categories: loans, Treasury bills, and government bonds. Costs incurred on financial operations consist of earnings on yield-bearing deposit liabilities (earnings on savings deposits ESD in the model), and operating costs of lending institution OCLI. These operating costs reflect the purchase of services, labor, capital, etc., necessary to do business. In the current model, OCLI is defined as a temporary variable (Equation 135) that depends on the size (total assets) and activity (purchase of assets) of the lending institution. OCLI represents the cost of buying services from the service sector of the National Model,

which, in turn, orders and uses labor services, capital, and other factor inputs. Taxes in lending institution TLI also are defined by a temporary equation (#136).

$$\text{PLI.K(L)} = \text{RILO.K(L)} + \text{RITB.K(L)} + \text{RIGB.K(L)} - \text{ESD.K(L)} + \text{DSDL.K(L)} - \text{OCLI.K(L)} - \text{TLI.K(L)} - \text{DLO.K(L)} \quad 32, A$$

PLI - PROFIT OF LENDING INSTITUTION (DOLLARS/YEAR)
L - INDEX FOR LENDERS
RILO - RECEIPT OF INTEREST ON LOANS OUTSTANDING (DOLLARS/YEAR)
RITB - RECEIPT OF INTEREST ON TREASURY BILLS (DOLLARS/YEAR)
RIGB - RECEIPT OF INTEREST ON GOVERNMENT BONDS (DOLLARS/YEAR)
ESD - EARNINGS ON SAVINGS DEPOSITS (DOLLARS/YEAR)
DSDL - DEFAULTS ON SAVINGS DEPOSITS OF LENDER (DOLLARS/YEAR)
OCLI - OPERATING COSTS OF LENDING INSTITUTION (DOLLARS/YEAR)
TLI - TAX ON LENDING INSTITUTION (DOLLARS/YEAR)
DLO - DEFAULTS ON LOANS OUTSTANDING (DOLLARS/YEAR)

Related to profitability, but not the same thing, is the spread between what lenders must pay for deposits and the return they can earn on yield-bearing assets. Profitability reflects the flow of revenues and costs (based in the case of loans and bonds on past as well as present interest rates), loan defaults, and the level of equity. The spread reflects the difference between current returns and costs and thereby indicates the marginal relationships that influence profits over time. For example, bankers are reluctant to take on additional deposits if their cost at the margin exceeds the return that can be achieved on the incremental acquisition of assets.

Equation 33 and Figure A-6 express the important influence of

interest rate spreads on rate-setting. (The spread also influences the return on savings deposits, as we shall see later.) When the ratio of current to acceptable spread RCAS exceeds one, lenders are encouraged to lower interest rates, or (what is more likely when other influences are active) to slow the pace of rising returns. That is, concern for orderly financial markets, as well as competitive pressures, causes lenders to resist too sharp a rise in interest rates when the resulting spread exceeds the traditional, and therefore acceptable, spread. The restraint on rising returns, however, is fairly weak, reaching only a 15% downward pressure. On the other hand, lenders more readily raise interest rates in anticipation of the adverse effect on profits of a low marginal spread in returns. A negative spread, such as occurred for some banks during the early 1970's (when Eurodollars and some CD's actually cost more than the prime rate) can generate a maximum value of 1.6 in the multiplier from spread on return on loans.

MSRL.K(L)=TABLE(TMSRL,RCAS.K(L),-1,3,1) 33, A
MSRL - MULTIPLIER FROM SPREAD ON RETURN ON LOANS
(DIMENSIONLESS)
L - INDEX FOR LENDERS
TMSRL - TABLE FOR MULTIPLIER FROM SPREAD ON RETURN
ON LOANS
RCAS - RATIO OF CURRENT TO ACCEPTABLE SPREAD
(DIMENSIONLESS)

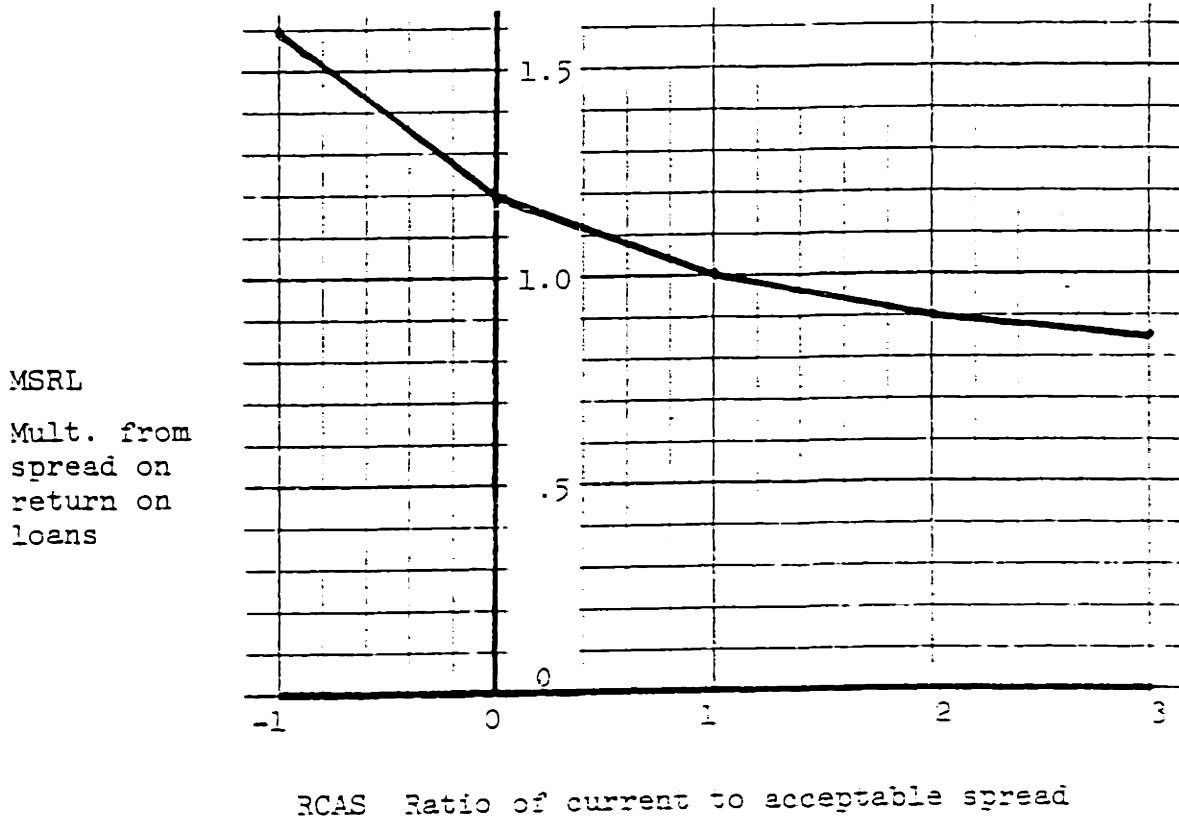


Figure A-6.
TABLE FOR MULTIPLIER FROM SPREAD ON RETURN ON LOANS

Equation 34 defines the ratio of current to acceptable spread

RCAS.

$$RCAS.K(L) = CRSR.K(L) / ARSR.K(L) \quad 34, A$$

RCAS - RATIO OF CURRENT TO ACCEPTABLE SPREAD
(DIMENSIONLESS)

L - INDEX FOR LENDERS

CRSR - CURRENT RELATIVE SPREAD IN RETURNS
(DIMENSIONLESS)

ARSR - ACCEPTABLE RELATIVE SPREAD IN RETURNS
(DIMENSIONLESS)

The current relative spread on returns CRSR in Equation 35 compares the difference between the average return on assets ARA (defined later) and the effective return on savings deposits ERSD. The

spread is then normalized by the effective return on savings deposits ERSD. Using a relative, rather than an absolute, spread assumes that marginal operating costs tend to rise with interest rates (say, because of inflation or because of the more intensive use of resources during a boom period) and therefore require a higher absolute marginal spread. Thus, a 1% spread when savings deposits yield 5% has the same impact on loan returns as a 2% spread when deposits yield 10%.

$$\text{CRSR.K(L)} = (\text{ARA.K(L)} - \text{ERSD.K(L)}) / \text{ERSD.K(L)} \quad 35, A$$

CRSR - CURRENT RELATIVE SPREAD IN RETURNS
(DIMENSIONLESS)
L - INDEX FOR LENDERS
ARA - AVERAGE RETURN ON ASSETS (FRACTION/YEAR)
ERSD - EFFECTIVE RETURN ON SAVINGS DEPOSITS
(FRACTION/YEAR)

In Equation 36, the target, or acceptable, spread is defined as the weighted average of a normal relative spread in returns NRSR and a traditional relative spread in return TRSR. When the weighting factor for spread in returns WFSR equals 0, the acceptable relative spread is based entirely on tradition. When WFSR equals 1, the acceptable relative spread reflects a constant normal value (NRSR). A weighting somewhere between 0 and 1 seems appropriate, but in testing the model in Chapter IV (and therefore in the current model version), WFSR is equal to 1.

$ARSR.K(L) = TRSR.K(L) + (NRSR(L) - TRSR.K(L)) * WFSR$ 36, A
ARSR - ACCEPTABLE RELATIVE SPREAD IN RETURNS
(DIMENSIONLESS)
L - INDEX FOR LENDERS
TRSR - TRADITIONAL RELATIVE SPREAD IN RETURNS
(DIMENSIONLESS)
NRSR - NORMAL RELATIVE SPREAD ON RETURNS
(DIMENSIONLESS)
WFSR - WEIGHTING FACTOR FOR SPREAD IN RETURNS
(DIMENSIONLESS)

The traditional relative spread reflects exponentially smoothed values of the relative spread. A value of 15 years for the time for traditional spread in returns TTSR assures that this moving goal adjusts very slowly over time.*14*

$TRSR.K(L) = TRSR.J(L) + (DT/TTSR)(CRSR.J(L) - TRSR.J(L))$ 37, L
 $TRSR(L) = CRSR(L)$ 37.1, N
TRSR - TRADITIONAL RELATIVE SPREAD IN RETURNS
(DIMENSIONLESS)
L - INDEX FOR LENDERS
DT - TIME STEP FOR INTEGRATION (YEARS)
TTSR - TIME FOR TRADITIONAL SPREAD IN RETURNS
(YEARS)
CRSR - CURRENT RELATIVE SPREAD IN RETURNS
(DIMENSIONLESS)

D. INVESTMENT IN GOVERNMENT SECURITIES--TREASURY BILLS (F-59)

In the National Model only the Financial Sector holds government securities. For simplicity, the Model does not represent explicitly any secondary transactions, even though in reality

*14*Here and elsewhere in the model, a "floating" goal describes the influence of tradition on operating objectives. Forrester (1964) describes the floating goals process in detail. Behrens (1975) makes extensive use of such moving targets in his portrayal of Federal Reserve policies.

individuals and firms are constantly exchanging securities before they mature. Here, secondary transactions are assumed to occur within each aggregate lending or savings institution, so that the only seller of government securities appearing in the model is the government itself.*15* Each institution can increase its holding of bills or bonds by raising purchases, or reduce its holding by allowing securities to mature faster than they are replaced by new purchases. This block of equations expresses the desired purchase of Treasury bills by participants in the securities markets and determines the actual allocation of securities among the various market participants. Security transactions of the Monetary Authority are determined by a separate sector of the National Model; but, for the sake of simulating the Financial Sector, now appear in the test generator.

Equation 38 expresses the purchase of Treasury bills PTB by each financial institution as the desired purchase of Treasury bills DPTB times the multiplier on purchase of Treasury bills MPTB. The multiplier relates the impact of market demand (total desired purchases) and supply (total desired sales by the Treasury) on each participant's actual purchase rate. The multiplier is described more fully below. The coefficient for testing financial sector CTFS appears in Equation 38 so that institutions not being simulated (say, the Mortgage Lender in a test of just the Bank) will always be able to purchase bills at the

*15*At present, government securities in the model include state and local obligations as well as debts of the US government.

desired rate (CTFS = 0); while the institution being tested (the Bank) will be affected by market conditions (CTFS = 1).

$$PTB.K(FI) = DPTB.K(FI) * (MPTB.K * CTFS(FI) + (1 - CTFS(FI))) \quad 38, A$$

PTB - PURCHASE OF TREASURY BILLS (DOLLARS/YEAR)
FI - INDEX FOR FINANCIAL INSTITUTIONS
DPTB - DESIRED PURCHASE OF TREASURY BILLS (DOLLARS/YEAR)
MPTB - MULTIPLIER ON PURCHASE OF TREASURY BILLS (DIMENSIONLESS)
CTFS - COEFFICIENT FOR TESTING FINANCIAL SECTOR (DIMENSIONLESS)

As shown in Equation 39, the desired purchase of Treasury bills DPTB reflects the replacement of maturing bills plus the influence of cash holdings (embodied in the multiplier from cash in Treasury bills MCTB) and relative returns (through the multiplier from returns on Treasury bills MRTB). The use of the coefficient again activates all of these influences for the institutions being tested (CTFS = 1) and sets desired purchases to maturities for the other financial institutions (CTFS = 0). *16*

*16*CTFS appears in both Equation 38 and Equation 39 because desired purchases affect interest rates while actual purchases affect money flows. The use of the coefficient, then, assures that neutral (non-tested) institutions have no effect on either market returns on the flow of funds.

$TB.K(FI)=TB.J(FI)+(DT)(PTB.J(FI)-MTB.J(FI))$	41, L
$TB(FI)=ITB(FI)$	41.1, N
TB	- TREASURY BILLS (DOLLARS)
FI	- INDEX FOR FINANCIAL INSTITUTIONS
DT	- TIME STEP FOR INTEGRATION (YEARS)
PTB	- PURCHASE OF TREASURY BILLS (DOLLARS/YEAR)
MTB	- MATURITY OF TREASURY BILLS (DOLLARS/YEAR)
ITB	- INITIAL TREASURY BILLS (DOLLARS)

The multiplier on purchase of Treasury bills MPTG in Equation 42 serves to allocate the actual purchase of bills by participants in the market according to their proportion of total demand. The table function in Figure A-7 shows that when the Treasury's desired sale of Treasury bills DSTB equals total desired purchases, the multiplier equals one, and each institution in the bill market achieves its desired rate of purchase. When desired sales are greater than total demand, the multiplier exceeds one by a small amount. If the table were horizontal beyond the point where $DSTB = TDPTB$, the Treasury would be able to sell securities only to the point of total demand. The slightly positive slope in the figure, however, signifies that the Treasury (which includes municipalities in the model) can prevail on potential purchasers to buy somewhat more than they would normally be inclined to buy. This condition existed recently in the case of New York City and New York State (MAC) bonds, which to some extent were forced on the banks against their own sense of prudence. Federal authorities also seem to be able to influence banks and other investors to buy U.S. government securities during refinancings, even when normal

.

considerations of liquidity and yield would prevail against additional purchases.

When demand (total desired purchases) exceeds supply, the multiplier declines to the point where zero supply (or infinite demand) would cut off purchases altogether. A straight 45-degree line between 0 and 1 in Figure A-7 would imply that potential purchasers can obtain only what the Treasury normally wants to sell. The smooth slope above a 45-degree line, however, signifies a willingness of public authorities to sell somewhat more than they normally would when demand for securities is relatively high. In summary, the nonlinear, but smooth, function shown in the figure implies a degree of mutual influence between buyers and sellers of government securities.

MPTB.K=TABLE(TMPGS,DSTB.K/TDPTB.K,0,2,.25) 42, A
MPTB - MULTIPLIER ON PURCHASE OF TREASURY BILLS
(DIMENSIONLESS)
TMPGS - TABLE FOR MULTIPLIER ON PURCHASE OF
GOVERNMENT SECURITIES
DSTB - DESIRED SALE OF TREASURY BILLS (DOLLARS/
YEAR)
TDPTB - TOTAL DESIRED PURCHASE OF TREASURY BILLS
(DOLLARS/YEAR)

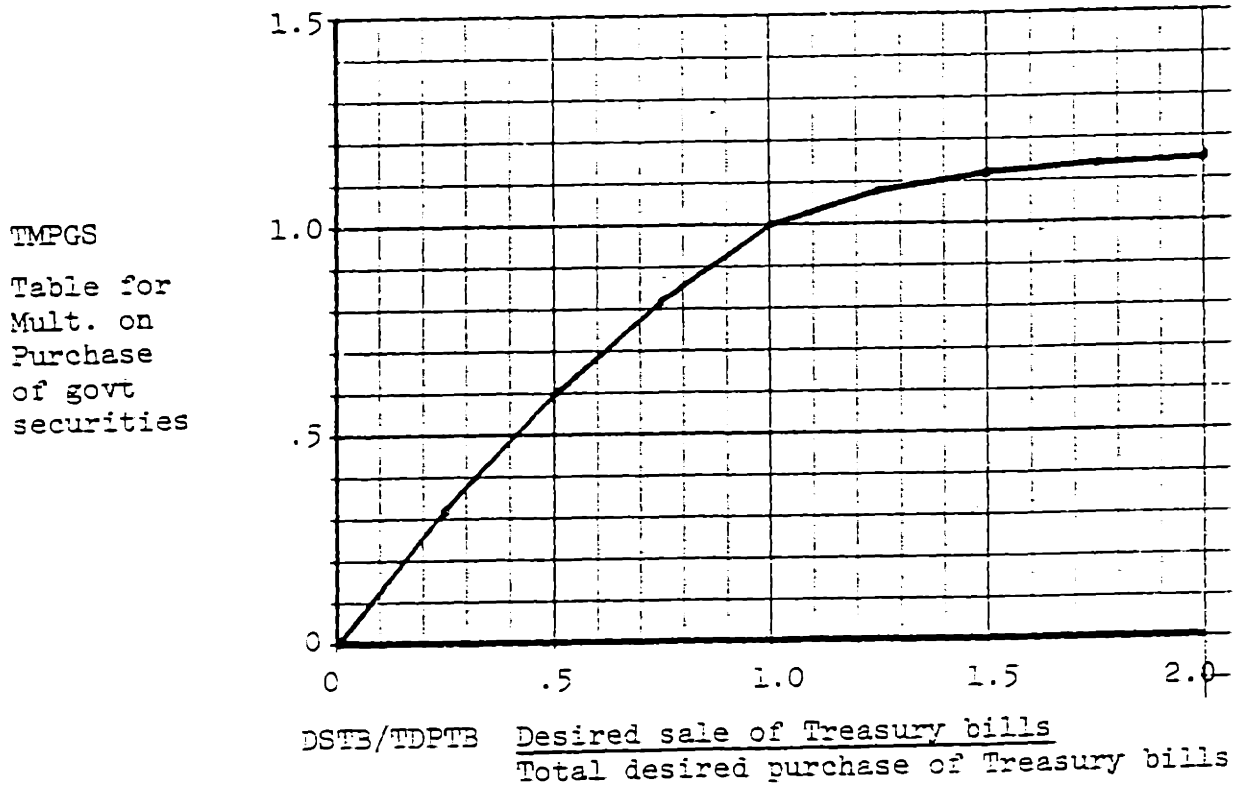


Figure A-7.
TABLE FOR MULTIPLIER ON PURCHASE OF GOVERNMENT SECURITIES

Equation 43 adds the desired bill purchases of all four financial institutions to those of the Monetary Authority to yield total desired purchase of Treasury bills.*18*

*18*Desired sales of Treasury bills DSTB is defined in the test generator described in Appendix 2.

TDPTB.K=SUMV(DPTB.K,1,TFI)+DPTBM.K 43, A
TDPTB - TOTAL DESIRED PURCHASE OF TREASURY BILLS
(DOLLARS/YEAR)
SUMV - FUNCTION FOR SUM OF VECTORS
DPTB - DESIRED PURCHASE OF TREASURY BILLS
(DOLLARS/YEAR)
TFI - TOTAL FINANCIAL INSTITUTIONS
DPTBM - DESIRED PURCHASE OF TREASURY BILLS BY
MONETARY AUTHORITY (DOLLARS/YEAR)

Equation 44 introduces the impact of any discrepancy between actual and desired cash on the purchase of Treasury bills. Each institution tries to keep cash funds close to a desired proportion of liquid assets by buying more near-cash assets (e.g., bills) when cash funds are excessive or by buying fewer such assets when cash funds are insufficient. The table for multiplier from cash on Treasury bills MCTB, like the functions expressing the relationship between cash funds and the purchase of other assets, contains the same values as the table for multiplier from cash funds on lending which is shown in Figure A-1. When cash is adequate, the multiplier equals one. Inadequate cash reduces the purchase of bills, to the extreme point where a zero level of cash funds prevents bill purchases altogether, despite any yield advantage that might encourage a larger holding. On the other hand, purchases rise with excessive cash. The table saturates, though, at a value of 1.16, which implies that investors are likely, in light of the desire to maintain orderly markets, to avoid an explosive percentage change in security holdings.

$MCTB.K(FI)=TABLE(TMCTB,RCF.K(FI),0,2,.25)$ 44, A
MCTB - MULTIPLIER FROM CASH ON PURCHASE OF
TREASURY BILLS (DIMENSIONLESS)
FI - INDEX FOR FINANCIAL INSTITUTIONS
TMCTB - TABLE FOR MULTIPLIER FROM CASH ON PURCHASE
OF TREASURY BILLS
RCF - RELATIVE CASH FUNDS (DIMENSIONLESS)

The argument to all of the multipliers from cash on the purchase of assets is relative cash funds RCF, which is specified by Equation 45 and equals the ratio of actual to desired cash funds. The coefficient (CTRCF) normally equals one, but can be set to zero for specific institutions so that RCF would equal one and exert no influence on asset transactions.

$RCF.K(FI)=CTRCF(FI)*(CFFI.K(FI)/DCF.K(FI))+(1-CTRCF(FI))$ 45, A
RCF - RELATIVE CASH FUNDS (DIMENSIONLESS)
FI - INDEX FOR FINANCIAL INSTITUTIONS
CTRCF - COEFFICIENT FOR TESTING RELATIVE CASH FUNDS
(DIMENSIONLESS)
CFFI - CASH FUNDS OF FINANCIAL INSTITUTION
(DOLLARS)
DCF - DESIRED CASH FUNDS (DOLLARS)

Equation 46 expresses cash funds for the Bank as excess reserves times the conversion factor described previously. Although any individual bank has only excess reserves to invest, the value of those funds in terms of the loans or security holdings they can support is greater than their immediate cash value. The appearance of the conversion factor in Equation 46 is consistent with its use in the equations relating borrowed reserves to the lending rate (Equations 15

and 16) and excess reserves to liquid assets (Equation 7).

$$\text{CFFI.K(BK)} = \text{CFRB.K} * \text{ERB.K} \quad 46, A$$

CFFI - CASH FUNDS OF FINANCIAL INSTITUTION
(DOLLARS)
BK - INDEX FOR BANK
CFRB - CONVERSION FACTOR FOR RESERVES OF BANK
(DIMENSIONLESS)
ERB - EXCESS RESERVES OF BANK (DOLLARS)

For non-Bank lenders (NBL), cash funds (Equation 47) equal the difference between liquid assets LA and Treasury bills TB.

$$\text{CFFI.K(NBL)} = \text{LA.K(NBL)} - \text{TB.K(NBL)} \quad 47, A$$

CFFI - CASH FUNDS OF FINANCIAL INSTITUTION
(DOLLARS)
NBL - INDEX FOR NON-BANK LENDERS
LA - LIQUID ASSETS (DOLLARS)
TB - TREASURY BILLS (DOLLARS)

Equation 48 defines cash funds for the Savings Investor as liquid assets minus bills and savings deposits of the lending institutions.

$$\text{CFFI.K(SI)} = \text{LA.K(SI)} - \text{TB.K(SI)} - \text{SUMV(SD.K,1,TL)} \quad 48, A$$

CFFI - CASH FUNDS OF FINANCIAL INSTITUTION
(DOLLARS)
SI - INDEX FOR SAVINGS INVESTOR
LA - LIQUID ASSETS (DOLLARS)
TB - TREASURY BILLS (DOLLARS)
SUMV - FUNCTION FOR SUM OF VECTORS
SD - SAVINGS DEPOSITS (DOLLARS)
TL - TOTAL LENDERS

Desired cash funds DCF are defined in Equation 49 as a fraction of desired liquid assets DLA. In other words, under usual conditions, financial institutions are assumed to keep some amount of desired liquidity in cash funds, to assure that unexpected cash obligations can be met readily. The constant term, normal cash fraction

of liquid assets NCFLA, represents an average of the values that prevailed for lenders during the period 1967-1970.*19* For the Savings Investor, NCFLA equals only 0.033, a much smaller portion of liquid assets than the cash fractions observed in lending institutions over recent years. NCFLA(SI) is small because the cash assets held by private savers (represented by the Savings Investor) are not required for transactions purposes in the way that cash is held by lending institutions, which must protect against unexpected deposit withdrawals and other money flows related to the conduct of business. Money in the Savings Investor represents mainly the cash that has been put aside as savings but has not yet been deposited in a savings bank or invested in other yield-bearing liquid assets.

$$DCF.K(FI) = NCFLA(FI) * DLA.K(FI) \quad 49, A$$

DCF - DESIRED CASH FUNDS (DOLLARS)
 FI - INDEX FOR FINANCIAL INSTITUTIONS
 NCFLA - NORMAL CASH FRACTION OF LIQUID ASSETS (FRACTION)
 DLA - DESIRED LIQUID ASSETS (DOLLARS)

As we saw earlier, the desired purchase of Treasury bills DPTB was affected by relative returns, as well as by discrepancies in cash funds. In Equation 50, the multiplier from return on Treasury bills MRTB expresses this influence as a nonlinear function of the relative

*19*For the Bank, the proportion of cash funds to liquid assets (as defined in the model) was averaged over 4 year-end values to produce NCFLA(1) = 0.07. For the Corporate Lender and Mortgage Lender, the proportion of money to estimated short-term government securities in savings and loan associations was averaged over 4 years to arrive at NCFLA(2) = 0.75 and NCFLA(3) = 0.75.

return on Treasury bills RRTB. The table for multiplier from relative return TMRR was shown in Figure A-3 in regard to the impact of relative returns on lending. As in the case of lending, the effect of relative returns on the purchase of Treasury bills is to increase purchases as the yield rises. And a zero return on bills results in zero purchases, because even Treasury bills with a zero yield offer no advantage over cash.

$$\text{MRTB.K(FI)} = \text{TABLE}(\text{TMRR}, \text{RRTB.K(FI)}, 0, 3, .5) \quad 50, A$$

MRTB - MULTIPLIER FROM RETURN ON TREASURY BILLS
(DIMENSIONLESS)
FI - INDEX FOR FINANCIAL INSTITUTIONS
TMRR - TABLE FOR MULTIPLIER FROM RELATIVE RETURNS
RRTB - RELATIVE RETURN ON TREASURY BILLS
(DIMENSIONLESS)

Equation 51 exhibits the relative return on Treasury bills RRTB in a form similar to the relative return on loans RRL described in Equation 19. Here the return on Treasury bills RTB, adjusted by a risk and cost premium on Treasury bills RCPTB, is compared to each institution's average return on assets ARA. The risk and cost "premium" is actually a negative figure for most institutions, reflecting the fact that bills constitute a relatively low-risk asset. RCPTB is derived from 1967-1970 data (as explained previously) and equals -0.0007 for the Bank, -0.003 for the Corporate Lender, -0.002 for the Mortgage Lender, and 0.0035 for the Savings Investor.

$$\text{RRTB.K(FI)} = (\text{RTB.K} - \text{RCPTB(FI)}) / \text{ARA.K(FI)} \quad 51, \text{ A}$$

RTB - RELATIVE RETURN ON TREASURY BILLS
(DIMENSIONLESS)
FI - INDEX FOR FINANCIAL INSTITUTIONS
RTB - RETURN ON TREASURY BILLS (FRACTION/YEAR)
RCPTB - RISK AND COST PREMIUM ON TREASURY BILLS
(FRACTION/YEAR)
ARA - AVERAGE RETURN ON ASSETS (FRACTION/YEAR)

Like the return on loans outstanding RLO, interest rates on bills and bonds are modeled as level variables that adjust over time to relative market conditions. Equation 52 formulates the return on Treasury bills as a level variable that changes in response to market demand and supply.

$$\text{RTB.K} = \text{RTB.J} + (\text{DT})(\text{CRTB.JK}) \quad 52, \text{ L}$$
$$\text{RTB} = \text{IRTB} \quad 52.1, \text{ N}$$

RTB - RETURN ON TREASURY BILLS (FRACTION/YEAR)
DT - TIME STEP FOR INTEGRATION (YEARS)
CRTB - CHANGE IN RETURN ON TREASURY BILLS
(FRACTION/YEAR/YEAR)
IRTB - INITIAL RETURN ON TREASURY BILLS (FRACTION/YEAR)

In Equation 53, the change in return on Treasury bills CRTB equals the product of a fractional change variable and the current return.

$$\text{CRTB.KL} = \text{FCRTB.K} * \text{RTB.K} \quad 53, \text{ R}$$

CRTB - CHANGE IN RETURN ON TREASURY BILLS
(FRACTION/YEAR/YEAR)
FCRTB - FRACTIONAL CHANGE IN RETURN ON TREASURY
BILLS (FRACTION/YEAR)
RTB - RETURN ON TREASURY BILLS (FRACTION/YEAR)

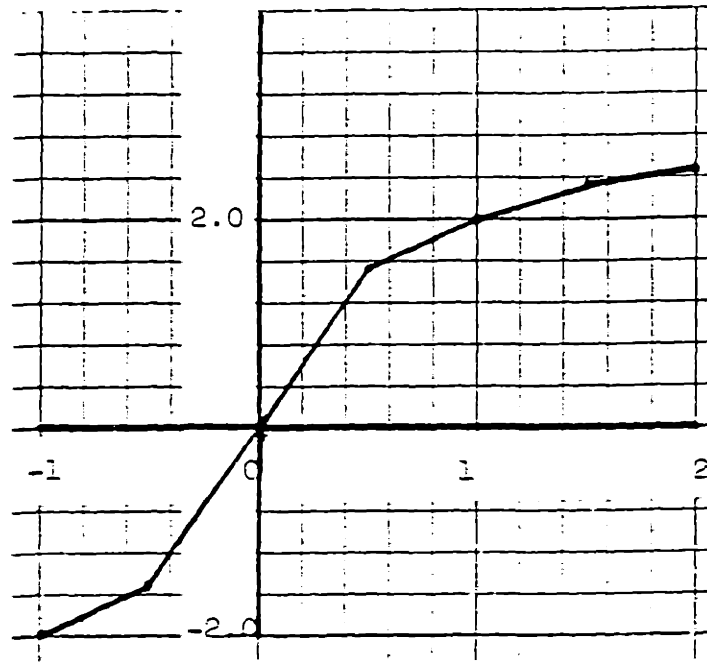
The fractional change in return on Treasury bills FCRTB, shown in Equation 54, responds to relative desired Treasury bills RDTB, which is defined in the next equation. The table for fractional change in

return TFCR, shown in Figure A-8, defines the impact of the imbalance in demand and supply. For example, when desired sales of Treasury bills DSTB exceed total desired purchases (i.e., when $RDTB > 0$), the fractional change in return is positive. The slope of the table declines, however, to imply that at extreme discrepancies in the market, the pace of the increase in interest rates can be suppressed by government intervention.*20* On the other hand, relatively high demand relative to supply drives rates down at an increasingly rapid pace.

FCRTB.K=TABLE(TFCR,RDTB.K,-1,2,.5) 54, A
FCRTB - FRACTIONAL CHANGE IN RETURN ON TREASURY
BILLS (FRACTION/YEAR)
TFCR - TABLE FOR FRACTIONAL CHANGE IN RETURN
RDTB - RELATIVE DESIRED TREASURY BILLS (FRACTION/
YEAR)

*20*The maximum value of 2.5 in TFCR implies a maximum doubling time in bill rates of $12/2.5 = 4.8$ months, an extreme that would be reached only if the difference between desired sales and purchases equaled twice the total amount of Treasury bills outstanding (see the description of RDTB).

FFCR
Table for
fractional
change in
return



RDTB Relative desired treasury bills

Figure A-8.
TABLE FOR FRACTIONAL CHANGE IN RETURN

Equation 55 defines relative desired Treasury bills RDTB as the difference between total desired sales and purchases, normalized by the total amount of bills outstanding. The difference in the numerator reflects the sum of net desired purchases by the aggregate institutions appearing in the model, less the Treasury's desired sales. Within each entity of the model, however, a massive volume of secondary transactions normally occurs (but is not shown explicitly here). The discrepancy in the numerator is measured with reference to the size of the total market, the amount of total bills outstanding serving as a proxy in this case for total desired transactions. If desired sale of Treasury bills

DSTB by the government equals total desired purchase of Treasury bills TDPTB, the return remains unchanged. If desired sales exceed desired purchases, RDTB is positive and the return on Treasury bills rises. If the discrepancy is small relative to total bills outstanding TBO, however, the impact on the bill rate is small.

$$RDTB.K = (DSTB.K - TDPTB.K) / TBO.K \quad 55, A$$

RDTB - RELATIVE DESIRED TREASURY BILLS (FRACTION/
YEAR)
DSTB - DESIRED SALE OF TREASURY BILLS (DOLLARS/
YEAR)
TDPTB - TOTAL DESIRED PURCHASE OF TREASURY BILLS
(DOLLARS/YEAR)
TBO - TREASURY BILLS OUTSTANDING (DOLLARS)

Treasury bills outstanding TBO, in Equation 56, equals the sum of Treasury bills held by the four financial institutions plus the Monetary Authority.

$$TBO.K = \text{SUMV}(TB.K, 1, TFI) + TBM.K \quad 56, A$$

TBO - TREASURY BILLS OUTSTANDING (DOLLARS)
SUMV - FUNCTION FOR SUM OF VECTORS
TB - TREASURY BILLS (DOLLARS)
TFI - TOTAL FINANCIAL INSTITUTIONS
TBM - TREASURY BILLS IN MONETARY AUTHORITY
(DOLLARS)

The receipt of interest on Treasury bills RITB, Equation 57, applies the average return on Treasury bills ARTB to outstanding bills. This formulation is somewhat unrealistic, but serves to simplify the model. Bills usually are discounted securities, which are sold at a price that will provide a market-determined yield. At maturity, they

are redeemed at face value. Interest is not paid to the holder during the short lifetime of the bill.

Discounting and interest accrual distinguishes bills from most loans, which require periodic interest payments, and from government bonds, which usually are sold at face value and carry coupons for periodic redemption. We treat the receipt of interest on bills like the receipt of interest on other assets in order to avoid special calculations of current price (which would differ from face value) and to permit an easier calculation of equilibrium conditions for model testing. The deviation from reality seems slight in contrast to the advantages.

$$\text{RITB.K(FI)} = \text{ARTB.K} * \text{TB.K(FI)} \quad 57, A$$

RITB - RECEIPT OF INTEREST ON TREASURY BILLS
(DOLLARS/YEAR)
FI - INDEX FOR FINANCIAL INSTITUTIONS
ARTB - AVERAGE RETURN ON TREASURY BILLS (FRACTION/
YEAR)
TB - TREASURY BILLS (DOLLARS)

Equation 58 specifies the average return on Treasury bills ARTB as a one-half-year (= ALTB) exponential smoothing of the actual bill rate. The average return, rather than the current return, is used in calculating the receipt of interest on Treasury bills, because bills in the model carry coupons that reflect the interest rates prevailing when the bills are issued. We shall see that an average return is also used to determine the flow of interest receipts on bonds.

$$\text{ARTB.K} = \text{ARTB.J} + (\text{DT}/\text{ALTB})(\text{RTB.J} - \text{ARTB.J})$$

58, L
ARTB=RTB 58.1, N

ARTB - AVERAGE RETURN ON TREASURY BILLS (FRACTION/
YEAR)

DT - TIME STEP FOR INTEGRATION (YEARS)

ALTB - AVERAGE LIFE OF TREASURY BILLS (YEARS)

RTB - RETURN ON TREASURY BILLS (FRACTION/YEAR)

E. INVESTMENT IN GOVERNMENT SECURITIES--GOVERNMENT BONDS (F-60)

The purchase of government bonds PGB is modeled in a fashion similar to the purchase of Treasury bills. In Equation 59, bond purchases equal the desired amount modified by the multiplier on purchase of government bonds MPGB. The coefficient to test financial sector CTFS appears in the equation for testing purposes, as explained earlier in connection with the purchase of Treasury bills.

$$\text{PGB.K}(\text{FI}) = \text{DPGB.K}(\text{FI}) * (\text{MPGB.K} * \text{CTFS}(\text{FI}) + (1 - \text{CTFS}(\text{FI})))$$

59, A

PGB - PURCHASE OF GOVERNMENT BONDS (DOLLARS/YEAR)

FI - INDEX FOR FINANCIAL INSTITUTIONS

DPGB - DESIRED PURCHASE OF GOVERNMENT BONDS
(DOLLARS/YEAR)

MPGB - MULTIPLIER ON PURCHASE OF GOVERNMENT BONDS
(DIMENSIONLESS)

CTFS - COEFFICIENT FOR TESTING FINANCIAL SECTOR
(DIMENSIONLESS)

Desired purchase of government bonds DPGB is defined in Equation 60 as maturities of government bonds MGB times three multipliers that express the influence of liquidity, cash, and relative returns. When the multipliers together equal one, desired purchases simply replace bonds that mature, thereby maintaining a constant level of bonds.

$$\text{DPGB.K(FI)} = \text{MGB.K(FI)} * (\text{MLGB.K(FI)} * \text{MCGB.K(FI)} * \text{MRGB.K(FI)} * \text{CTFS(FI)} + (1 - \text{CTFS(FI)})) \quad 60, A$$

DPGB - DESIRED PURCHASE OF GOVERNMENT BONDS (DOLLARS/YEAR)

FI - INDEX FOR FINANCIAL INSTITUTIONS

MGB - MATURITY OF GOVERNMENT BONDS (DOLLARS/YEAR)

MLGB - MULTIPLIER FROM LIQUIDITY ON GOVERNMENT BONDS (DIMENSIONLESS)

MCGB - MULTIPLIER FROM CASH ON GOVERNMENT BONDS (DIMENSIONLESS)

MRGB - MULTIPLIER FROM RETURN ON GOVERNMENT BONDS (DIMENSIONLESS)

CTFS - COEFFICIENT FOR TESTING FINANCIAL SECTOR (DIMENSIONLESS)

Maturities of government bonds MGB in Equation 61 are based on the 6-year average life of government bonds ALGB.*21* Each year a fraction (= 1/6) of outstanding bonds matures.

$$\text{MGB.K(FI)} = \text{GB.K(FI)} / \text{ALGB} \quad 61, A$$

MGB - MATURITY OF GOVERNMENT BONDS (DOLLARS/YEAR)

FI - INDEX FOR FINANCIAL INSTITUTIONS

GB - GOVERNMENT BONDS (DOLLARS)

ALGB - AVERAGE LIFE OF GOVERNMENT BONDS (YEARS)

Equation 62 accumulates bond purchases less maturities in a level of government bonds GB for each financial institution.

*21*The 6-year average life is based on a weighted average of the different maturity categories of marketable public debt for 1960-70, shown in the Statistical Abstract 1974, p. 234.

$$\begin{aligned} \text{GB.K(FI)} &= \text{GB.J(FI)} + (\text{DT})(\text{PGB.J(FI)} - \text{MGB.J(FI)}) && 62, \text{ L} \\ \text{GB(FI)} &= \text{IGB(FI)} && 62.1, \text{ N} \\ \text{GB} & - \text{GOVERNMENT BONDS (DOLLARS)} \\ \text{FI} & - \text{INDEX FOR FINANCIAL INSTITUTIONS} \\ \text{DT} & - \text{TIME STEP FOR INTEGRATION (YEARS)} \\ \text{PGB} & - \text{PURCHASE OF GOVERNMENT BONDS (DOLLARS/YEAR)} \\ \text{MGB} & - \text{MATURITY OF GOVERNMENT BONDS (DOLLARS/YEAR)} \\ \text{IGB} & - \text{INITIAL GOVERNMENT BONDS (DOLLARS)} \end{aligned}$$

In Equation 63, the multiplier on purchase of government bonds MPGB, like its counterpart for Treasury bills, relates the ratio of desired sales to total desired purchases. The table function was shown in Figure A-7.

$$\begin{aligned} \text{MPGB.K} &= \text{TABLE}(\text{TMPGS}, \text{DSGB.K}/\text{TDPGB.K}, 0, 2, .25) && 63, \text{ A} \\ \text{MPGB} & - \text{MULTIPLIER ON PURCHASE OF GOVERNMENT BONDS} \\ & \quad \text{(DIMENSIONLESS)} \\ \text{TMPGS} & - \text{TABLE FOR MULTIPLIER ON PURCHASE OF} \\ & \quad \text{GOVERNMENT SECURITIES} \\ \text{DSGB} & - \text{DESIRED SALE OF GOVERNMENT BONDS (DOLLARS/} \\ & \quad \text{YEAR)} \\ \text{TDPGB} & - \text{TOTAL DESIRED PURCHASE OF GOVERNMENT BONDS} \\ & \quad \text{(DOLLARS/YEAR)} \end{aligned}$$

Equation 64 sums desired bond purchases of all the financial institutions plus the desired purchase of government bonds by the Monetary Authority DPGBM to derive total desired purchase of government bonds TDPGB.

$$\begin{aligned} \text{TDPGB.K} &= \text{SUMV}(\text{DPGB.K}, 1, \text{TFI}) + \text{DPGBM.K} && 64, \text{ A} \\ \text{TDPGB} & - \text{TOTAL DESIRED PURCHASE OF GOVERNMENT BONDS} \\ & \quad \text{(DOLLARS/YEAR)} \\ \text{SUMV} & - \text{FUNCTION FOR SUM OF VECTORS} \\ \text{DPGB} & - \text{DESIRED PURCHASE OF GOVERNMENT BONDS} \\ & \quad \text{(DOLLARS/YEAR)} \\ \text{TFI} & - \text{TOTAL FINANCIAL INSTITUTIONS} \\ \text{DPGBM} & - \text{DESIRED PURCHASE OF GOVERNMENT BONDS BY} \\ & \quad \text{MONETARY AUTHORITY (DOLLARS/YEAR)} \end{aligned}$$

The first influence that encourages investors to change bond holdings is relative liquidity. Equation 65 computes the multiplier from liquidity on government bonds MLGB as an increasing function of the difference between liquid assets and desired liquid assets. For each financial institution, the argument to the table function shown in Figure A-9 is

$$(CLA/MGB) = (LA - DLA)/(NTAL * MGB)$$

where

- CLA - CORRECTION IN LIQUID ASSETS (DOLLARS/YEAR)
- MGB - MATURITY OF GOVERNMENT BONDS (DOLLARS/YEAR)
- LA - LIQUID ASSETS (DOLLARS)
- DLA - DESIRED LIQUID ASSETS (DOLLARS)
- NTAL - NORMAL TIME TO ADJUST LIQUIDITY (YEARS)
- MGB - MATURITY OF GOVERNMENT BONDS (DOLLARS/YEAR)

The function states, in essence, that bond purchases will be adjusted in order to equate liquid assets with desired levels over a normal adjustment time (NTAL = 2 years).^{*22*} If the liquidity discrepancy is small relative to the usual rate of maturities, the adjustment takes place at the normal desired pace, assuming other influences are neutral. If cash funds are short, though, or if bonds carry abnormally low rates, the adjustment in liquidity through this channel takes more time than implied by NTAL. As the table function reveals, bond purchases rise to accommodate excess liquid assets. If the bond level (and therefore maturities) is small to begin with, a

^{*22*}Recall that relative liquidity also affects lending and the establishment of deposit yields necessary to affect the incoming flow of deposits (for Lenders). Thus liquidity usually adjusts more rapidly than implied by NTAL.

large surplus of liquidity can produce a rapid proportional change in bonds.*23*

If liquid assets are in short supply, the multiplier causes purchases to drop below the replacement rate, but on the negative side the slope of the function is less than one, thereby implying a longer period of adjustment than the normal two years. Even when the correction in liquid assets is negative and greater in absolute value than maturities, the multiplier exceeds zero. The positive value of the table at the left-hand extreme represents the fact that, even when average liquidity for the aggregate institutional category is very low, individual institutions will enjoy enough liquidity to be expanding or maintaining their bond portfolios.

$$MLGB.K(FI)=TABLE(TMLGB,CLA.K(FI)/MGB.K(FI),-1.5,2, 65, A .5)$$

MLGB - MULTIPLIER FROM LIQUIDITY ON GOVERNMENT BONDS (DIMENSIONLESS)
FI - INDEX FOR FINANCIAL INSTITUTIONS
TMLGB - TABLE FOR MULTIPLIER FROM LIQUIDITY ON GOVERNMENT BONDS
CLA - CORRECTION IN LIQUID ASSETS (DOLLARS/YEAR)
MGB - MATURITY OF GOVERNMENT BONDS (DOLLARS/YEAR)

*23*TMLGB retains a 45-degree slope on the positive side, because, ceteris paribus, institutions want to transfer excess liquidity into non-liquid assets. The "other things being equal" should be understood here to mean that the relative return calculation already adjusts for the risk from capital depreciation from holding non-liquid assets. That is, when relative return on government bonds RRGB equals one, the bond yield already reflects the relative risk premium associated with holding non-liquid versus liquid assets. Therefore, TMLGB does not exhibit a declining slope as liquid assets increase relative to the desired amount.

Investor) by equating LA(SI) with an auxiliary value, liquid assets of Savings Investor LASI.*24*

$$\text{LA.K(SI)} = \text{LASI.K} \quad 67, A$$

LA - LIQUID ASSETS (DOLLARS)
SI - INDEX FOR SAVINGS INVESTOR
LASI - LIQUID ASSETS OF SAVINGS INVESTOR (DOLLARS)

Liquid assets of Savings Investor, in Equation 68, equals cash funds plus bills and savings deposits, or what is equivalent, total savings TSAV less non-liquid assets (bonds and common stock). Total savings TSAV consist of all the savings levels in the rest of the National Model (see Appendix 2 for details) and, because all flows that directly change the level of savings in a production or household sector simultaneously affect assets of the Savings Investor, TSAV equals total assets of the Savings Investor. Transactions within the Savings Investor, however, have no impact on total savings but, through bond purchases (or, later, equity transactions), can change the amount of liquid assets.

$$\text{LASI.K} = \text{TSAV.K} - \text{GB.K(SI)} - \text{VCS.K} \quad 68, A$$

LASI - LIQUID ASSETS OF SAVINGS INVESTOR (DOLLARS)
TSAV - TOTAL SAVINGS (DOLLARS)
GB - GOVERNMENT BONDS (DOLLARS)
SI - INDEX FOR SAVINGS INVESTOR
VCS - VALUE OF COMMON STOCK (DOLLARS)

*24*This formulation, rather than equating LA(SI) with the variables prescribed for LASI, is required by the DYNAMO compiler to avoid a "pseudo-simultaneous" relationship. (See Coupling Equation 73 for a similar case.)

Equation 69 defines desired liquid assets DLA for the Savings Investor, a value also required to compute MLGB. Here, desired liquid assets are not related to loan demand, as is the case for lending institutions, but equals the desired liquid fraction of savings DLFS times total savings TSAV. If TSAV is constant, desired liquidity is a constant.

$$DLA.K(SI)=DLFS.K*TSAV.K \quad 69, A$$

DLA - DESIRED LIQUID ASSETS (DOLLARS)
SI - INDEX FOR SAVINGS INVESTOR
DLFS - DESIRED LIQUID FRACTION OF SAVINGS
(FRACTION)
TSAV - TOTAL SAVINGS (DOLLARS)

As we saw previously, relative cash funds affects all asset transactions. Equation 70 expresses the relationship for bonds. The table function for the multiplier from cash on government bonds MCGB is equivalent to the tables relating cash to bills and loans, which is shown in Figure A-1.

$$MCGB.K(FI)=TABLE(TMCGB,RCF.K(FI),0,2,.25) \quad 70, A$$

MCGB - MULTIPLIER FROM CASH ON GOVERNMENT BONDS
(DIMENSIONLESS)
FI - INDEX FOR FINANCIAL INSTITUTIONS
TMCGB - TABLE FOR MULTIPLIER FROM CASH ON
GOVERNMENT BONDS
RCF - RELATIVE CASH FUNDS (DIMENSIONLESS)

Just as relative interest rates influence loans and Treasury bill transactions, so they also affect bond purchases. In Equation 71 the relative return on government bonds RRGB, together with the table for multiplier from relative returns already shown in Figure A-3, determines the value of the multiplier from return on government bonds

MRGB. When bond yields (adjusted for non-default risk and administrative costs) are high, for example, investors try to expand bond holdings by purchasing more than the flow of maturities. When effective bond yields are low, the multiplier reduces bond purchases and permits a runoff of bonds as they mature.

$$\text{MRGB.K(FI)} = \text{TABLE}(\text{TMRR}, \text{RRGB.K(FI)}, 0, 3, .5) \quad 71, A$$

MRGB - MULTIPLIER FROM RETURN ON GOVERNMENT BONDS
(DIMENSIONLESS)
FI - INDEX FOR FINANCIAL INSTITUTIONS
TMRR - TABLE FOR MULTIPLIER FROM RELATIVE RETURNS
RRGB - RELATIVE RETURN ON GOVERNMENT BONDS
(DIMENSIONLESS)

The relative return on government bonds RRGB in Equation 72 reflects a comparison of the expected return on government bonds ERGB, adjusted for the risk and cost premium, with the average return on assets ARA held by each institution. In the model, the risk and cost "premiums" over ARA are -0.002 for the Bank, -0.004 for the Corporate Lender, -0.003 for the Mortgage Lender, and 0.0025 for the Savings Investor. Like the other risk and cost premiums already described, the values of RCPGB are based on data for the 1967-1970 period.

$$\text{RRGB.K(FI)} = (\text{ERGB.K} - \text{RCPGB(FI)}) / \text{ARA.K(FI)} \quad 72, A$$

RRGB - RELATIVE RETURN ON GOVERNMENT BONDS
(DIMENSIONLESS)
FI - INDEX FOR FINANCIAL INSTITUTIONS
ERGB - EFFECTIVE RETURN ON GOVERNMENT BONDS
(FRACTION/YEAR)
RCPGB - RISK AND COST PREMIUM ON GOVERNMENT BONDS
(FRACTION/YEAR)
ARA - AVERAGE RETURN ON ASSETS (FRACTION/YEAR)

The equations for average return on assets ARA and relative return on government bonds RRGB contain the effective, rather than the current, return on government bonds. The effective return takes into account the expected change in the return on government bonds and is defined by Equation 73. It signifies the importance of variable interest rates on the price of long-term credit instruments traded in secondary markets. When the yield on a 10-year bond with a 5% coupon rises from 5% to 6%, for example, the price falls by roughly 10%. This decline represents a substantial capital loss which could be avoided if one delayed his bond purchases until the expected rise in interest rates occurred.

Investors regularly time their purchase of long-term bonds to take advantage of anticipated rate changes.*25* As shown in Equation 73, a positive expected change in the return on bonds ECRB reduces the effective return on government bonds ERGB and, thereby, tempers the incentive to purchase bonds. When rates are expected to decline, on the other hand, investors are more likely to accelerate their purchases so as to take advantage of the anticipated rise in bond prices. The planning horizon for purchase of bonds PHPB, over which the expected rate change is assessed, is 0.25 years. This period corresponds to the implied planning horizon of the primary lending

*25*See the Merrill, Lynch brochure on managing client portfolios for an example of how a portfolio manager exploits expected rate changes (Merill, Lynch 1975).

institutions in the model, where loan requests accumulate in backlog for a normal period of 0.25 years and where security portfolios are managed primarily to accommodate loan demand. When no change in interest rates is expected over the planning horizon, of course, the expected return on government bonds ERGB simply equals the current return.

$$\text{ERGB.K} = (1 - \text{ECRB.K} * \text{PHPB}) * \text{RGB.K} \quad 73, A$$

ERGB - EFFECTIVE RETURN ON GOVERNMENT BONDS
(FRACTION/YEAR)
ECRB - EXPECTED CHANGE IN RETURN ON BONDS
(FRACTION/YEAR)
PHPB - PLANNING HORIZON FOR PURCHASE OF BONDS
(YEARS)
RGB - RETURN ON GOVERNMENT BONDS (FRACTION/YEAR)

The expected change in return on bonds, computed in Equation 74, uses the TRND macro to determine the recent past trend in the return on government bonds. As described in Britting (1976), the TRND equations compare a short-term smoothed value of some variable with a longer-term smoothing of the same variable. The difference is divided by the longer-term average and the time constant used to produce the longer-term average. Using the symbols employed in the "macro,"

$$\text{TRND.K} = (\$AIN1.K - \$AIN2.K) / (\$AIN2.K * \$TASI)$$

TRND - TREND (FRACTION/YEAR)
\$AIN1 - SHORT-TERM EXPONENTIAL AVERAGE OF INPUT
\$AIN2 - LONG-TERM EXPONENTIAL AVERAGE OF INPUT
\$TASI - TIME TO AVERAGE SHORT-TERM INPUT (YEARS)

The first term in parentheses in Equation 74 shows that the trend is to be found for the return on government bonds RGB. The second term, time to average return on bonds TARB, indicates the smoothing time used to produce the two lagging values. TARB equals one year. \$AIN1

uses a smoothing time of $0.1 * \text{TARB}$, or 0.1 years; $\$ \text{AIN1}$ uses a time constant of $0.9 * \text{TTDF} = 0.9$ years (= $\$ \text{TASI}$). The third term in parentheses provides the initial expected change in return IECR (= 0).

$\text{ECRB.K} = \text{TRND}(\text{RGB.K}, \text{TARB}, \text{IECR})$ 74, A
ECRB - EXPECTED CHANGE IN RETURN ON BONDS
(FRACTION/YEAR)
TRND - FUNCTION TO GENERATE TREND
RGB - RETURN ON GOVERNMENT BONDS (FRACTION/YEAR)
TARB - TIME TO AVERAGE RETURN ON BONDS (YEARS)
IECR - INITIAL EXPECTED CHANGE IN RETURN
(FRACTION/YEAR)

The return on government bonds RGB is modeled as a level variable in Equation 75.

$\text{RGB.K} = \text{RGB.J} + (\text{DT})(\text{CRGB.JK})$ 75, L
 $\text{RGB} = \text{IRGB}$ 75.1, N
RGB - RETURN ON GOVERNMENT BONDS (FRACTION/YEAR)
DT - TIME STEP FOR INTEGRATION (YEARS)
CRGB - CHANGE IN RETURN ON GOVERNMENT BONDS
(FRACTION/YEAR/YEAR)
IRGB - INITIAL RETURN ON GOVERNMENT BONDS
(FRACTION/YEAR)

Equation 76 models the change in return on government bonds CRGB, like the change in return on Treasury bills CRTB, as the product of a fractional change variable and the current rate.

$\text{CRGB.KL} = \text{FCRGB.K} * \text{RGB.K}$ 76, R
CRGB - CHANGE IN RETURN ON GOVERNMENT BONDS
(FRACTION/YEAR/YEAR)
FCRGB - FRACTIONAL CHANGE IN RETURN ON GOVERNMENT
BONDS (FRACTION/YEAR)
RGB - RETURN ON GOVERNMENT BONDS (FRACTION/YEAR)

The fractional change, in Equation 77, is proportional to relative desired government bonds. The table for fractional change in return TFCR, shown in Figure A-8, defines the relationship (see

description for fractional change in return on Treasury bills, Equation 54).

$$\text{FCRGB.K} = \text{TABLE}(\text{TFCR}, \text{RDGB.K}, -1, 2, .5) \quad 77, \text{ A}$$

FCRGB - FRACTIONAL CHANGE IN RETURN ON GOVERNMENT BONDS (FRACTION/YEAR)
TFCR - TABLE FOR FRACTIONAL CHANGE IN RETURN
RDGB - RELATIVE DESIRED GOVERNMENT BONDS (FRACTION/YEAR)

Equation 78 relates the discrepancy in total desired sales and purchases to total government bonds outstanding GBO to derive relative desired government bonds RDGB.

$$\text{RDGB.K} = (\text{DSGB.K} - \text{TDPGB.K}) / \text{GBO.K} \quad 78, \text{ A}$$

RDGB - RELATIVE DESIRED GOVERNMENT BONDS (FRACTION/YEAR)
DSGB - DESIRED SALE OF GOVERNMENT BONDS (DOLLARS/YEAR)
TDPGB - TOTAL DESIRED PURCHASE OF GOVERNMENT BONDS (DOLLARS/YEAR)
GBO - GOVERNMENT BONDS OUTSTANDING (DOLLARS)

Equation 79 sums all of the five government bond levels to produce total government bonds outstanding GBO.

$$\text{GBO.K} = \text{SUMV}(\text{GB.K}, 1, \text{TFI}) + \text{GBM.K} \quad 79, \text{ A}$$

GBO - GOVERNMENT BONDS OUTSTANDING (DOLLARS)
SUMV - FUNCTION FOR SUM OF VECTORS
GB - GOVERNMENT BONDS (DOLLARS)
TFI - TOTAL FINANCIAL INSTITUTIONS
GBM - GOVERNMENT BONDS IN MONETARY AUTHORITY (DOLLARS)

In Equation 80, the receipt of interest on government bonds RIGB, like the receipt of interest on loans and on Treasury bills, is based on an average return, which reflects the return that prevailed when the bonds were sold. The average life of bonds is 6 years in the

model, so the difference between current interest rates and the return used to calculate interest receipts can be substantial.

$$\text{RIGB.K(FI)} = \text{ARGB.K} * \text{GB.K(FI)} \quad 80, A$$

RIGB - RECEIPT OF INTEREST ON GOVERNMENT BONDS
(DOLLARS/YEAR)
FI - INDEX FOR FINANCIAL INSTITUTIONS
ARGB - AVERAGE RETURN ON GOVERNMENT BONDS
(FRACTION/YEAR)
GB - GOVERNMENT BONDS (DOLLARS)

Equation 81 provides an average return on government bonds ARGB, which represents an exponential smoothing of the actual return over the 6-year average life of government bonds ALGB. The average rate is used to determine the receipt of interest of government bonds RIGB.

$$\text{ARGB.K} = \text{ARGB.J} + (\text{DT}/\text{ALGB})(\text{RGB.J} - \text{ARGB.J}) \quad 81, L$$
$$\text{ARGB} = \text{RGB} \quad 81.1, N$$

ARGB - AVERAGE RETURN ON GOVERNMENT BONDS
(FRACTION/YEAR)
DT - TIME STEP FOR INTEGRATION (YEARS)
ALGB - AVERAGE LIFE OF GOVERNMENT BONDS (YEARS)
RGB - RETURN ON GOVERNMENT BONDS (FRACTION/YEAR)

F. LIABILITIES--SAVINGS DEPOSITS (F-61)

Banks and other lending institutions can increase loan capacity by adjusting their asset portfolios--e.g., by selling bonds--or by taking on more liabilities. The major element of liability management consists of adjusting the interest rate that banks and others are willing to pay on time deposits and, thereby, the volume of such deposits that people are willing to hold. In the model, the prime source of funds for each of the three lenders is savings deposits SD. The block of equations described here represents the changes in savings

deposits SD and the return on savings deposits RSD.

Earnings on savings deposits ESD in Equation 82 consist of savings deposits times the current return on savings deposits. Unlike most bonds or loans, where earnings are based on the rate prevailing when the assets were purchased, the earnings on savings deposits depend on the current return, rather than the average past return.

$$\text{ESD.K(L)} = \text{RSD.K(L)} * \text{SD.K(L)} \quad 82, A$$

ESD	- EARNINGS ON SAVINGS DEPOSITS (DOLLARS/YEAR)
L	- INDEX FOR LENDERS
RSD	- RETURN ON SAVINGS DEPOSITS (FRACTION/YEAR)
SD	- SAVINGS DEPOSITS (DOLLARS)

As explained earlier, private savers, represented in the model by the Savings Investor, can invest in government securities, in the savings deposit liabilities of the three lending institutions, or in common stocks. The three deposit levels represent liabilities of the lenders and, therefore, have the subscript "L". As shown in Equation 83, the rates that affect the level of savings deposits SD also carry the "L" subscript, even though in the case of deposits and withdrawals, the rates represent decisions made by the Savings Investor rather than the lenders. Savings deposits SD rise with the purchase of deposits by the Savings Investor PDSI and earnings (which may be withdrawn simultaneously or allowed to accrue in the account). Deposits decline with the withdrawal of deposits by the Savings Investor WDSI and defaults of savings deposits of lender DSDL.

$$SD.K(L) = SD.J(L) + (DT)(PDSI.J(L) - WDSI.J(L) + ESD.J(L) - DSDL.J(L)) \quad 83, L$$

$$SD(L) = ISD(L) \quad 83.1, N$$

SD - SAVINGS DEPOSITS (DOLLARS)
 L - INDEX FOR LENDERS
 DT - TIME STEP FOR INTEGRATION (YEARS)
 PDSI - PURCHASE OF DEPOSITS BY SAVINGS INVESTOR (DOLLARS/YEAR)
 WDSI - WITHDRAWAL OF DEPOSITS BY SAVINGS INVESTOR (DOLLARS/YEAR)
 ESD - EARNINGS ON SAVINGS DEPOSITS (DOLLARS/YEAR)
 DSDL - DEFAULTS ON SAVINGS DEPOSITS OF LENDER (DOLLARS/YEAR)
 ISD - INITIAL SAVINGS DEPOSITS (DOLLARS)

Equation 84 computes the purchase of deposits by the Savings Investor PDSI. In equilibrium, the purchase of deposits would offset withdrawals (represented for simplicity in the model as "maturities" of savings deposits MSD). In disequilibrium, the level of deposits grows when the Savings Investor wants to adjust its cash position (reflected in the multiplier from cash on savings deposits MCSD) or when relative rates attract or repel funds (reflected in the multiplier from return on savings deposits MRSD). The coefficient for testing savings deposits CTSD equals 1 unless one wishes to hold savings deposits at a constant level for testing purposes. In that case, CTSD equals zero and purchases offset maturities. In testing just the Bank, for example, non-bank deposits are held constant by setting $CTSD(2) = CTSD(3) = 0$, thereby applying the effect of relative returns or cash funds to Bank deposits only.

$$PDSI.K(L) = MSD.K(L) * (MCS D.K * MRS D.K(L) * CTSD(L) + (1 - CTSD(L))) \quad 84, A$$

- PDSI - PURCHASE OF DEPOSITS BY SAVINGS INVESTOR (DOLLARS/YEAR)
- L - INDEX FOR LENDERS
- MSD - MATURITY OF SAVINGS DEPOSITS (DOLLARS/YEAR)
- MCS D - MULTIPLIER FROM CASH ON SAVINGS DEPOSITS (DIMENSIONLESS)
- MRS D - MULTIPLIER FROM RETURN ON SAVINGS DEPOSITS (DIMENSIONLESS)
- CTSD - COEFFICIENT FOR TESTING SAVINGS DEPOSITS (DIMENSIONLESS)

Like the purchase of deposits, the withdrawal of deposits by Savings Investor WDSI in Equation 85 reflects a decision of the Savings Investor (not the lender). Withdrawals consist of "maturities" (explained below) less defaults (failure of lenders to pay off deposits because of bankruptcy). In addition, savers can withdraw earnings as they accrue (when CWESD = 1) or let them augment deposits (when CWESD = 0). In equilibrium, earnings are withdrawn, so the coefficient equals 1 unless otherwise specified for testing purposes.

$$WDSI.K(L) = MSD.K(L) - DSDL.K(L) + CWESD * ESD.K(L) \quad 85, A$$

- WDSI - WITHDRAWAL OF DEPOSITS BY SAVINGS INVESTOR (DOLLARS/YEAR)
- L - INDEX FOR LENDERS
- MSD - MATURITY OF SAVINGS DEPOSITS (DOLLARS/YEAR)
- DSDL - DEFAULTS ON SAVINGS DEPOSITS OF LENDER (DOLLARS/YEAR)
- CWESD - COEFFICIENT FOR WITHDRAWAL OF EARNINGS ON SAVINGS DEPOSITS (DIMENSIONLESS)
- ESD - EARNINGS ON SAVINGS DEPOSITS (DOLLARS/YEAR)

Although savings deposits generally do not "mature" at a specified time, we assume in Equation 86 a 0.5-year average life of savings deposits ALSD to compute maturities of savings deposits MSD. This short turnover does not correspond to the average turnover of

savings deposits which, in reality, is more like every three years (USL 1973, p. 69). Rather, six months may be considered the period over which deposits can be liquidated (given that some deposits are contracted for long periods of time while most can be withdrawn virtually immediately). Assuming an average "lifetime" permits a standard equilibrium flow of deposits which can be modified through the simple use of multipliers (e.g., to express the impact of relative cash funds on returns). Also, the formulation resembles the equations for purchases and maturities of other kinds of assets.

$$\text{MSD.K(L)} = \text{SD.K(L)} / \text{ALSD} \quad 86, A$$

MSD - MATURITY OF SAVINGS DEPOSITS (DOLLARS/YEAR)
L - INDEX FOR LENDERS
SD - SAVINGS DEPOSITS (DOLLARS)
ALSD - AVERAGE LIFE OF SAVINGS DEPOSITS (YEARS)

Defaults on savings deposits of lender DSDL normally occur only in very small amounts, if at all; but in a liquidity crisis, banks and other fiduciary institutions can refuse to permit deposit withdrawals. These defaults reduce aggregate withdrawals, as we saw in the preceding equation. Equation 87 defines defaults on savings deposits of lender DSDL as the default fraction on savings deposits DFSD times savings deposits SD.

$$\text{DSDL.K(L)} = \text{DFSD.K(L)} * \text{SD.K(L)} \quad 87, A$$

DSDL - DEFAULTS ON SAVINGS DEPOSITS OF LENDER (DOLLARS/YEAR)
L - INDEX FOR LENDERS
DFSD - DEFAULT FRACTION ON SAVINGS DEPOSITS (FRACTION/YEAR)
SD - SAVINGS DEPOSITS (DOLLARS)

The default fraction, defined in Equation 88 and Figure A-10, is a function of relative equity ratios. When the current ratio of equity to assets CREA exceeds the acceptable ratio, the aggregate lending institution may be considered relatively solvent and the default fraction equals 0.0005. This low, but positive minimum default fraction reflects the fact that banks and savings institutions occasionally fail even in good times. When liquidity becomes increasingly tight, say because of heavy defaults on outstanding loans, the default fraction on deposits starts to rise above zero and eventually reaches 0.4.

$DFSD.K(L) = TABHL(TDFSD, CREA.K(L)/AREA.K(L), 0, 1, .25)$ 88, A
DFSD - DEFAULT FRACTION ON SAVINGS DEPOSITS
(FRACTION/YEAR)
L - INDEX FOR LENDERS
TDFSD - TABLE FOR DEFAULT FRACTION ON SAVINGS
DEPOSITS
CREA - CURRENT RATIO OF EQUITY TO ASSETS
(DIMENSIONLESS)
AREA - ACCEPTABLE RATIO OF EQUITY TO ASSETS
(DIMENSIONLESS)

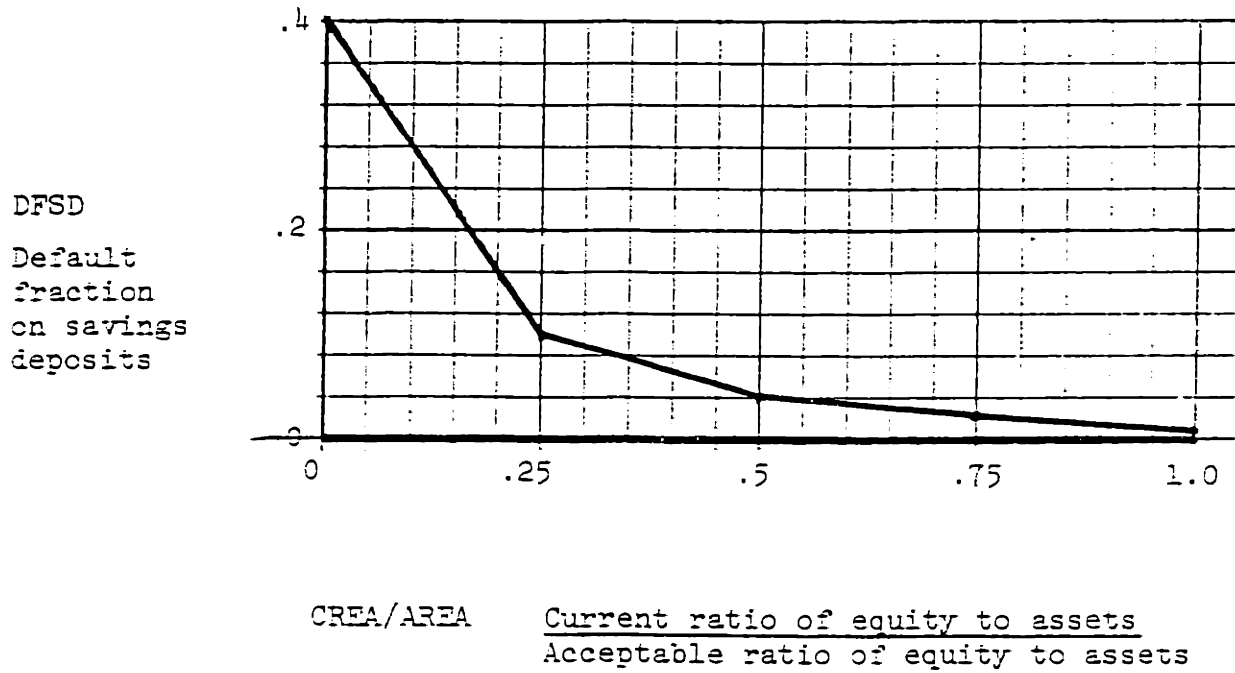


Figure A-10.
TABLE FOR DEFAULT FRACTION ON SAVINGS DEPOSITS

The multiplier from cash on savings deposits MCS_D is defined in Equation 89 as the counterpart of the Savings Investor's multiplier from cash on Treasury bills MCTB (Equation 44). That is, the Savings Investor adjusts imbalances in cash funds across the entire range of assets. The table function is the same as the previous cash functions and is exhibited in Figure A-3.

MCSD.K=TABLE(TMCS D,RCF.K(SI),0,2,.25) 89, A
MCSD - MULTIPLIER FROM CASH ON SAVINGS DEPOSITS
(DIMENSIONLESS)
TMCS D - TABLE FOR MULTIPLIER FROM CASH ON SAVINGS
DEPOSITS
RCF - RELATIVE CASH FUNDS (DIMENSIONLESS)
SI - INDEX FOR SAVINGS INVESTOR

Whereas a discrepancy in cash funds of the Savings Investor has the same proportional impact on all three savings deposit categories, changes in relative returns cause the Savings Investor to shift between different classes of deposits and other assets. For example, if the Bank raises the rate it pays on its savings deposits, the Savings Investor is encouraged to purchase more of the Bank's deposits and fewer of the deposits in other lending institutions. In Equation 90, the multiplier from return on savings deposits MRSD expresses the impact of the return on each lender's deposits relative to the Savings Investor's average return on assets ARA. The table that translates the impact of relative returns onto the Savings Investor's purchase of savings deposits was described previously and appears in Figure A-3.

MRSD.K(L)=TABLE(TMRS D,RRSD.K(L),0,3,.5) 90, A
MRSD - MULTIPLIER FROM RETURN ON SAVINGS DEPOSITS
(DIMENSIONLESS)
L - INDEX FOR LENDERS
TMRS D - TABLE FOR MULTIPLIER FROM RETURN ON SAVINGS
DEPOSITS
RRSD - RELATIVE RETURN ON SAVINGS DEPOSITS
(DIMENSIONLESS)

Equation 91 relates the return on savings deposits, adjusted for risk and costs, to the Savings Investor's average return on assets ARA. The formulation is similar to the relative returns on

loans, bills, and bonds that were described previously. The risk and cost "premium" on savings deposits RCPSD equals -0.002 for each of the three deposit categories.*26*

$$RRSD.K(L) = (ERSD.K(L) - RCPSD(L)) / ARA.K(SI) \quad 91, A$$

RRSD - RELATIVE RETURN ON SAVINGS DEPOSITS
(DIMENSIONLESS)
L - INDEX FOR LENDERS
ERSD - EFFECTIVE RETURN ON SAVINGS DEPOSITS
(FRACTION/YEAR)
RCPSD - RISK AND COST PREMIUM ON SAVINGS DEPOSITS
(FRACTION/YEAR)
ARA - AVERAGE RETURN ON ASSETS (FRACTION/YEAR)
SI - INDEX FOR SAVINGS INVESTOR

The effective return on savings deposits ERSD, like the effective return on loans defined earlier, appears in Equation 92 as the nominal return less the default fraction.

$$ERSD.K(L) = RSD.K(L) - DFSD.K(L) \quad 92, A$$

ERSD - EFFECTIVE RETURN ON SAVINGS DEPOSITS
(FRACTION/YEAR)
L - INDEX FOR LENDERS
RSD - RETURN ON SAVINGS DEPOSITS (FRACTION/YEAR)
DFSD - DEFAULT FRACTION ON SAVINGS DEPOSITS
(FRACTION/YEAR)

*26*In the current version of the financial model, the average return on assets ARA for the Savings Investor is based on Treasury bills, government bonds, and the three types of savings deposits (see Equation 133). The risk and cost premium on savings deposits is based on the average of those rates, as observed over the 1967-1970 period. Eventually, (expected) returns on common stocks will be factored into the average return and, therefore, the various risk and cost premiums for the Savings Investor.

The major form of liability management for banks and savings institutions consists of adjusting the return paid on deposits so as to attract or reduce outstanding deposit liabilities. During recent years, however, banks and other fiduciary institutions have been forced by law (mainly the Federal Reserve's Regulation Q) to limit the rate they can pay on savings deposits. Thus Equation 93 denotes the return on savings deposits RSD as the minimum of a "standard" return that responds to internally generated pressures or an externally imposed "permissible" return.

$$RSD.K(L) = \text{MIN}(SRSD.K(L), PRSD.K(L)) \quad 93, A$$

RSD - RETURN ON SAVINGS DEPOSITS (FRACTION/YEAR)
L - INDEX FOR LENDERS
MIN - FUNCTION FOR MINIMUM VALUE
SRSD - STANDARD RETURN ON SAVINGS DEPOSITS
(FRACTION/YEAR)
PRSD - PERMISSIBLE RETURN ON SAVINGS DEPOSITS
(FRACTION/YEAR)

In Equation 94, the standard return, like other interest rates in the model, is a level variable.

$$SRSD.K(L) = SRSD.J(L) + (\Delta T)(CRSD.JK(L)) \quad 94, L$$
$$SRSD(L) = IRS D(L) \quad 94.1, N$$

SRSD - STANDARD RETURN ON SAVINGS DEPOSITS
(FRACTION/YEAR)
L - INDEX FOR LENDERS
DT - TIME STEP FOR INTEGRATION (YEARS)
CRSD - CHANGE IN RETURN ON SAVINGS DEPOSITS
(FRACTION/YEAR/YEAR)
IRSD - INITIAL RETURN ON SAVINGS DEPOSITS
(FRACTION/YEAR)

The standard return is structured in a manner similar to the standard return on loans outstanding SRL0. That is, the lending institution adjusts what it pays on deposits to a desired return over an

adjustment time. The time to adjust return on savings deposits TARSD considerably exceeds the adjustment time on loan yields (one year versus 0.3 year), on the premise that banks and the like are reluctant to change deposit rates rapidly. Deposit yields, unlike loan rates, must be posted and cannot vary in the way loan yields can deviate from the announced prime rate. Moreover, banks and savings institutions count on maintaining a stable source of funds and do not want to encourage rapid changes in yields that would encourage savers to become overly responsive to changes in deposit rates. The coefficient in Equation 95 is used, as before, when testing subsets of the four financial institutions.

$$\text{CRSD.KL(L)} = \text{CTFS(L)} * (\text{DRSD.K(L)} - \text{SRSD.K(L)}) / \text{TARSD(L)} \quad 95, R$$

CRSD - CHANGE IN RETURN ON SAVINGS DEPOSITS
(FRACTION/YEAR/YEAR)

L - INDEX FOR LENDERS

CTFS - COEFFICIENT FOR TESTING FINANCIAL SECTOR
(DIMENSIONLESS)

DRSD - DESIRED RETURN ON SAVINGS DEPOSITS
(FRACTION/YEAR)

SRSD - STANDARD RETURN ON SAVINGS DEPOSITS
(FRACTION/YEAR)

TARSD - TIME TO ADJUST RETURN ON SAVINGS DEPOSITS
(YEARS)

The desired return on savings deposits DRSD changes in response to relative liquidity, profit, and interest-rate spread. In Equation 96 the term in parentheses reflects the influence of relative spread in returns. As the average return on assets ARA changes, lenders are willing to adjust deposit yields in order to maintain an acceptable spread in return on assets ASRA. The two multipliers in the equation express the influence of liquidity and profitability.

$$\text{DRSD.K(L)} = (\text{ARA.K(L)} - \text{ASRA.K(L)}) * \text{MLRD.K(L)} * \text{MPRD.K(L)} \quad 96, \text{ A}$$

DRSD - DESIRED RETURN ON SAVINGS DEPOSITS
(FRACTION/YEAR)

L - INDEX FOR LENDERS

ARA - AVERAGE RETURN ON ASSETS (FRACTION/YEAR)

ASRA - ACCEPTABLE SPREAD IN RETURN ON ASSETS
(FRACTION/YEAR)

MLRD - MULTIPLIER FROM LIQUIDITY ON RETURN ON
DEPOSITS (DIMENSIONLESS)

MPRD - MULTIPLIER FROM PROFIT ON RETURN ON
DEPOSITS (DIMENSIONLESS)

To derive the acceptable absolute spread in returns, Equation 97 applies the acceptable relative spread in returns ARSR to the current return on deposits. ARSR was defined by Equation 36 and reflects a multiple of the deposit yield.

$$\text{ASRA.K(L)} = \text{ARSR.K(L)} * \text{RSD.K(L)} \quad 97, \text{ A}$$

ASRA - ACCEPTABLE SPREAD IN RETURN ON ASSETS
(FRACTION/YEAR)

L - INDEX FOR LENDERS

ARSR - ACCEPTABLE RELATIVE SPREAD IN RETURNS
(DIMENSIONLESS)

RSD - RETURN ON SAVINGS DEPOSITS (FRACTION/YEAR)

Equation 98 computes the impact of relative liquidity on the rate that lenders are willing to pay on savings deposits. To meet excess loan demand, lending institutions can augment capacity (liquidity) by selling off long-term securities or by raising liabilities. Therefore, a falling liquid assets ratio LAR (= LA/DLA) induces lenders to bid with growing aggressiveness for deposits, by raising the return on savings deposits RSD. The slope of the curve in Figure A-11 increases as liquidity approaches zero to reflect a lender's growing effort to replenish liquidity during periods of high demand and tight money. The slope decreases as liquidity becomes excessive,

however, because lending institutions do not want to lose too quickly the stable source of funds that savings deposits represent.*27*

MLRD.K(L)=TABLE(TMLRD,LAR.K(L),0,3,.5) 98, A
MLRD - MULTIPLIER FROM LIQUIDITY ON RETURN ON
DEPOSITS (DIMENSIONLESS)
L - INDEX FOR LENDERS
TMLRD - TABLE FOR MULTIPLIER FROM LIQUIDITY ON
RETURN ON DEPOSITS
LAR - LIQUID ASSETS RATIO (DIMENSIONLESS)

*27*It should be noted again that in the model all kinds of time and savings deposits are lumped together into one category for each lending institution. It is clear, however, that consumer-type savings deposits are a far more stable source of funds than certificates of deposit (CD's), which fluctuate widely in response to changes in relative returns. Eventually, we may have to separate the two types of yield-bearing deposits, an alternative explained more fully in Chapter VI.

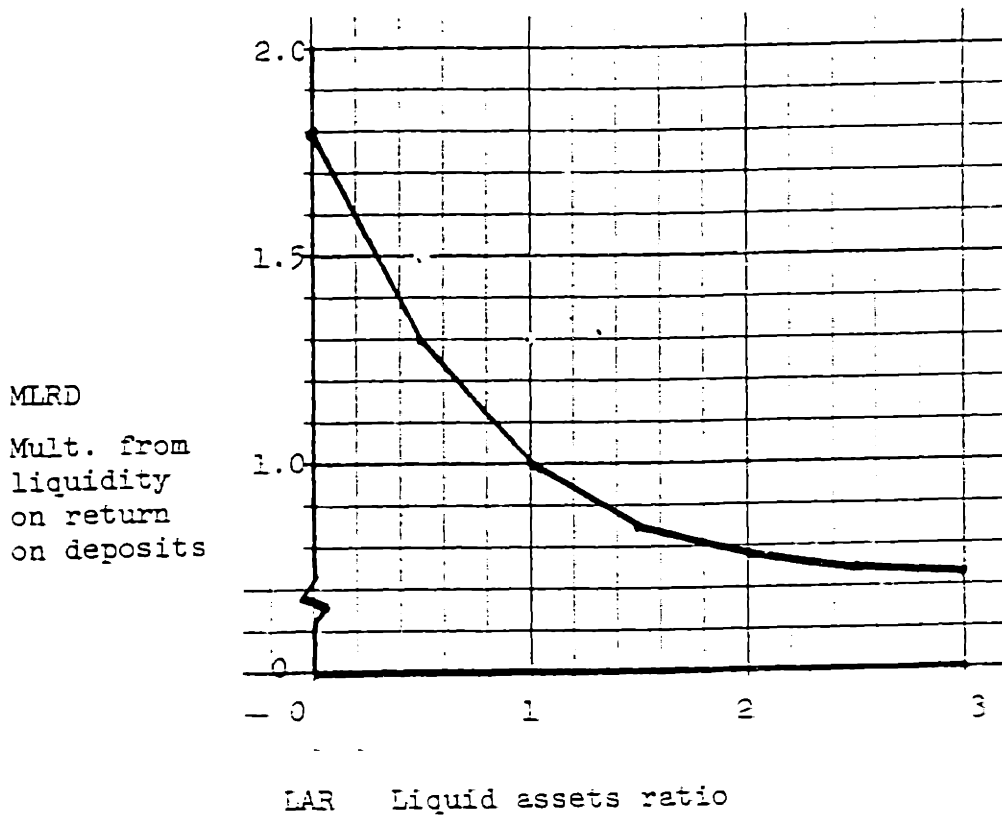


Figure A-11.
TABLE FOR MULTIPLIER FROM LIQUIDITY ON RETURN ON DEPOSITS

Equation 99 expresses the influence of profit on deposit rates. The multiplier from profit on return on deposits MPRD is a positive function of the relative profit of lending institution RPLI (defined by Equation 30). When the return on assets exceeds the required return, the lender is somewhat willing to raise the return on deposits, although the incentive is weak, as shown by the nonlinearity of the table function in Figure A-12. Inadequate profitability, on the other hand, produces increasing pressure to reduce the cost of deposits and, thereby, improve profit conditions.

MPRD.K(L)=TABLE(TMPRD,RPLI.K(L),-1,3,1) 99, A
MPRD - MULTIPLIER FROM PROFIT ON RETURN ON DEPOSITS (DIMENSIONLESS)
L - INDEX FOR LENDERS
TMPRD - TABLE FOR MULTIPLIER FROM PROFIT ON RETURN ON DEPOSITS
RPLI - RELATIVE PROFIT OF LENDING INSTITUTION (DIMENSIONLESS)

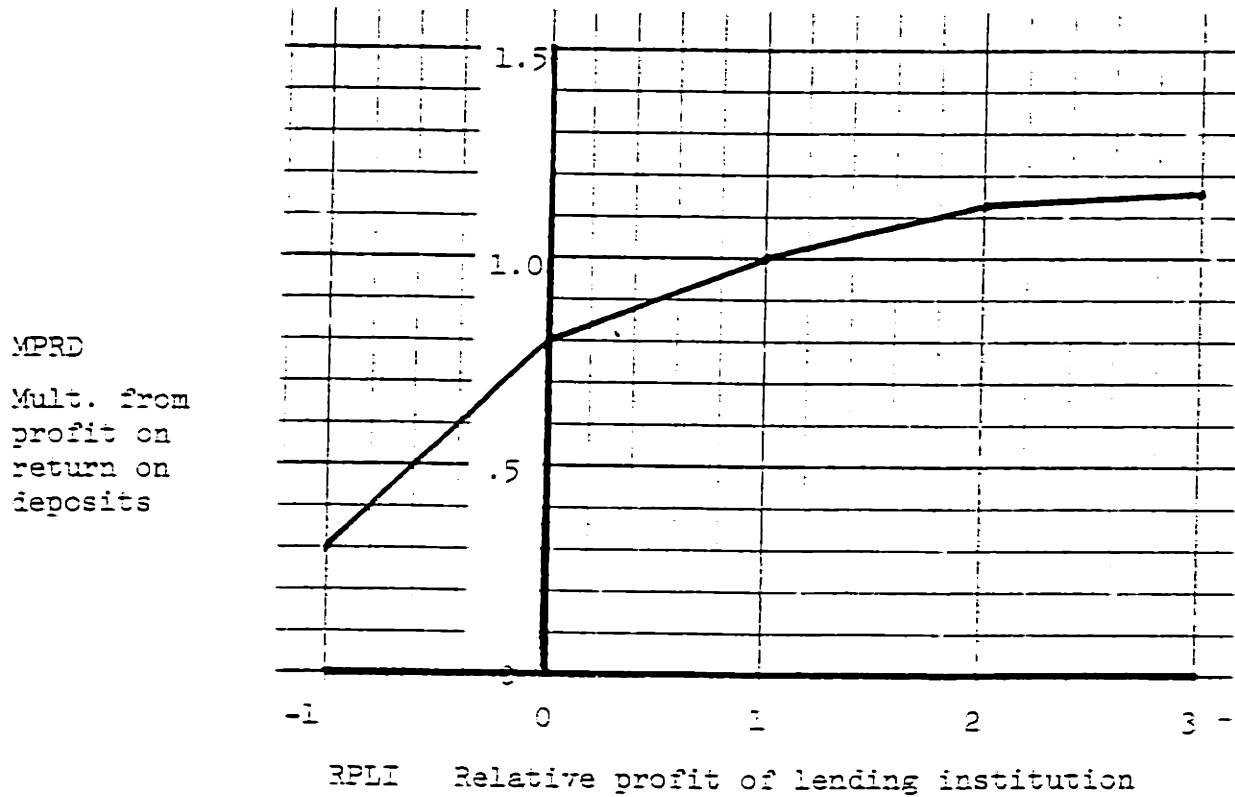


Figure A-12.
TABLE FOR MULTIPLIER FROM PROFIT ON RETURN ON DEPOSITS

G. LIABILITIES--EQUITY (F-62)

This block of equations specifies the level of equity for the lending institutions and the payment of dividends. Equity in lending institution ELI is computed as an auxiliary that subtracts all non-equity liabilities from total assets. For the Bank, these

liabilities include demand deposits DDEP, savings deposits SD, and borrowed reserves, as shown in Equation 100.

$$\begin{aligned} \text{ELI.K(BK)} &= \text{TALI.K(BK)} - \text{SD.K(BK)} - \text{DDEP.K} - \text{BRB.K} && 100, \text{ A} \\ \text{ELI} & - \text{EQUITY IN LENDING INSTITUTION (DOLLARS)} \\ \text{BK} & - \text{INDEX FOR BANK} \\ \text{TALI} & - \text{TOTAL ASSETS OF LENDING INSTITUTION} \\ & \quad \text{(DOLLARS)} \\ \text{SD} & - \text{SAVINGS DEPOSITS (DOLLARS)} \\ \text{DDEP} & - \text{DEMAND DEPOSITS (DOLLARS)} \\ \text{BRB} & - \text{BORROWED RESERVES OF BANK (DOLLARS)} \end{aligned}$$

For non-Bank lenders, Equation 101 subtracts the only non-equity liability, savings deposits SD, from total assets to derive the equity value.

$$\begin{aligned} \text{ELI.K(NBL)} &= \text{TALI.K(NBL)} - \text{SD.K(NBL)} && 101, \text{ A} \\ \text{ELI} & - \text{EQUITY IN LENDING INSTITUTION (DOLLARS)} \\ \text{NBL} & - \text{INDEX FOR NON-BANK LENDERS} \\ \text{TALI} & - \text{TOTAL ASSETS OF LENDING INSTITUTION} \\ & \quad \text{(DOLLARS)} \\ \text{SD} & - \text{SAVINGS DEPOSITS (DOLLARS)} \end{aligned}$$

Total assets in lending institution TALI for the Bank is defined in Equation 102. Bank assets include total reserves of the Bank RB (required reserves as well as any excess over requirements) plus earning assets.

$$\begin{aligned} \text{TALI.K(BK)} &= \text{RB.K} + \text{TB.K(BK)} + \text{GB.K(BK)} + \text{LO.K(BK)} && 102, \text{ A} \\ \text{TALI} & - \text{TOTAL ASSETS OF LENDING INSTITUTION} \\ & \quad \text{(DOLLARS)} \\ \text{BK} & - \text{INDEX FOR BANK} \\ \text{RB} & - \text{RESERVES OF BANK (DOLLARS)} \\ \text{TB} & - \text{TREASURY BILLS (DOLLARS)} \\ \text{GB} & - \text{GOVERNMENT BONDS (DOLLARS)} \\ \text{LO} & - \text{LOANS OUTSTANDING (DOLLARS)} \end{aligned}$$

Total assets of non-Bank lenders consist of liquid assets (money plus Treasury bills), bonds, and loans.

$$\begin{aligned} \text{TALI.K(NBL)} &= \text{LA.K(NBL)} + \text{GB.K(NBL)} + \text{LO.K(NBL)} && 103, A \\ \text{TALI} &- \text{TOTAL ASSETS OF LENDING INSTITUTION} && \\ & \quad \text{(DOLLARS)} && \\ \text{NBL} &- \text{INDEX FOR NON-BANK LENDERS} && \\ \text{LA} &- \text{LIQUID ASSETS (DOLLARS)} && \\ \text{GB} &- \text{GOVERNMENT BONDS (DOLLARS)} && \\ \text{LO} &- \text{LOANS OUTSTANDING (DOLLARS)} && \end{aligned}$$

Lending institutions, like other profit-making institutions, pay out dividends on the basis of established practice, current profits, available funds, and the need to maintain an adequate level of retained earnings.*28* These influences are reflected in Equation 104, which defines the payment of dividends by lending institution PDLI. Traditional dividends of lending institution TDLI expresses established practice. The other influences are reflected by the three multipliers. If the multipliers together equal one, lenders simply continue to pay out earnings at the established rate.

*28*Returns available on the firm's investments relative to what the investor can earn also influence dividend policy. But, as equities are not yet fully represented in the model, this influence on dividend payments has been deferred until a later version of the Financial Sector is developed.

$$PDLI.K(L) = TDLI.K(L) * MPPD.K(L) * MCPD.K(L) * MEPD.K(L) \quad 104, A$$

PDLI - PAYMENT OF DIVIDENDS BY LENDING INSTITUTION (DOLLARS/YEAR)
L - INDEX FOR LENDERS
TDLI - TRADITIONAL DIVIDENDS OF LENDING INSTITUTION (DOLLARS/YEAR)
MPPD - MULTIPLIER FROM PROFIT ON PAYMENT OF DIVIDENDS (DIMENSIONLESS)
MCPD - MULTIPLIER FROM CASH ON PAYMENT OF DIVIDENDS (DIMENSIONLESS)
MEPD - MULTIPLIER FROM EQUITY ON PAYMENT OF DIVIDENDS (DIMENSIONLESS)

Equation 105 represents traditional dividends as a one-year exponential smoothing of current dividend payments.

$$TDLI.K(L) = TDLI.J(L) + (DT/TTDLI)(PDLI.J(L) - TDLI.J(L)) \quad 105, L$$
$$TDLI(L) = PLI(L) \quad 105.1, N$$

TDLI - TRADITIONAL DIVIDENDS OF LENDING INSTITUTION (DOLLARS/YEAR)
L - INDEX FOR LENDERS
DT - TIME STEP FOR INTEGRATION (YEARS)
TTDLI - TIME FOR TRADITIONAL DIVIDENDS OF LENDING INSTITUTION (YEARS)
PDLI - PAYMENT OF DIVIDENDS BY LENDING INSTITUTION (DOLLARS/YEAR)
PLI - PROFIT OF LENDING INSTITUTION (DOLLARS/YEAR)

The multiplier from profits on payment of dividends MPPD, in Equation 106, augments dividends when profits exceed traditional dividends and reduces the payment when profits decline. If the table in Figure A-13 exhibited a slope of unity, dividends would equal current profits (assuming the other multipliers equal one). However, the firm is unlikely to pay out a very high level of profits immediately, which is why the function's slope decreases as profits increase. As profits decline, even into a negative range, dividends are still paid out by the aggregate institution, on the assumption that even in the worst of times

some firms are still doing fairly well and can support continued dividend payments.

MPPD.K(L)=TABLE(TMPPD,PLI.K(L)/TDLI.K(L),-1,3,.5) 106, A
MPPD - MULTIPLIER FROM PROFIT ON PAYMENT OF DIVIDENDS (DIMENSIONLESS)
L - INDEX FOR LENDERS
TMPPD - TABLE FOR MULTIPLIER FROM PROFIT ON PAYMENT OF DIVIDENDS
PLI - PROFIT OF LENDING INSTITUTION (DOLLARS/YEAR)
TDLI - TRADITIONAL DIVIDENDS OF LENDING INSTITUTION (DOLLARS/YEAR)

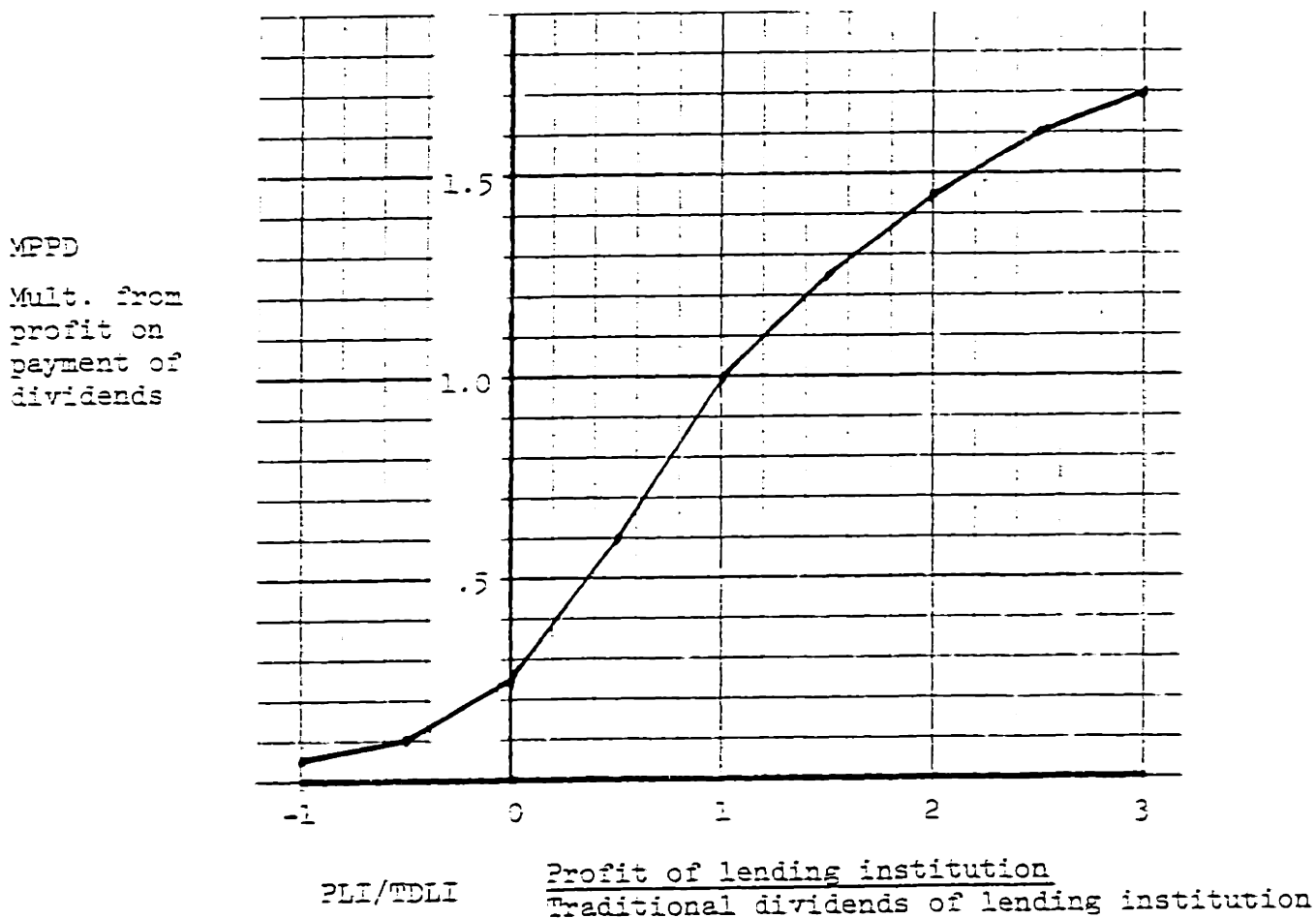


Figure A-13.
TABLE FOR MULTIPLIER FROM PROFIT ON PAYMENT OF DIVIDENDS

The multiplier from cash on payment of dividends MCPD is shown in Equation 107 as an increasing function of relative cash funds. As with other transactions, no dividends can be paid if cash equals zero. As cash funds become excessive, lenders may pay out dividends at a slightly higher rate, but the table function in Figure A-14 saturates to indicate that cash is likely to be absorbed elsewhere rather than simply flowing out to the stockholders.

MCPD.K(L)=TABLE(TMCPD,RCF.K(L),0,3,.5) 107, A
MCPD - MULTIPLIER FROM CASH ON PAYMENT OF
DIVIDENDS (DIMENSIONLESS)
L - INDEX FOR LENDERS
TMCPD - TABLE FOR MULTIPLIER FROM CASH ON PAYMENT
OF DIVIDENDS
RCF - RELATIVE CASH FUNDS (DIMENSIONLESS)

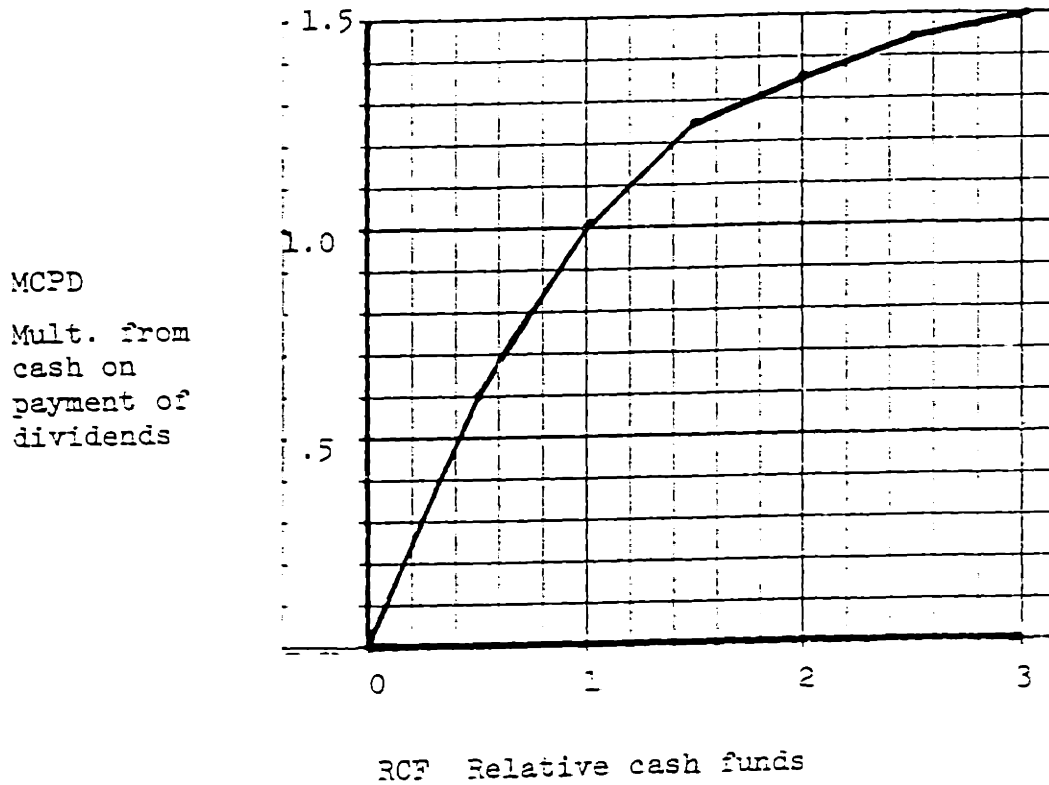


Figure A-14.
TABLE FOR MULTIPLIER FROM CASH ON PAYMENT OF DIVIDENDS

The multiplier from equity on payment of dividends MEPD (Equation 108) causes the lending institutions to pay out more or less of their current profits when equity diverges from the desired amount. In equilibrium, therefore, all profits are paid out, but when the current ratio of equity to assets CREA is less than the acceptable ratio, lenders pay out less than the flow of profits, thereby retaining earnings and rebuilding the equity account. In this fashion, each lender in the model finances its own equity needs and does not have to

tap outside markets. This formulation may be changed later to permit new equity issues, as well as to reflect the importance of future liquidity requirements.

MEPD.K(L)=TABLE(TMEPD,CREA.K(L)/AREA.K(L),0,2,.5) 108, A
MEPD - MULTIPLIER FROM EQUITY ON PAYMENT OF
DIVIDENDS (DIMENSIONLESS)
L - INDEX FOR LENDERS
TMEPD - TABLE FOR MULTPIPLIER FROM EQUITY ON PAYMENT
OF DIVIDENDS
CREA - CURRENT RATIO OF EQUITY TO ASSETS
(DIMENSIONLESS)
AREA - ACCEPTABLE RATIO OF EQUITY TO ASSETS
(DIMENSIONLESS)

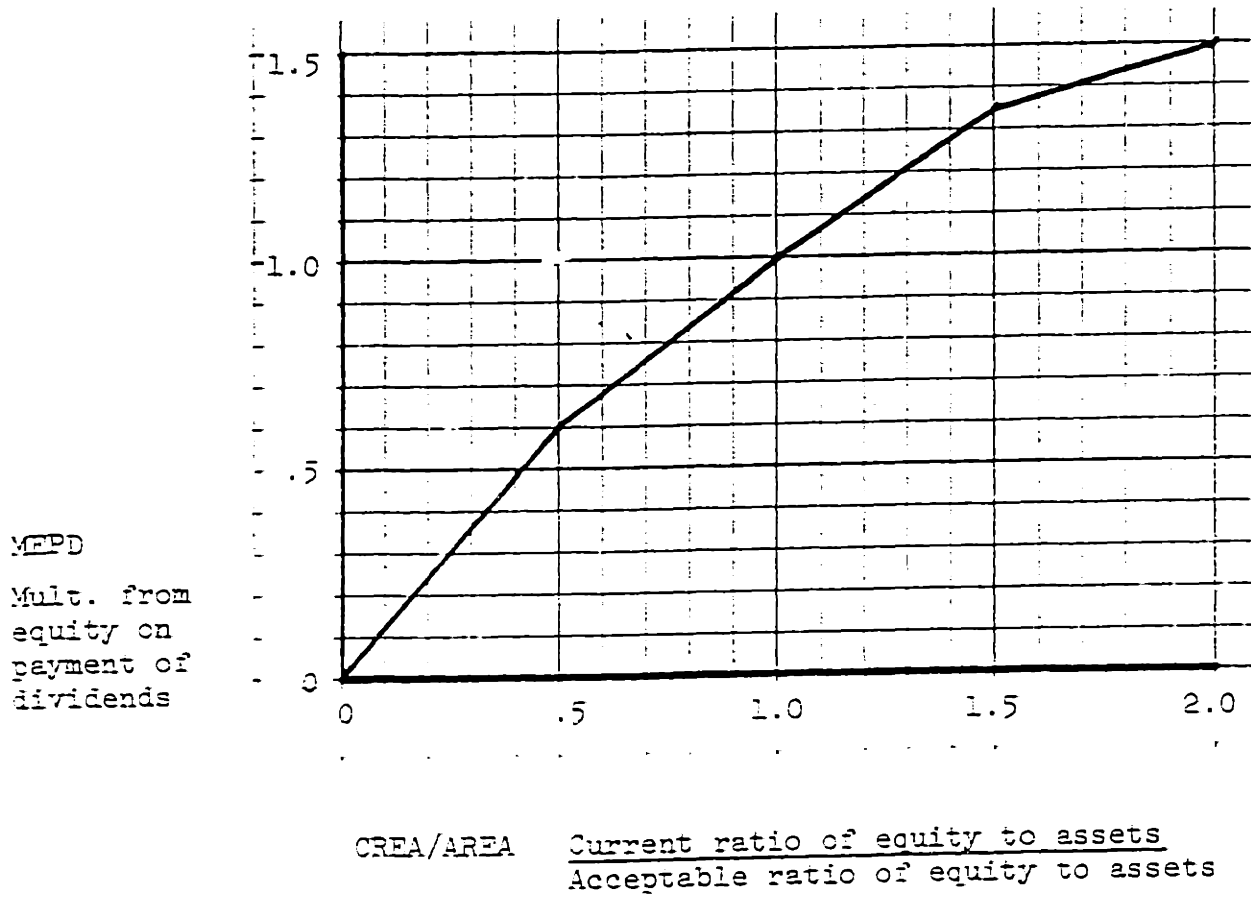


Figure A-15
TABLE FOR MULTIPLIER FROM EQUITY ON PAYMENT OF DIVIDENDS

The current ratio of equity to assets CREA appears in Equation

$$\text{CREA.K(L)} = \text{ELI.K(L)} / \text{TALI.K(L)} \quad 109, A$$

CREA - CURRENT RATIO OF EQUITY TO ASSETS
(DIMENSIONLESS)
L - INDEX FOR LENDERS
ELI - EQUITY IN LENDING INSTITUTION (DOLLARS)
TALI - TOTAL ASSETS OF LENDING INSTITUTION
(DOLLARS)

The acceptable ratio of equity to assets AREA, which eventually could reflect recent experience on loan defaults and general financial conditions, is now shown in Equation 110 as a constant (initial) value.

$$\text{AREA.K(L)} = \text{IREA(L)} \quad 110, A$$

AREA - ACCEPTABLE RATIO OF EQUITY TO ASSETS
(DIMENSIONLESS)
L - INDEX FOR LENDERS
IREA - INITIAL RATIO OF EQUITY TO ASSETS
(DIMENSIONLESS)

As we saw previously, lending institutions compare the current return on equity to the required return, in order to derive a measure of relative profitability. Equation 111 temporarily defines the required return as a weighted average of the traditional return on assets TRA that prevailed in the past and a normal return on assets NRA.*29* The weighting factor = 0.5. Other influences on required return, including

*29*The normal return for this temporary equation simply equals the initial return on assets so as to start the basic model in equilibrium for the tests described in Chapter IV. That is:

$$N \quad \text{NRA(L)} = \text{RALI(L)},$$

where NRA is normal return on assets and RALI is return on assets of lending institution.

the (risk-adjusted) returns available on other financial assets, eventually would enter the calculation.

$$\text{RRA.K(L)} = \text{TRA.K(L)} + (\text{NRA(L)} - \text{TRA.K(L)}) * \text{WFRA} \quad 111, A$$

RRA - REQUIRED RETURN ON ASSETS (FRACTION/YEAR)
L - INDEX FOR LENDERS
TRA - TRADITIONAL RETURN ON ASSETS (DOLLARS/YEAR)
NRA - NORMAL RETURN ON ASSETS (FRACTION/YEAR)
WFRA - WEIGHTING FACTOR FOR RETURN ON ASSETS
(DIMENSIONLESS)

In Equation 112, the traditional return on assets TRA smoothes the actual return over a 15-year time to average return on assets TARE. This smoothing time extends beyond the normal short-term business cycle to generate one's perception of what usually can be obtained on assets.

$$\text{TRA.K(L)} = \text{TRA.J(L)} + (\text{DT/TARA})(\text{RALI.J(L)} - \text{TRA.J(L)}) \quad 112, L$$
$$\text{TRA(L)} = \text{RALI(L)} \quad 112.1, N$$

TRA - TRADITIONAL RETURN ON ASSETS (DOLLARS/YEAR)
L - INDEX FOR LENDERS
DT - TIME STEP FOR INTEGRATION (YEARS)
TARA - TIME TO AVERAGE RETURN ON ASSETS (YEARS)
RALI - RETURN ON ASSETS OF LENDING INSTITUTION
(FRACTION/YEAR)

H. BANK RESERVES AND CURRENCY (F-63)

Unlike the other lending institutions, banks do not have a pool of money, increasing with deposits and loan repayments or declining when loans are made. Instead of money, the Bank owns reserves, which consist of deposits at the Federal Reserve plus currency. Since the Federal Reserve will substitute on demand one component of reserves for the other, the Financial Sector model aggregates both components into one reserve variable. As explained more fully in Chapter III, banks are

required to hold reserves equal to a designated fraction of deposits. Any reserves in excess of the required amount constitute funds that a bank can lend out or invest in securities. Total reserves, and therefore excess reserves, are augmented in the model when the Monetary Authority purchases government securities or when the public deposits currency with the banking system.

Equation 113 defines excess reserves of Bank ERB. At any point in time, excess reserves reflect the difference between total reserves of the Bank RB and required reserves of the Bank RRB. Excess reserves represent funds available for lending and investment and, therefore, are analogous to money in other sectors. As we saw from the description of lending equations, bank lending can be restrained when liquid asset "inventories," which include excess reserves, are insufficient.

$$\begin{array}{l} \text{ERB.K} = \text{RB.K} - \text{RRB.K} \qquad \qquad \qquad 113, \text{ A} \\ \text{ERB} \quad - \text{EXCESS RESERVES OF BANK (DOLLARS)} \\ \text{RB} \quad \quad - \text{RESERVES OF BANK (DOLLARS)} \\ \text{RRB} \quad - \text{REQUIRED RESERVES OF BANK (DOLLARS)} \end{array}$$

In Equation 114, reserves of the Bank RB equal the sum of owned and borrowed reserves.

$$\begin{array}{l} \text{RB.K} = \text{BRB.K} + \text{ORB.K} \qquad \qquad \qquad 114, \text{ A} \\ \text{RB} \quad \quad - \text{RESERVES OF BANK (DOLLARS)} \\ \text{BRB} \quad - \text{BORROWED RESERVES OF BANK (DOLLARS)} \\ \text{ORB} \quad - \text{OWNED RESERVES OF BANK (DOLLARS)} \end{array}$$

Equation 115 denotes borrowed reserves of Bank BRB. The borrowed component of bank reserves simply reflects the Bank's need to meet the reserve requirements dictated by the Monetary Authority.

Several auxiliary variables enter into the computation in order to assure that, at all times, the Monetary Authority acts as "lender of last resort" to make up for any reserve deficiency. However, as revealed previously in the lending equations, sustained borrowing leads to official pressure on the Bank to reduce the extension of credit. In Equation 115, borrowed reserves reflect the product of standard borrowed reserves of Bank SBRB and a multiplier. Standard borrowing is always positive, implying that individual banks borrow even when owned reserves and required reserves of the aggregate system are in balance. The multiplier reduces the system's borrowing to very low levels when the aggregate Bank has a surplus of reserves, which can be distributed through the system by means of the federal funds market.

$$\text{BRB.K} = \text{SBRB.K} * \text{MRBR.K} \quad 115, A$$

BRB - BORROWED RESERVES OF BANK (DOLLARS)
SBRB - STANDARD BORROWED RESERVES OF BANK (DOLLARS)
MRBR - MULTIPLIER FROM RELATIVE BORROWED RESERVES (DIMENSIONLESS)

Equation 116 defines standard borrowed reserves of Bank SBRB. Even in times of easy credit conditions, some individual banks within the aggregate banking system still have to borrow. This local borrowing component is represented as a fraction of required reserves. If required reserves rise, therefore, more member banks begin to incur a reserve deficit, whether or not the aggregate reserve portion balances. The normal borrowing fraction NBF equals 0.01, which was the average fraction that prevailed during the 1967-1970 period (= the mean of 4 year-end ratios).

$$\text{SBRB.K} = \text{NBF} * \text{RRB.K} \quad 116, \text{ A}$$

SBRB - STANDARD BORROWED RESERVES OF BANK (DOLLARS)
 NBF - NORMAL BORROWING FRACTION (FRACTION)
 RRB - REQUIRED RESERVES OF BANK (DOLLARS)

Equation 117 applies the Monetary Authority's required reserve ratios on outstanding demand and time deposits to derive required reserves of Bank RRB.

$$\text{RRB.K} = \text{RRDD.K} * \text{DDEP.K} + \text{RRTD.K} * \text{SD.K}(\text{BK}) \quad 117, \text{ A}$$

RRB - REQUIRED RESERVES OF BANK (DOLLARS)
 RRDD - RESERVE RATIO ON DEMAND DEPOSITS (FRACTION)
 DDEP - DEMAND DEPOSITS (DOLLARS)
 RRTD - RESERVE RATIO ON TIME DEPOSITS (FRACTION)
 SD - SAVINGS DEPOSITS (DOLLARS)
 BK - INDEX FOR BANK

Total demand deposits DDEP are computed by Equation 118 as the difference between total money TM and total currency in public TCP.

$$\text{DDEP.K} = \text{TM.K} - \text{TCP.K} \quad 118, \text{ A}$$

DDEP - DEMAND DEPOSITS (DOLLARS)
 TM - TOTAL MONEY (DOLLARS)
 TCP - TOTAL CURRENCY IN PUBLIC (DOLLARS)

The multiplier from relative borrowed reserves MRBR in Equation 119 assures that Bank borrowing cannot decline below zero, even if aggregate bank reserves are more than adequate. When the difference between owned reserves of the Bank ORB and required reserves of Bank RRB is negative, relative borrowed reserves for requirements RBRR is negative, as shown in Figure A-16. But borrowed reserves still cannot go below 10% of standard borrowed reserves of the Bank SBRB. As required reserves rise above the level of owned reserves, however, the

multiplier rises accordingly, so as to accommodate the Bank's immediate requirements.

MRBR.K=TABLE(TMRBR,RBRR.K,-4,10,2) 119, A
MRBR - MULTIPLIER FROM RELATIVE BORROWED RESERVES
(DIMENSIONLESS)
TMRBR - TABLE FOR MULTIPLIER FROM RESERVES ON
BORROWED RESERVES
RBRR - RELATIVE BORROWED RESERVE RATIO
(DIMENSIONLESS)

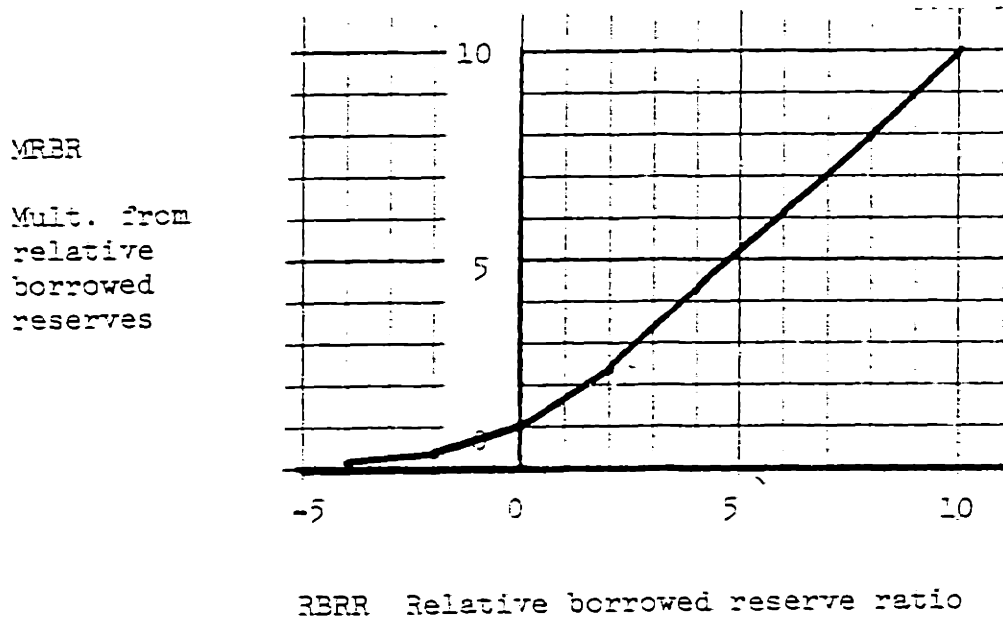


Figure A-16
TABLE FOR MULTIPLIER FROM RESERVES ON BORROWED RESERVES

Equation 120 relates the difference between owned and required reserves to normal borrowing in order to derive the relative borrowed reserve ratio RBRR.

$$RBRR.K = (RRB.K - ORB.K) / SBRB.K \quad 120, A$$

RBRR - RELATIVE BORROWED RESERVE RATIO
(DIMENSIONLESS)
RRB - REQUIRED RESERVES OF BANK (DOLLARS)
ORB - OWNED RESERVES OF BANK (DOLLARS)
SBRB - STANDARD BORROWED RESERVES OF BANK
(DOLLARS)

Owned reserves of the Bank ORB (Equation 121) accumulates the public's currency deposits and withdrawals as well as the value of open-market operations VOMO by the Monetary Authority. Currency deposits and withdrawals reflect changing public preferences as to the composition of money (defined as the sum of currency and demand deposits). This preference is reflected in the desired ratio of currency to money DRCM, which appears later as a temporary equation, while currency deposits and withdrawals will be specified shortly. The value of open-market operations reflects the direct effect on bank reserves of the Federal Reserve's transactions in government securities.

$$ORB.K = ORB.J + (DT)(VOMO.JK + CDR.J - CWR.J) \quad 121, L$$
$$ORB = RRB + IERB - SBRB \quad 121.1, N$$

ORB - OWNED RESERVES OF BANK (DOLLARS)
DT - TIME STEP FOR INTEGRATION (YEARS)
VOMO - VALUE OF OPEN MARKET OPERATIONS (DOLLARS/
YEAR)
CDR - CURRENCY DEPOSIT RATE (DOLLARS/YEAR)
CWR - CURRENCY WITHDRAWAL RATE (DOLLARS/YEAR)
RRB - REQUIRED RESERVES OF BANK (DOLLARS)
IERB - INITIAL EXCESS RESERVES OF BANK (DOLLARS)
SBRB - STANDARD BORROWED RESERVES OF BANK
(DOLLARS)

Equation 122, which defines the value of open-market operations VOMO, represents a simplification of reality. As we saw previously, the government securities markets represent five purchasers (the four financial institutions plus the Monetary Authority) and one

seller (the Treasury). Secondary sales between aggregate institutions in the model are not portrayed explicitly. However, the securities allocation procedure that was described previously permits the Monetary Authority to adjust both its absolute volume of purchases as well as its proportion of total transactions. If the authorities want to expand reserves by purchasing bills, for example, they increase their desired purchases of Treasury bills and, thereby, obtain a higher portion of the total bills being sold by the Treasury. In actual markets, when the Federal Reserve purchases a bill (or bond), the seller may be the Treasury or some current holder wishing to sell the security before it matures. In either case, the seller receives a check drawn on a Federal Reserve account which, when deposited in a bank, adds to the owned reserves of the banking system.

The Federal Reserve can reduce bank reserves by selling government securities that it has purchased previously from the government. Such a secondary sale withdraws reserves directly when the Bank buys the security and indirectly when someone else buys the security. In the model, secondary sales do not appear explicitly. When the Monetary Authority wants to reduce reserves, therefore, its desired purchases decline, and this causes maturities to exceed purchases, thereby running down the Monetary Authority's holding of bills or bonds. To make payment on these securities as they mature, the government is assumed in the model to withdraw the amount in question from its accounts in the banking system. Therefore, owned reserves of the Bank are depleted by maturities of bills and bonds held by the Monetary

Authority. In equilibrium, these maturities offset the Monetary Authority's purchases, and the value of open-market operations VOMO equals zero.

$$\text{VOMO.KL} = \text{PTBM.K} + \text{PGBM.K} - \text{MTBM.K} - \text{MGBM.K} \quad 122, R$$

VOMO - VALUE OF OPEN MARKET OPERATIONS (DOLLARS/YEAR)
PTBM - PURCHASE OF TREASURY BILLS BY MONETARY AUTHORITY (DOLLARS/YEAR)
PGBM - PURCHASE OF GOVERNMENT BONDS BY MONETARY AUTHORITY (DOLLARS/YEAR)
MTBM - MATURITY OF TREASURY BILLS IN MONETARY AUTHORITY (DOLLARS/YEAR)
MGBM - MATURITY OF GOVERNMENT BONDS IN MONETARY AUTHORITY (DOLLARS/YEAR)

Currency deposits also serve to increase the level of owned reserves. Equation 123 generates the currency deposit rate CDR as the standard currency turnover SCT modified by the influence of public holdings of currency. Even in an overall equilibrium, currency flows into and out of banks as people buy goods and services. This standard currency turnover in the model appears in both the deposit and withdrawal streams. The flows are adjusted, however, when a discrepancy develops between actual and desired currency levels.

$$\text{CDR.K} = \text{SCT.K} * \text{MCCD.K} \quad 123, A$$

CDR - CURRENCY DEPOSIT RATE (DOLLARS/YEAR)
SCT - STANDARD CURRENCY TURNOVER (DOLLARS/YEAR)
MCCD - MULTIPLIER FROM CURRENCY ON CURRENCY DEPOSITS (DIMENSIONLESS)

Standard currency turnover SCT is expressed in Equation 124 as the desired ratio of currency to money DRCM times total payments for factors TPAY. The desired ratio is defined in a temporary equation. The total transactions term is a coupling equation that sums the

expenditures occurring among production and household sectors. The formulation for SCT implies that all people and firms pay for goods and services in accordance with an overall desired composition of money.

$$\text{SCT.K} = \text{DRCM.K} * \text{TPAY.K} \quad 124, A$$

SCT - STANDARD CURRENCY TURNOVER (DOLLARS/YEAR)
DRCM - DESIRED RATIO OF CURRENCY TO MONEY
(DIMENSIONLESS)
TPAY - TOTAL PAYMENTS (DOLLARS/YEAR)

Equation 125 specifies the multiplier from currency on currency deposits MCCD. As Figure A-17 shows, currency deposits occur in accordance with the standard turnover when total currency in public TCP exceeds desired levels--that is, when $\text{MCCD} = 1.*30*$ Relatively low currency levels, however, encourage people to reduce their currency deposits (as well as to increase their withdrawals) in order to redress the balance. At the extreme, when the public holds no currency, deposits of currency cannot take place.

$$\text{MCCD.K} = \text{TABHL}(\text{TMCCD}, \text{TCP.K}/\text{DCP.K}, 0, 1, .25) \quad 125, A$$

MCCD - MULTIPLIER FROM CURRENCY ON CURRENCY DEPOSITS (DIMENSIONLESS)
TMCCD - TABLE FOR MULTIPLIER FROM CORRECTION IN CURRENCY ON DEPOSITS
TCP - TOTAL CURRENCY IN PUBLIC (DOLLARS)
DCP - DESIRED CURRENCY IN PUBLIC (DOLLARS)

*30*Note that when $\text{TCP} < \text{DCP}$, the imbalance is corrected in the currency withdrawal stream, as shown in later equations.

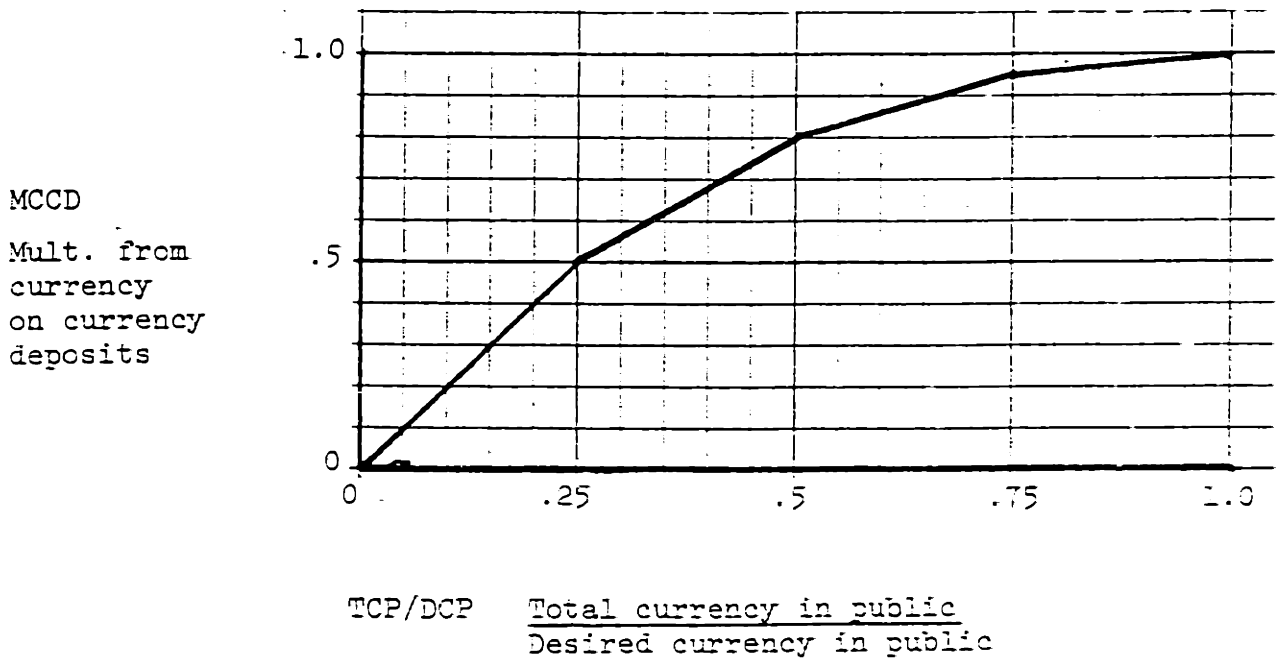


Figure A-17.
TABLE FOR MULTIPLIER FROM CURRENCY ON CURRENCY DEPOSITS

Total currency in public TCP (Equation 126) accumulates all of the publicly-held currency which, in reality, is distributed among the money levels contained in each non-bank sector. Thus the pools of money, which vary with intersectoral transactions, contain undifferentiated amounts of demand deposits and currency, in proportions that are the same for every sector and which change according to the public's desired ratio of currency to money DRCM. As the currency-to-money ratio varies, the public deposits or withdraws currency from the Bank. For example, if people want to hold less currency, they will exchange currency holdings for a deposit at the

Bank. The exchange will not affect directly the total money supply, but it will affect owned reserves of the Bank which, eventually, could influence lending and total money balances.

$$\begin{aligned} \text{TCP.K} &= \text{TCP.J} + (\text{DT})(\text{CWR.J} - \text{CDR.J}) && 126, \text{ L} \\ \text{TCP} &= \text{DCP} && 126.1, \text{ N} \\ \text{TCP} & \quad - \text{TOTAL CURRENCY IN PUBLIC (DOLLARS)} \\ \text{DT} & \quad - \text{TIME STEP FOR INTEGRATION (YEARS)} \\ \text{CWR} & \quad - \text{CURRENCY WITHDRAWAL RATE (DOLLARS/YEAR)} \\ \text{CDR} & \quad - \text{CURRENCY DEPOSIT RATE (DOLLARS/YEAR)} \\ \text{DCP} & \quad - \text{DESIRED CURRENCY IN PUBLIC (DOLLARS)} \end{aligned}$$

Equation 127 multiplies the total money supply by the public's desired ratio of currency to money DRCM to generate desired currency in public DCP.

$$\begin{aligned} \text{DCP.K} &= \text{DRCM.K} * \text{TM.K} && 127, \text{ A} \\ \text{DCP} & \quad - \text{DESIRED CURRENCY IN PUBLIC (DOLLARS)} \\ \text{DRCM} & \quad - \text{DESIRED RATIO OF CURRENCY TO MONEY} \\ & \quad \quad \quad (\text{DIMENSIONLESS}) \\ \text{TM} & \quad - \text{TOTAL MONEY (DOLLARS)} \end{aligned}$$

The currency withdrawal rate CWR appears in Equation 128. Under usual conditions, withdrawals amount to the standard currency turnover SCT (based on transactions) and the correction of currency in public CCP (which adjusts actual to desired levels of currency). In equilibrium, both the deposit and withdrawal rates equal the volume of standard currency turnover SCT. The two multipliers in Equation 128 prevent gross withdrawals from falling below zero when the correction term is negative and large or when reserves of the banking system become severely depleted.

$$CWR.K = (SCT.K + CCP.K) * MCCW.K * MRRW.K \quad 128, A$$

CWR - CURRENCY WITHDRAWAL RATE (DOLLARS/YEAR)
SCT - STANDARD CURRENCY TURNOVER (DOLLARS/YEAR)
CCP - CORRECTION IN CURRENCY OF PUBLIC (DOLLARS/YEAR)
MCCW - MULTIPLIER FROM CURRENCY CORRECTION ON WITHDRAWALS (DIMENSIONLESS)
MRRW - MULTIPLIER FROM RELATIVE RESERVES ON WITHDRAWALS (DIMENSIONLESS)

Equation 129 divides the discrepancy between desired and actual currency holdings by the normal time for currency adjustment NTCA. The value of this normal time constant (= 1 year) reflects the fact that people's desired money composition is a vague concept that adjusts over time more or less unconsciously. The currency discrepancy also affects currency deposits, as shown above in the multiplier from currency on currency deposits MCCD; and the multipliers in Equation 129 may restrain withdrawals. Therefore, the actual time to adjust currency may diverge from the normal time.

$$CCP.K = (DCP.K - TCP.K) / NTCA \quad 129, A$$

CCP - CORRECTION IN CURRENCY OF PUBLIC (DOLLARS/YEAR)
DCP - DESIRED CURRENCY IN PUBLIC (DOLLARS)
TCP - TOTAL CURRENCY IN PUBLIC (DOLLARS)
NTCA - NORMAL TIME FOR CURRENCY ADJUSTMENT (YEARS)

In Equation 130, the withdrawal stream is restrained by the multiplier from currency correction on withdrawals MCCW when the correction term (CCP) becomes negative and approaches the usual flow related to transactions (SCT). The equation for CCP together with Equation 130 reveal that when total currency exceeds desired currency by

more and more, the public reduces withdrawals and thereby seeks to redress the balance faster than is implied by the normal time for currency adjustment NTCA.

MCCW.K=TABHL(TMCCW, CCP.K/SCT.K, -1, 0, .25) 130, A
 MCCW - MULTIPLIER FROM CURRENCY CORRECTION ON WITHDRAWALS (DIMENSIONLESS)
 TMCCW - TABLE FOR MULTIPLIER FROM CURRENCY CORRECTION ON WITHDRAWALS
 CCP - CORRECTION IN CURRENCY OF PUBLIC (DOLLARS/YEAR)
 SCT - STANDARD CURRENCY TURNOVER (DOLLARS/YEAR)

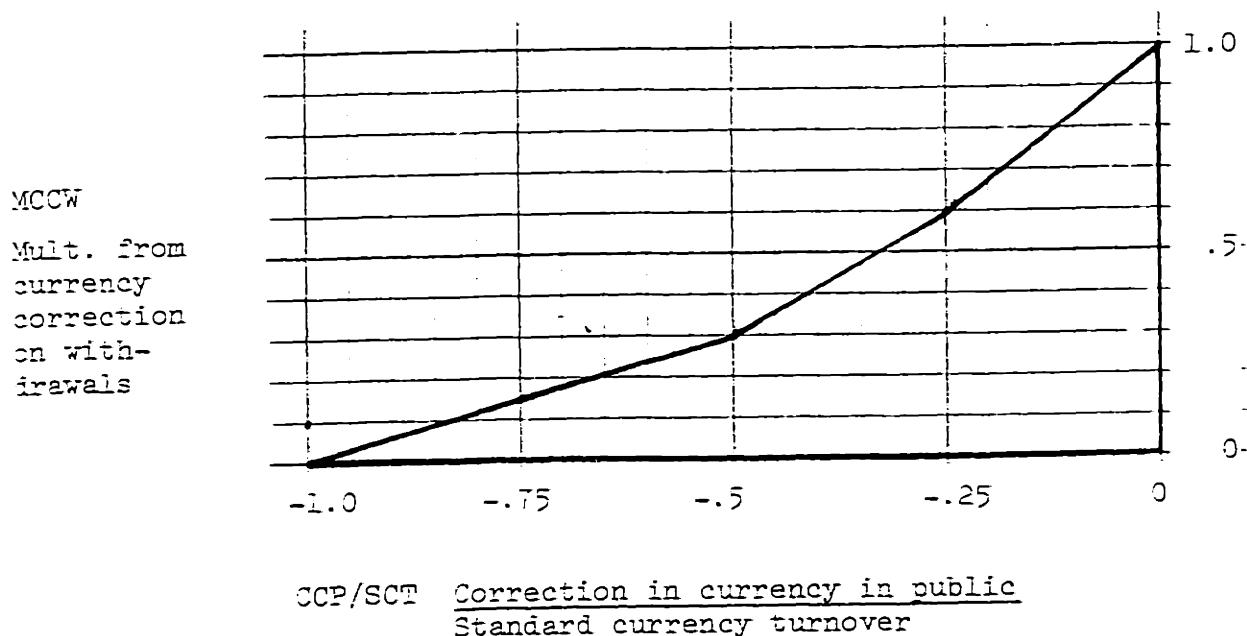


Figure A-18.
 TABLE FOR MULTIPLIER FROM CURRENCY CORRECTION ON WITHDRAWALS

more and more, the public reduces withdrawals and thereby seeks to redress the balance faster than is implied by the normal time for currency adjustment NTCA.

$MCCW.K = TABHL(TMCCW, CCP.K/SCT.K, -1, 0, .25)$ 130, A
MCCW - MULTIPLIER FROM CURRENCY CORRECTION ON WITHDRAWALS (DIMENSIONLESS)
TMCCW - TABLE FOR MULTIPLIER FROM CURRENCY CORRECTION ON WITHDRAWALS
CCP - CORRECTION IN CURRENCY OF PUBLIC (DOLLARS/YEAR)
SCT - STANDARD CURRENCY TURNOVER (DOLLARS/YEAR)

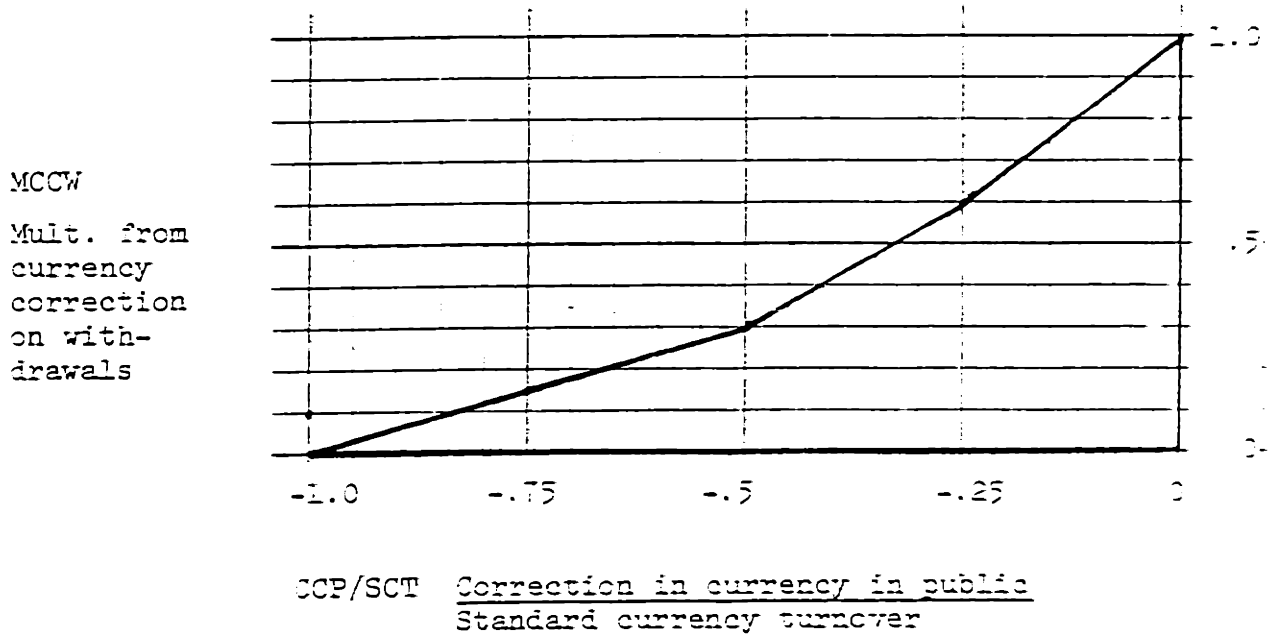


Figure A-18.
TABLE FOR MULTIPLIER FROM CURRENCY CORRECTION ON WITHDRAWALS

The multiplier from relative reserves on withdrawals MRRW in Equation 131 transmits the influence of the Bank's relative owned reserves position by means of a nonlinear table function. When owned reserves are adequate in relation to required reserves of Bank RRB, the multiplier takes a value of one. But when owned reserves fall further and further below required amounts, the multiplier imposes an increasingly greater constraint on the banking system's capacity to meet withdrawal demands.

The reader may recall from the description of reserve borrowing in the model that the Bank can always borrow from the Monetary Authority to meet official reserve requirements. Thus, total reserves of the Bank RB can never fall below required amounts, even though owned reserves may become a small proportion of the total. Despite the Monetary Authority's readiness to meet contemporaneous reserve deficiencies, we may assume that the declining portion of owned reserves in the aggregate Bank reflects an increasing number of bankruptcies among individual banks in the system. As a growing number of banks close their doors, more and more depositors become frustrated in their

attempt to exchange demand deposits for currency.*31*

Since the advent of deposit insurance in 1933, runs on the banking system have become extremely rare; and the multiplier described here need not be included in a model purporting to represent recently-observed conditions. But as the National Model eventually will simulate economic activity back to the 1800's, the impact of financial panics on the banking system's capacity to meet withdrawals must be represented explicitly.

MRRW.K=TABHL(TMRRW,ORB.K/RRB.K,0,1,.25) 131, A
MRRW - MULTIPLIER FROM RELATIVE RESERVES ON
WITHDRAWALS (DIMENSIONLESS)
TMRRW - TABLE FOR MULTIPLIER FROM RELATIVE RESERVES
ON WITHDRAWALS
ORB - OWNED RESERVES OF BANK (DOLLARS)
RRB - REQUIRED RESERVES OF BANK (DOLLARS)

*31*Moreover, depositors would most likely attempt to withdraw more deposits in the form of currency as bank failures accelerate. The demand for currency, in turn, would create more failures and more runs on bank deposits. This classic positive loop operated before the advent of Federal Deposit Insurance but is not very significant today. In the model, the impact of withdrawal constraints would appear in the formulation of the desired ratio of currency to money DRCM. But for now DRCM equals a constant (see Equation 139).

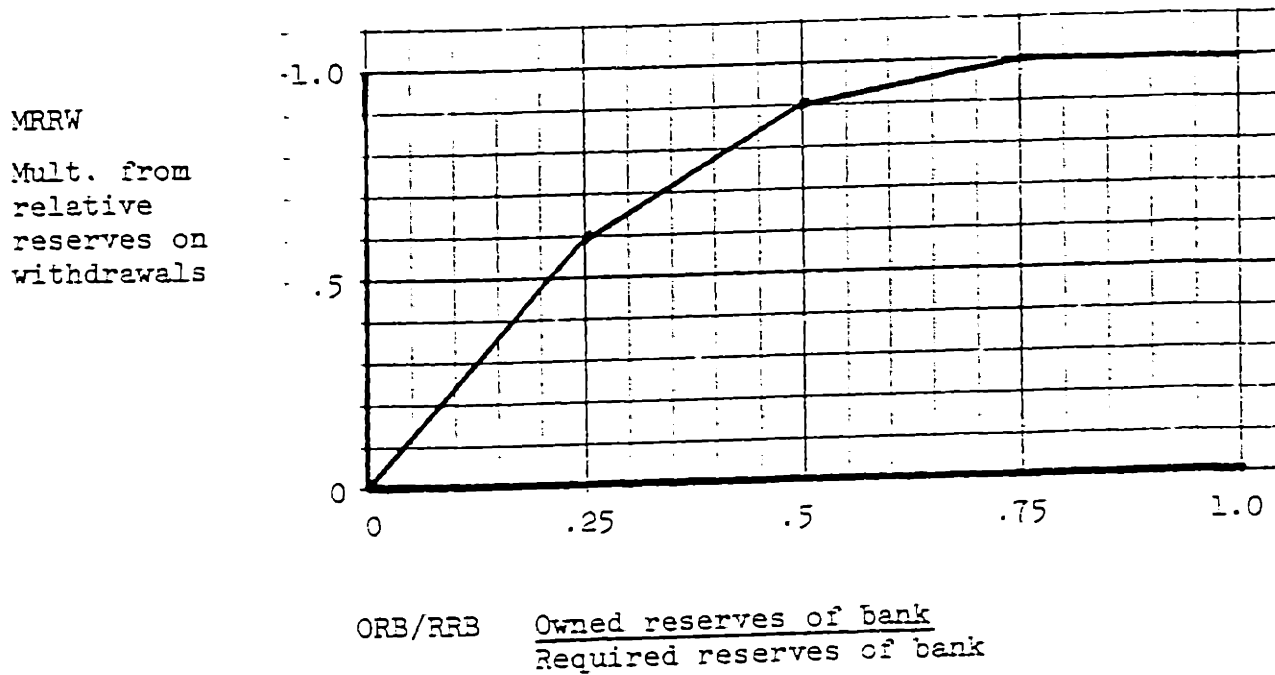


Figure A-19.
TABLE FOR MULTIPLIER FROM RELATIVE RESERVES ON WITHDRAWALS

I. TEMPORARY EQUATIONS (F-64)

This final block of equations consists of formulations that appear in some of the equations already described but that will require further development before being incorporated in the basic model. The manner in which these concepts eventually fit into the overall financial structure will be described in this section.

Equation 132 denotes the desired liquid fraction of savings DLFS. In reality, this fraction would vary over time in response to people's perceptions of liquidity which, in turn, would depend on past ability to liquidate bills, savings deposits, and the like. For now,

however, the desired fraction simply equals the normal liquid fraction of savings NLFS. Like other "normal" values in the Financial Sector, NLFS will be derived from actual data. Because common stocks currently appear only nominally as an asset of the Savings Investor, though, NLFS takes on the unrealistically high value of 0.83. When common stock holdings are fully accounted for, the value of NLFS will be considerably lower.

DLFS.K=NLFS	132, A
DLFS - DESIRED LIQUID FRACTION OF SAVINGS (FRACTION)	
NLFS - NORMAL LIQUID FRACTION OF SAVINGS (FRACTION)	

The average return on assets ARA(L) for lending institutions has already been defined as the simple average of the returns on assets available to each lender. The Savings Investor's average return on assets ARA(SI) is specified as a temporary equation, however, because the definition will change to include returns on common stocks once the equity market has been incorporated in the model. Equation 133, therefore, calculates ARA for the five assets that the Savings Investor holds in the current model version.

$ARA.K(SI) = (RTB.K + ERGB.K + SUMV(ERSD.K, 1, TL)) / ACFI(SI)$ 133, A

ARA - AVERAGE RETURN ON ASSETS (FRACTION/YEAR)
SI - INDEX FOR SAVINGS INVESTOR
RTB - RETURN ON TREASURY BILLS (FRACTION/YEAR)
ERGB - EFFECTIVE RETURN ON GOVERNMENT BONDS
(FRACTION/YEAR)
SUMV - FUNCTION FOR SUM OF VECTORS
ERSD - EFFECTIVE RETURN ON SAVINGS DEPOSITS
(FRACTION/YEAR)
TL - TOTAL LENDERS
ACFI - ASSET CATEGORIES IN FINANCIAL INSTITUTION
(DIMENSIONLESS)

Equation 134 expresses the value of common stock VCS, which appears as an asset on the books of the Savings Investor. As described previously, the Savings Investor collects all of the savings of households and business firms and then allocates the savings among the entire array of financial assets. While the model developed in this thesis has considered only the acquisition of interest-bearing obligations (loans, government securities, savings deposits), the complete Financial Sector model also will represent the extension and valuation of common stock. The entire ownership in the equity of other sectors will appear on the Savings Investor's balance sheet, although the procedure for valuing equity holdings has yet to be determined.*32* The value of common stock VCS held by the Savings Investor temporarily equals a constant \$10 billion. This holding entitles the Savings Investor to the flow of dividends paid out by the three lenders in the

*32*The common procedure is to show equity holdings on the balance sheet at book value, indicating the cost of the asset when it was originally acquired. This value is not the same as the capital and retained earnings liability on each sector's balance sheet, nor the same as the market's valuation of equity ownership.

model. Chapter VI describes how equity holdings may be handled in the future.

VCS.K=CVCS 134, A
VCS - VALUE OF COMMON STOCK (DOLLARS)
CVCS - CONSTANT VALUE OF COMMON STOCK (DOLLARS)

Operating costs in lending institution OCLI reflect each lender's expenditures for operating services provided by one of the service sectors of the National Model. Equation 135 expresses operating costs as a function of the lender's total size (in terms of total assets) and activity (in terms of asset purchases). Eventually a set of equations will have to be designed to link the Financial Sector and the service sector. These equations would probably resemble the set of ordering, backlog, and accounts payable equations found in the standard production sector of the National Model. For describing and testing the Financial Sector, however, these additional equations do not seem necessary and are replaced with the simple formulation shown below.*33* The two parameters are set to zero here but could be varied for testing purposes.

*33*One unresolved problem may be pointed out here. Other sectors of the National Model contain a production function which generates output according to the inventories of productive factors. If factors, such as services, are not available, then production is restrained. The Financial Sector contains no production function, although the lack of available services could impose a constraint, possibly through a simple multiplier function, on lending.

$$\text{OCLI.K(L)} - \text{PCA(L)} * \text{TALI.K(L)} + \text{PCT(L)} * (\text{LER.K(L)} + \text{PTB.K(L)} + \text{PGB.K(L)}) \quad 135, A$$

- OCLI - OPERATING COSTS OF LENDING INSTITUTION (DOLLARS/YEAR)
- L - INDEX FOR LENDERS
- PCA - PARAMETER FOR COST OF ASSETS (FRACTION/YEAR)
- TALI - TOTAL ASSETS OF LENDING INSTITUTION (DOLLARS)
- PCT - PARAMETER FOR COST OF TRANSACTIONS (DIMENSIONLESS)
- LER - LOAN EXTENSION RATE (DOLLARS/YEAR)
- PTB - PURCHASE OF TREASURY BILLS (DOLLARS/YEAR)
- PGB - PURCHASE OF GOVERNMENT BONDS (DOLLARS/YEAR)

Corporate taxation will also affect monetary flows in the financial sector. In Equation 136, tax on lending institution TLI could be based on a proportion of pre-tax earnings or on some more complicated formulation. For now, however, tax payments equal zero.

$$\text{TLI.K(L)} = 0 \quad 136, A$$

- TLI - TAX ON LENDING INSTITUTION (DOLLARS/YEAR)
- L - INDEX FOR LENDERS

In Equation 137, the weighted return on savings WRS is calculated by dividing total savings TSAV into total earnings on savings TES. The resulting return is transmitted to each sector so that the receipt of earnings by the Savings Investor can be properly accrued in the level of savings that resides in each household and production sector. That is, if the saving sector chooses not to withdraw its earnings from the Savings Investor, the product of WRS and the level of savings SAV generates an increase (in dollars/year) in the value of each sector's savings.

137, A

WRS.K=TES.K/TSAV.K
 WRS - WEIGHTED RETURN ON SAVINGS (FRACTION/YEAR)
 TES - TOTAL EARNINGS ON SAVINGS (DOLLARS/YEAR)
 TSAV - TOTAL SAVINGS (DOLLARS)

For the computation of the weighted return on savings WRS, Equation 138 provides total earnings on savings TES, which sums up the flow of interest receipts on government securities, the payment of earnings on savings deposits, and the payment of dividends by lending institution to the Savings Investor. Later, dividend payments from other sectors will also enter the calculation.

138, A

TES.K=RITB.K(SI)+RIGB.K(SI)+SUMV(ESD.K,1,TL)-
 SUMV(DSDL.K,1,TL)+SUMV(PDLI.K,1,TL)
 TES - TOTAL EARNINGS ON SAVINGS (DOLLARS/YEAR)
 RITB - RECEIPT OF INTEREST ON TREASURY BILLS (DOLLARS/YEAR)
 SI - INDEX FOR SAVINGS INVESTOR
 RIGB - RECEIPT OF INTEREST ON GOVERNMENT BONDS (DOLLARS/YEAR)
 SUMV - FUNCTION FOR SUM OF VECTORS
 ESD - EARNINGS ON SAVINGS DEPOSITS (DOLLARS/YEAR)
 TL - TOTAL LENDERS
 DSDL - DEFAULTS ON SAVINGS DEPOSITS OF LENDER (DOLLARS/YEAR)
 PDLI - PAYMENT OF DIVIDENDS BY LENDING INSTITUTION (DOLLARS/YEAR)

The desired ratio of currency to money DRCM, which was used to calculate desired currency in public DCP, is defined by Equation 139 at a constant value of 0.2 (roughly the observed ratio over the last 20 years). The model eventually will have to deal with historical runs on banks, in which people withdrew deposits in the wake of bank failures and eroded confidence. As we saw earlier, the currency withdrawal rate CWR includes a correction term that attempts to equate desired currency in public DCP with the actual amount of total currency in public TCP.

WRS.K=TES.K/TSAV.K 137, A
WRS - WEIGHTED RETURN ON SAVINGS (FRACTION/YEAR)
TES - TOTAL EARNINGS ON SAVINGS (DOLLARS/YEAR)
TSAV - TOTAL SAVINGS (DOLLARS)

For the computation of the weighted return on savings WRS, Equation 138 provides total earnings on savings TES, which sums up the flow of interest receipts on government securities, the payment of earnings on savings deposits, and the payment of dividends by lending institution to the Savings Investor. Later, dividend payments from other sectors will also enter the calculation.

TES.K=RITB.K(SI)+RIGB.K(SI)+SUMV(ESD.K,1,TL)- 138, A
SUMV(DSDL.K,1,TL)+SUMV(PDLI.K,1,TL)
TES - TOTAL EARNINGS ON SAVINGS (DOLLARS/YEAR)
RITB - RECEIPT OF INTEREST ON TREASURY BILLS
(DOLLARS/YEAR)
SI - INDEX FOR SAVINGS INVESTOR
RIGB - RECEIPT OF INTEREST ON GOVERNMENT BONDS
(DOLLARS/YEAR)
SUMV - FUNCTION FOR SUM OF VECTORS
ESD - EARNINGS ON SAVINGS DEPOSITS (DOLLARS/YEAR)
TL - TOTAL LENDERS
DSDL - DEFAULTS ON SAVINGS DEPOSITS OF LENDER
(DOLLARS/YEAR)
PDLI - PAYMENT OF DIVIDENDS BY LENDING INSTITUTION
(DOLLARS/YEAR)

The desired ratio of currency to money DRCM, which was used to calculate desired currency in public DCP, is defined by Equation 139 at a constant value of 0.2 (roughly the observed ratio over the last 20 years). The model eventually will have to deal with historical runs on banks, in which people withdrew deposits in the wake of bank failures and eroded confidence. As we saw earlier, the currency withdrawal rate CWR includes a correction term that attempts to equate desired currency in public DCP with the actual amount of total currency in public TCP.

Desired currency in public DCP was defined in Equation 127 as the product of DRCM and total money TM. Although DRCM now is held constant, it should eventually respond to the Bank's capacity to meet the desired currency withdrawal rate. For instance, if inadequate reserves cause banks within the aggregate system to fail, currency withdrawals will be restrained. This restraint, in turn, would reduce public confidence and cause a higher desired ratio of currency to money DRCM, thereby producing a more intensive effort to withdraw demand deposits.

DRCM.K=.2

139, A

DRCM - DESIRED RATIO OF CURRENCY TO MONEY
(DIMENSIONLESS)

The remaining two equations in the Financial Sector model produce an approximation of the return on federal funds. The model does not portray explicitly the federal funds market, because of its very short-term nature relative to the kinds of dynamic phenomena that represent the focus of the National Model.*34* However, it is claimed that the return on federal funds is an important indicator of short-term money markets and is relied upon by the Federal Reserve for setting monetary policy. Therefore, Equation 140 generates this return, which

*34*Federal funds are reserves that banks lend to each other, usually for periods of only a few days. The term of such loans is too short to contribute significantly to business cycles or longer-term disequilibrium phenomena. However, the funds market does serve to redistribute reserves around the banking system and permits banks (particularly those in the money centers) to borrow reserves continuously without relying too heavily on the Federal Reserve discount window.

could be a signal to the Monetary Authority in the model and does not enter any other Financial Sector equations. Under normal conditions, RFF closely approximates the bill rate (return on Treasury bills RTB).^{*35*} When total borrowed reserves of the Bank BRB deviate from their normal amount, however, the funds rate is affected. This influence is produced by the multiplier on return on federal funds MRFF.

$$RFF.K = RTB.K * MRFF.K \quad 140, A$$

RFF - RETURN ON FEDERAL FUNDS (FRACTION/YEAR)
RTB - RETURN ON TREASURY BILLS (FRACTION/YEAR)
MRFF - MULTIPLIER FOR RETURN ON FEDERAL FUNDS
(DIMENSIONLESS)

Through Equation 141, the overall amount of borrowing by the banking system influences the return on federal funds. For example, when excess reserves are high, and therefore borrowed funds are relatively low, reserves are readily offered for sale in the funds market and the related return is likely to decline. Relatively high borrowing, on the other hand, indicates the relative paucity of reserves for sale, and the funds rate climbs above the bill rate.

^{*35*}According to Boughton (1972, pp. 53-54), the funds rate and bill rate were virtually equal during the 1960's, although there was some variation over the short term.

MRFF.K=TABLE(TMRFF, SBRB.K/BRB.K, 0, 5, 1) 141, A
MRFF - MULTIPLIER FOR RETURN ON FEDERAL FUNDS
(DIMENSIONLESS)
TMRFF - TABLE FOR MULTIPLIER ON RETURN ON FEDERAL
FUNDS (DIMENSIONLESS)
SBRB - STANDARD BORROWED RESERVES OF BANK
(DOLLARS)
BRB - BORROWED RESERVES OF BANK (DOLLARS)

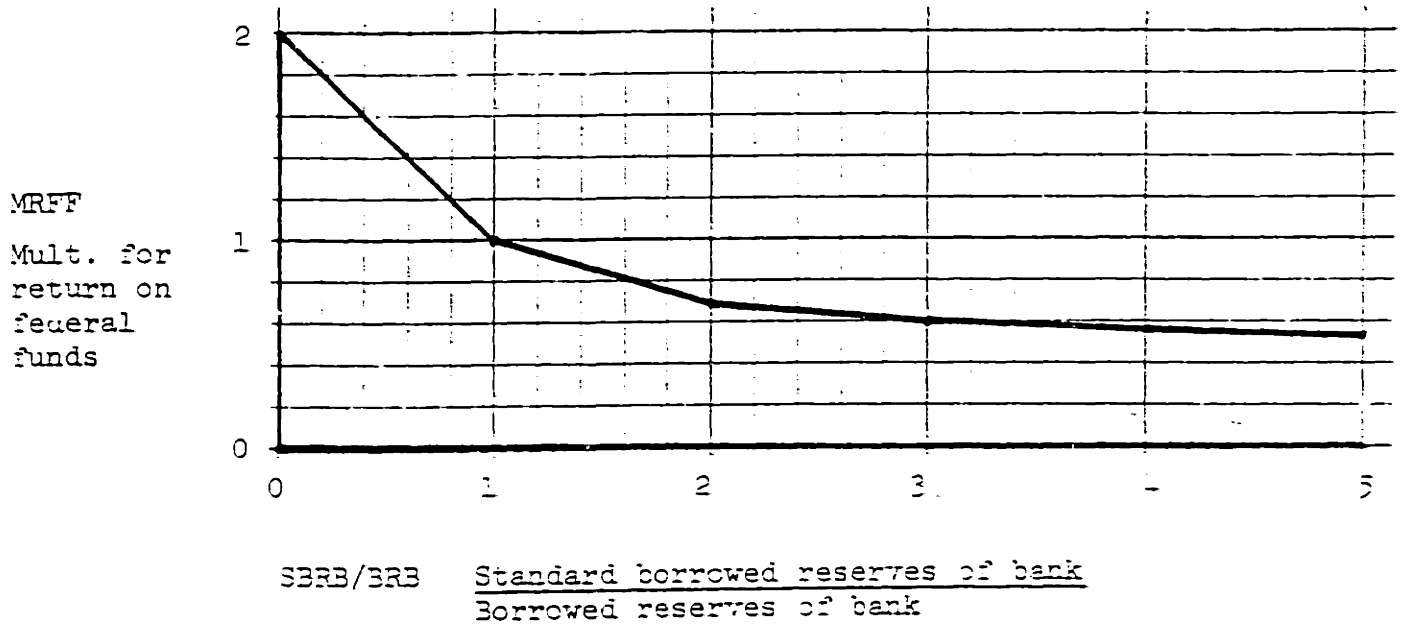
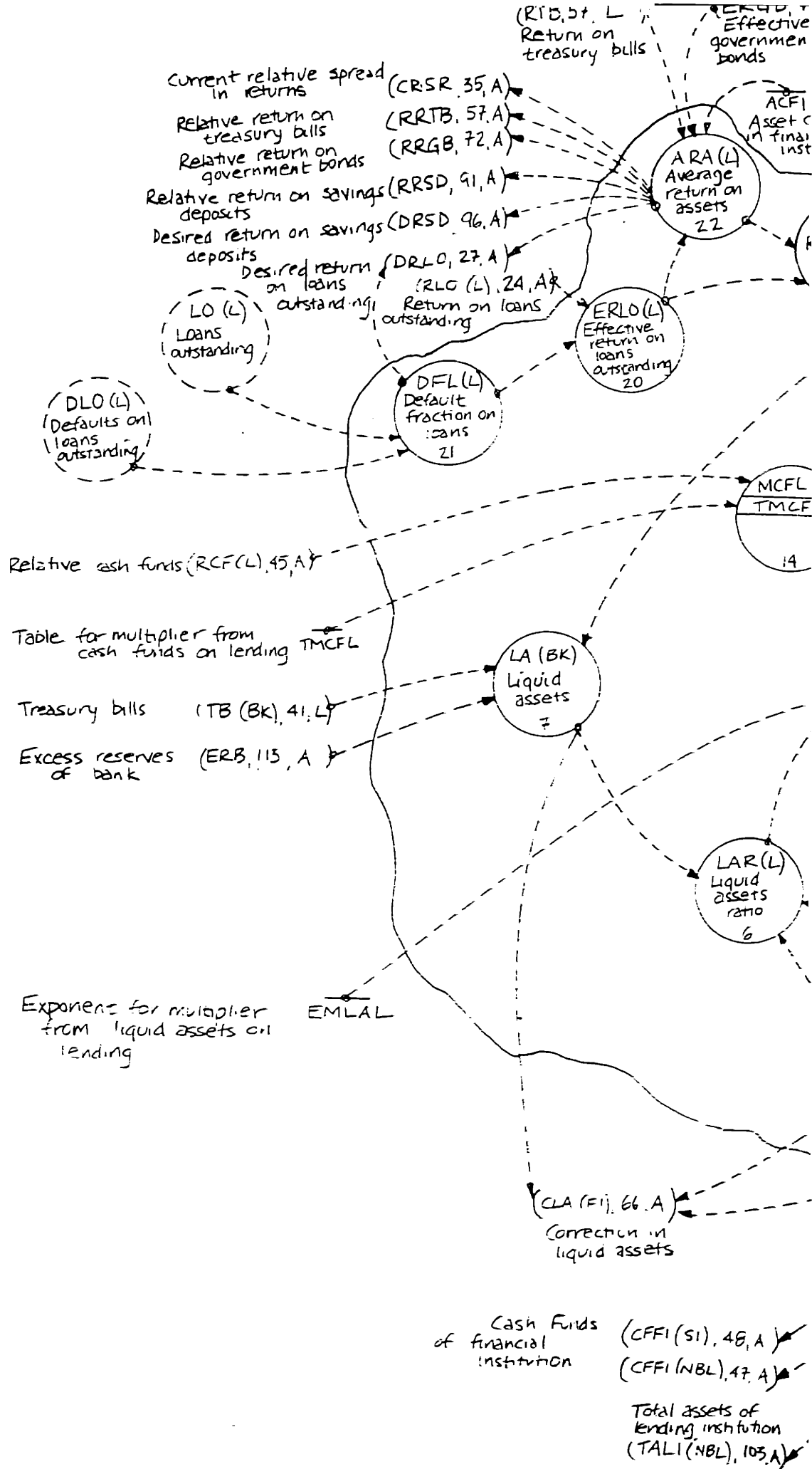
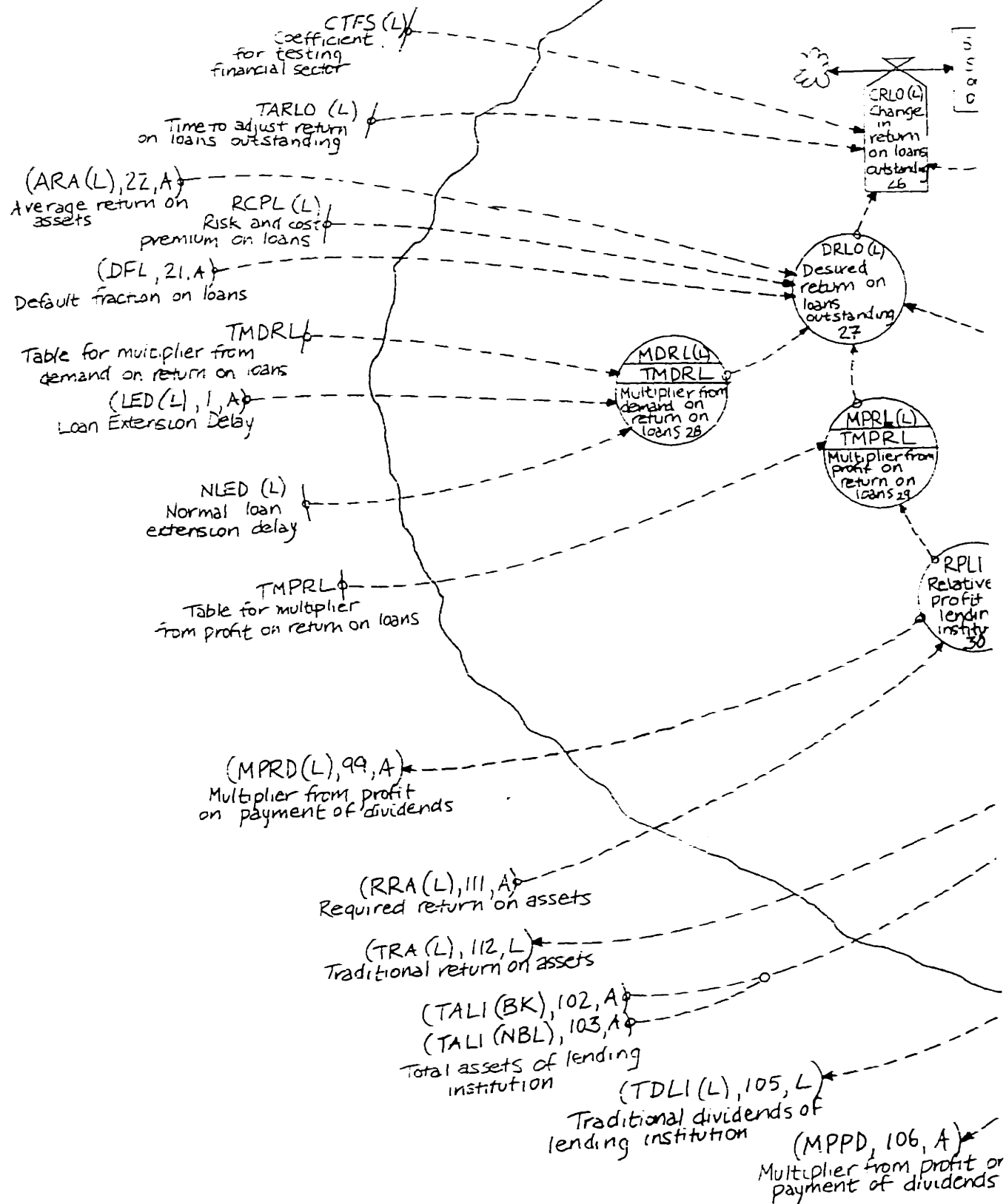


Figure A-20
TABLE FOR MULTIPLIER FOR RETURN ON FEDERAL FUNDS





addition to money in test generator
A MTG

(DSTB,) sector; now in test generator
ALTB

(SD(L), 83, L) Savings deposits

(LA(SI), 67, A) Liquid assets
(LA(NBL), 9, A)

Table for multiplier from cash on treasury bills
TMCTB

(MCFL(L), 14, A) Multiplier from cash funds on lending

(MCOB(FI), 70, A) Multiplier from cash on government bonds

(MCSD(L), 89, A) Multiplier from cash on savings deposits

(MCPD(L), 107, A) Multiplier from cash on payment of dividends

Coefficient for CTRCF(FI) testing relative cash funds

(ERB, 113, A) Excess reserves of bank

(CFRB, 8, A) Conversion factor for reserves of bank

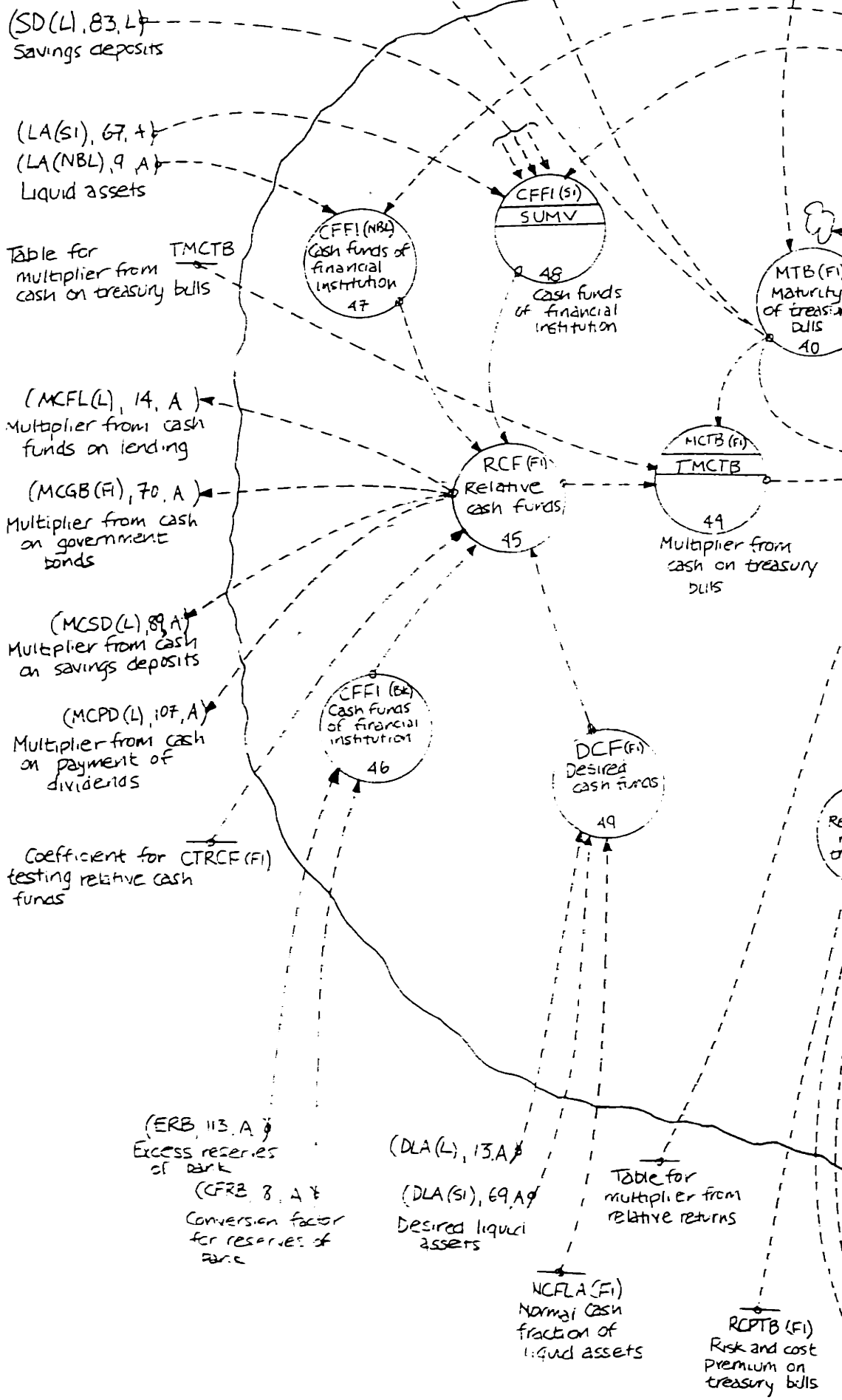
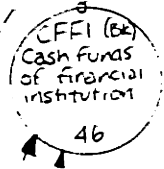
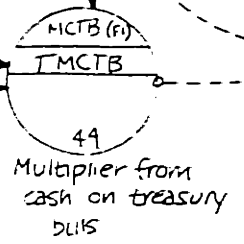
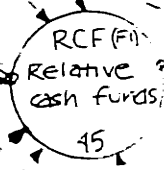
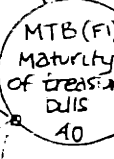
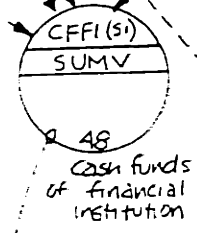
(DLA(L), 13, A)

(DLA(SI), 69, A) Desired liquid assets

Table for multiplier from relative returns

NCFLA(FI) Normal cash fraction of liquid assets

RCPTB(FI) Risk and cost premium on treasury bills



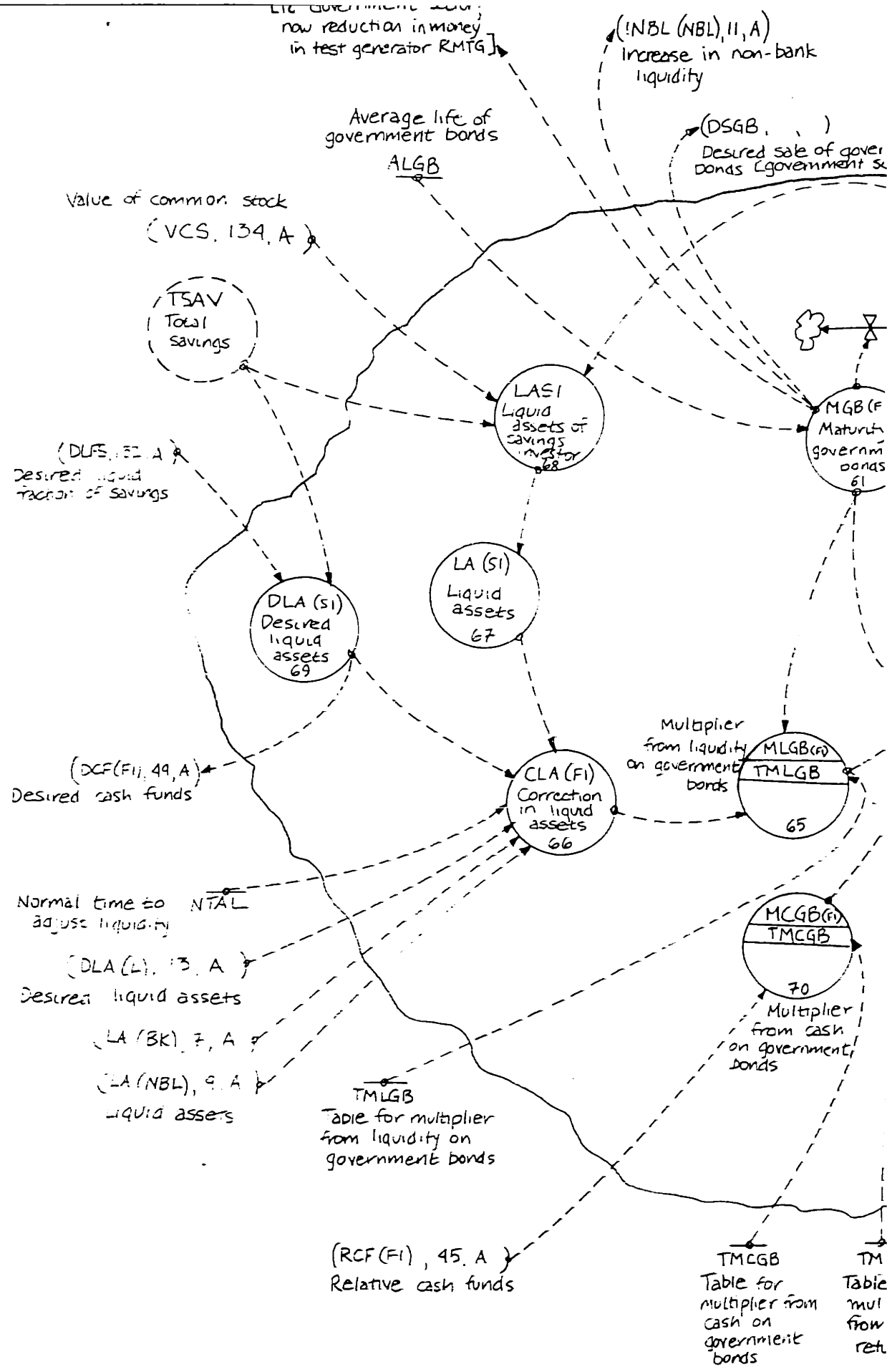


Table for multiplier from returns on savings deposits

TMRSD

Risk and cost premium on savings deposits

RCPSD(L)

(ARA(SI), 133, A)
Average return on assets

(CRSR, 35, A)
Current relative spread in returns

TARSD(L)
Time to adjust return on savings deposits

CTFS(L)
Coefficient for testing financial sector

Change in return on savings deposits

CRSD(L)

SRSD(L)
Standard return on savings deposits 94

ERSD
Effect return savng deas 92

RSD(L) & MIN
Return on savings deposits 93

(ARA(L), 22, A)
Average return on assets

DRSD(L)
Desired return on savings deposits 96

MPRD(L)
TMPRD
99

TMPRD
Table for multiplier from profit on return on deposits

(RPLI(L), 30, A)
Relative profit of lending institution

Multiplier from profit on returns on deposits

ASRA(L)
Acceptable spread in returns on assets 97

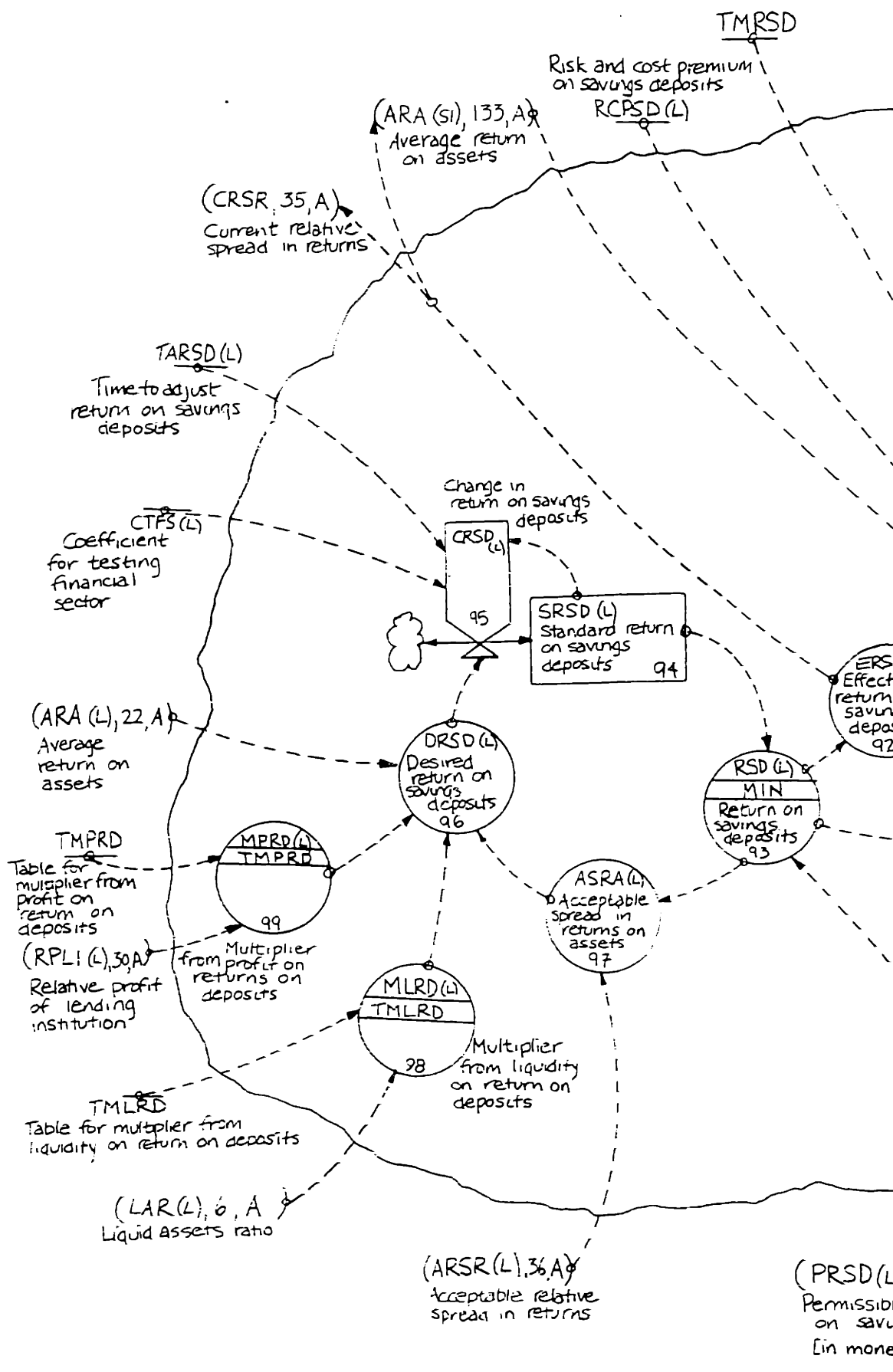
MLRD(L)
TMLRD
98
Multiplier from liquidity on return on deposits

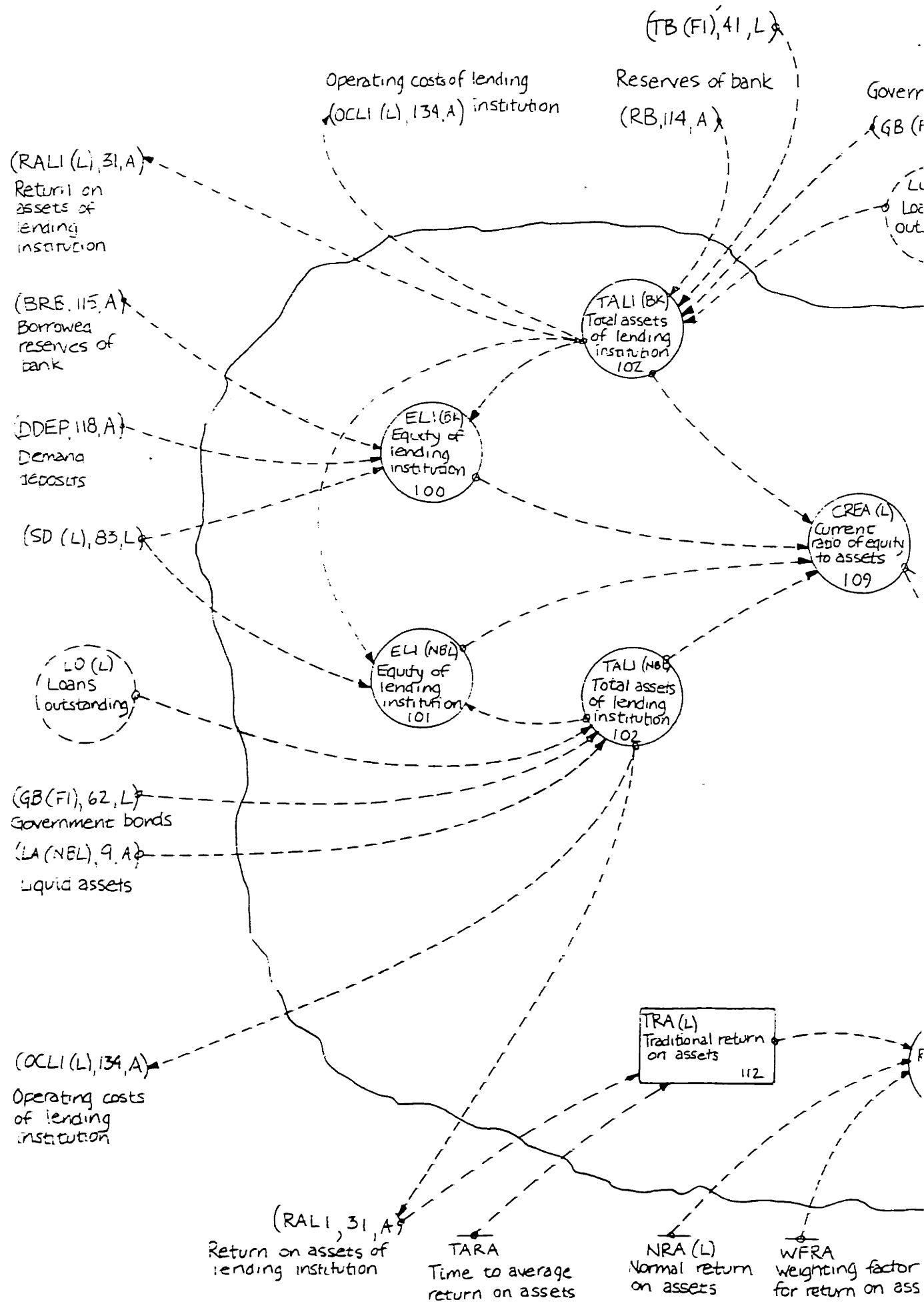
TMLRD
Table for multiplier from liquidity on return on deposits

(LAR(L), 6, A)
Liquid Assets ratio

(ARSR(L), 36, A)
Acceptable relative spread in returns

(PRSD(L)
Permissible on savu
[in mone





Purchase of treasury bills by monetary authority (PTBM)

Purchase of government bonds by monetary authority (PGBM)

Maturity of treasury bills in monetary authority (MTBM)

Maturity of government bonds in monetary authority (MGBM)

Table for multiplier from currency on currency deposits (TMCCD)

Table for multiplier from relative borrowed reserves (TMRBR)

Multiplier on return on federal funds (MRFF, 14, A)

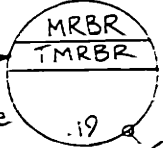
Correction in borrowed funds (CBF(BK), 16, A)

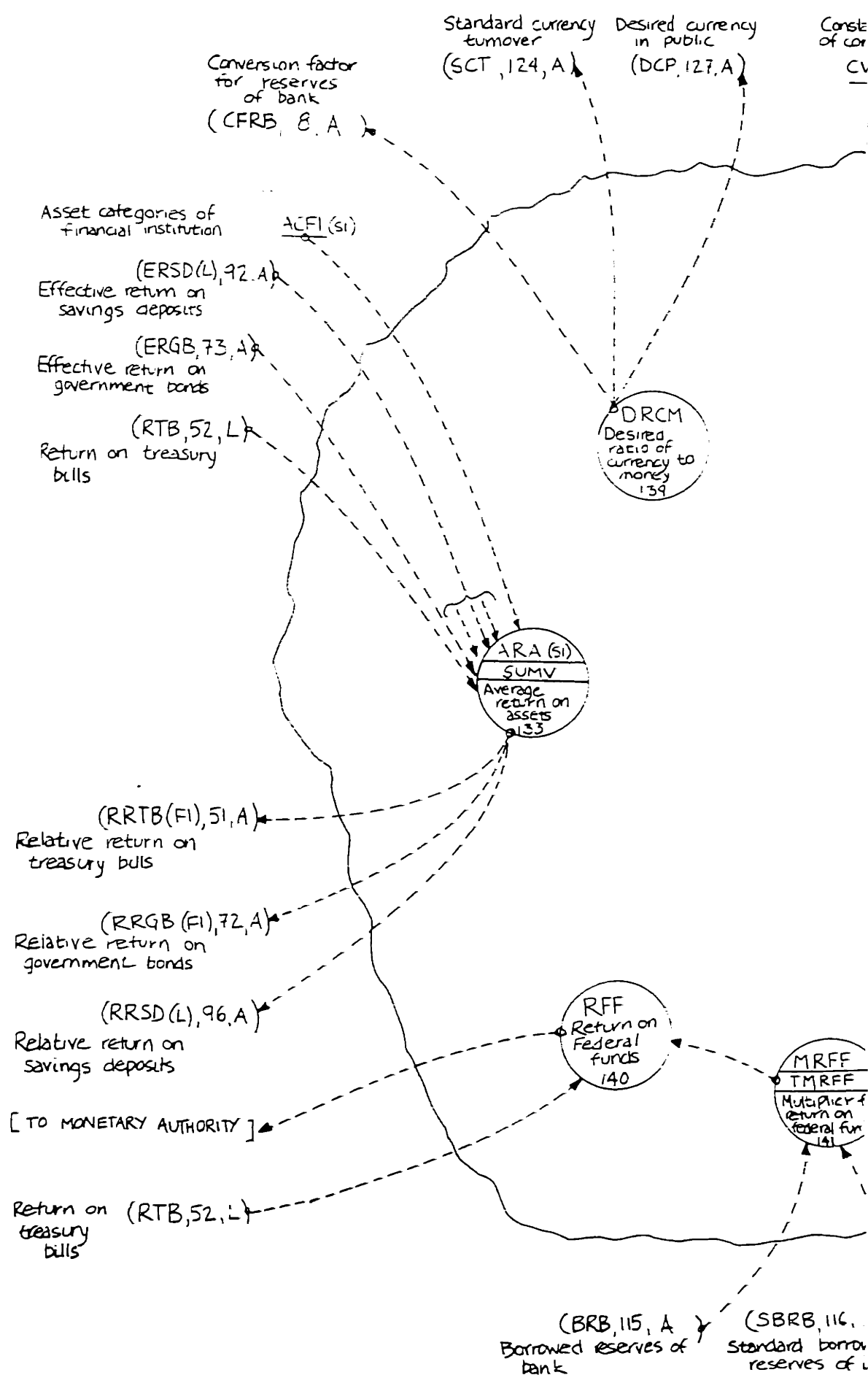
Equity of lending institution (ELI(BK), 100, A)

MR
TMR
Multipl
relati
on wi

ORB
Owned
of bar

Value of open market operations





APPENDIX 2
TEST GENERATORS AND COUPLING EQUATIONS
FOR THE FINANCIAL SECTOR MODEL

This appendix describes a group of equations which, in most cases, will be eliminated once the Financial Sector is incorporated into the rest of the National Model. To test the Financial Sector alone, a set of test and coupling equations is necessary. Appendix 2 describes the test equations, which were discussed in Chapters IV and V, and the coupling equations. Many of the coupling variables (e.g., total money TM) would be retained in any version of the National Model, but the precise specification would vary according to the model configuration.

A. TEST GENERATOR FOR BORROWING SECTORS (F-65, F-66)

This test generator produces the accumulation of loan requests, outstanding loans, a money pool, and a level of total private savings. Together, the equations represent a highly-abbreviated version of the National Model production and household sectors. Therefore, much of the detail that eventually influences the behavior of the Financial Sector is missing. The feedbacks that do occur between the sector and the test generator have already been outlined in Chapter IV.

In Equation 1, the backlog of loans in test generator BLTG, accumulates the difference between loan requests and arrivals for each of the three types of loans. The equation is initialized in equilibrium

to equal loan maturities (loans outstanding / normal payment time) times the normal delivery delay for factor NDDF.

$$\begin{aligned} \text{BLTG.K}(\text{FF}) &= \text{BLTG.J}(\text{FF}) + (\text{DT})(\text{RLTG.J}(\text{FF}) - \text{ALTG.J}(\text{FF})) && 1, L \\ \text{BLTG}(\text{FF}) &= (\text{LOTG}(\text{FF}) / \text{NPTL}(\text{FF})) * \text{NDDF}(\text{FF}) && 1.1, N \end{aligned}$$

BLTG - BACKLOG OF LOANS IN TEST GENERATOR
(DOLLARS)

FF - INDEX FOR FINANCIAL FACTORS

DT - TIME STEP FOR INTEGRATION (YEARS)

RLTG - REQUESTS FOR LOANS IN TEST GENERATOR
(DOLLARS/YEAR)

ALTG - ARRIVAL OF LOANS IN TEST GENERATOR
(DOLLARS/YEAR)

LOTG - LOANS OUTSTANDING IN TEST GENERATOR
(DOLLARS)

NPTL - NORMAL PAYMENT TIME ON LOANS (YEARS)

NDDF - NORMAL DELIVERY DELAY FOR FACTOR (YEARS)

Requests for loans in test generator RLTG is specified in Equation 2 and, in equilibrium, equals maturities. The correction term permits borrowers to adjust loans outstanding and backlogs to their desired levels, as we shall see later. The noise term equals 1 unless noise is introduced for testing purposes.

$$\begin{aligned} \text{RLTG.K}(\text{FF}) &= (\text{MLTG.K}(\text{FF}) + \text{CLBTG.K}(\text{FF})) * \text{NRLTG.K}(\text{FF}) && 2, A \end{aligned}$$

RLTG - REQUESTS FOR LOANS IN TEST GENERATOR
(DOLLARS/YEAR)

FF - INDEX FOR FINANCIAL FACTORS

MLTG - MATURITY OF LOANS IN TEST GENERATOR
(DOLLARS/YEAR)

CLBTG - CORRECTION OF LOANS AND BACKLOG IN TEST
GENERATOR (DOLLARS/YEAR)

NRLTG - NOISE IN REQUEST FOR LOANS IN TEST
GENERATOR (DIMENSIONLESS)

Equation 3 adjusts the difference between desired and actual loans and backlogs over the time to correct loans and backlogs in test generator TCLBTG. By referring to the previous equation, we can see that if desired loans or backlog of loan requests exceed the actual

levels, loan requests increase; while excessive loan or backlog levels serve to reduce requests for credit. The adjustment time (TCLBTG) is 0.75 (years) for Bank loans, and 1.5 years for long-term corporate and mortgage loans. Long-term loans generally require more time for planning and negotiation and, therefore, imply a longer adjustment time. The coefficient for backlog correction in test generator CBCTG permits one to test the impact of the correction in backlog on overall behavior. Here CBCTG = 1.

$$\text{CLBTG.K(FF)} = (\text{DLTG.K(FF)} - \text{LOTG.K(FF)} + \text{CBCTG} * \text{3, A} \\ (\text{DBTG.K(FF)} - \text{BLTG.K(FF)})) / \text{TCLBTG(FF)}$$

CLBTG - CORRECTION OF LOANS AND BACKLOG IN TEST GENERATOR (DOLLARS/YEAR)
FF - INDEX FOR FINANCIAL FACTORS
DLTG - DESIRED LOANS IN TEST GENERATOR (DOLLARS)
LOTG - LOANS OUTSTANDING IN TEST GENERATOR (DOLLARS)
CBCTG - COEFFICIENT FOR BACKLOG CORRECTION IN TEST GENERATOR (DIMENSIONLESS)
DBTG - DESIRED BACKLOG IN TEST GENERATOR (DOLLARS)
BLTG - BACKLOG OF LOANS IN TEST GENERATOR (DOLLARS)
TCLBTG - TIME TO CORRECT LOANS AND BACKLOG IN TEST GENERATOR (YEARS)

Desired loans in test generator DLTG is an important test input for the Financial Sector model. For example, several of the tests described in Chapter IV involve a step in the desired level of loans outstanding, to which the financial institutions adjust by manipulating asset and liability accounts and by modifying interest rates. Constant desired loans in test generator CDLTG is set by an initial value equation to equal the initial level of loans outstanding in test generator LOTG (see the "parameters for test generator" at the end of

this appendix.

Various types of functions used in testing system dynamics models are described elsewhere (Pugh 1976). In the case of a step input, the first term in parentheses is the amount of the step, while the second term indicates when the step will occur. The second test input permits a sine wave in desired loans, with a specified amplitude of sine wave AMPSW and period of sine wave PERSW. The switch in Equation 4 (SWTS) permits one to run the step or sine-wave inputs or, when SWTS = 0, to activate the time series inputs described in Chapter V.

$$DLTG.K(FF) = SWTS * (CDLTG(FF) + STEP(SDLTG(FF), TSDL) + \frac{AMPSW(FF)}{PERSW} * SIN(6.283 * TIME.K / PERSW)) + (1 - SWTS) * XDLTG.K(FF)$$

DLTG - DESIRED LOANS IN TEST GENERATOR (DOLLARS)
FF - INDEX FOR FINANCIAL FACTORS
SWTS - SWITCH FOR TIME SERIES (DIMENSIONLESS)
CDLTG - CONSTANT DESIRED LOANS IN TEST GENERATOR (DOLLARS)
STEP - FUNCTION TO GENERATE STEP INPUT
SDLTG - STEP IN DESIRED LOANS IN TEST GENERATOR (DOLLARS)
TSDL - TIME TO STEP DESIRED LOANS (TIME)
AMPSW - AMPLITUDE OF SINE WAVE (DOLLARS)
SIN - FUNCTION TO GENERATE SINE WAVE INPUT
PERSW - PERIOD OF SINE WAVE (YEARS)
XDLTG - EXOGENOUS DESIRED LOANS IN TEST GENERATOR (DOLLARS)

The use of desired and actual backlogs in the correction of loans and backlog in test generator CLBTG (defined previously) implies that potential borrowers, when requesting credit, are aware of the credit negotiations and plans currently in progress. As a reference for assessing the importance of the current backlog of loan requests,

desired backlog in test generator DBTG is shown in Equation 5 as maturities times the normal delivery delay for factor NDDF. By an initial value equation in the parameter dataset, NDDF is set equal to the normal loan extension delay NLED. The equation for desired backlog, therefore, signifies that one normally wants to maintain a "backlog" that is proportional to replacement needs. In the more detailed ordering equations of the standard production sector, of course, the formulation of desired backlog is more complicated.

$$DBTG.K(FF) = NDDF(FF) * MLTG.K(FF) \quad 5, A$$

DBTG - DESIRED BACKLOG IN TEST GENERATOR (DOLLARS)
FF - INDEX FOR FINANCIAL FACTORS
NDDF - NORMAL DELIVERY DELAY FOR FACTOR (YEARS)
MLTG - MATURITY OF LOANS IN TEST GENERATOR
(DOLLARS/YEAR)

Noise in request for loans in test generator NRLTG, which influences loan requests, is defined in Equation 6. The mean of noise in test generator MNTG = 0. The standard deviation can be set to permit a noise input (e.g., 0.05 for a 5% standard deviation in loan requests). The time constant for noise in test generator TCNTG specifies the time constant used in the "pink noise" PKNS "macro" which actually generates the noise input.*1*

*1*The "pink noise" macro is used elsewhere in testing various sectors of the National Model and is described in Britting (1975). The equations appear in the complete program listing for the Financial Sector and related formations, which appears in Appendix 3.

$$\text{NRLTG.K}(\text{FF}) = 1 + \text{PKNS}(\text{MNTG}, \text{SDNTG}(\text{FF}), \text{TCNTG}) \quad 6, \text{ A}$$

NRLTG - NOISE IN REQUEST FOR LOANS IN TEST
GENERATOR (DIMENSIONLESS)
FF - INDEX FOR FINANCIAL FACTORS
PKNS - FUNCTION TO GENERATE PINK NOISE
MNTG - MEAN OF NOISE IN TEST GENERATOR
(DIMENSIONLESS)
SDNTG - STANDARD DEVIATION OF NOISE IN TEST
GENERATOR (DIMENSIONLESS)
TCNTG - TIME CONSTANT OF NOISE IN TEST GENERATOR
(YEARS)

Arrivals of loans in test generator ALTG is defined by Equation 7 as the backlog divided by the delivery delay for factor DDF. Like the standard production sector's use of delivery delay (see Forrester et al. 1975, pp. 24-28), the formulation for loan arrivals serves to allocate actual loan extensions in accordance with each sector's portion of the total backlog of loan requests.

$$\text{ALTG.K}(\text{FF}) = \text{BLTG.K}(\text{FF}) / \text{DDF.K}(\text{FF}) \quad 7, \text{ A}$$

ALTG - ARRIVAL OF LOANS IN TEST GENERATOR
(DOLLARS/YEAR)
FF - INDEX FOR FINANCIAL FACTORS
BLTG - BACKLOG OF LOANS IN TEST GENERATOR
(DOLLARS)
DDF - DELIVERY DELAY FOR FACTOR (YEARS)

The maturity of loans in test generator MLTG is based in Equation 8 on a constant normal payment time on loans NPTL. The normal payment time on loans NPTL equals 1 year for Bank loans, 7 years for loans of the Corporate Lender, and 12 years for residential mortgage credit.

$$\text{MLTG.K}(\text{FF}) = \text{LOTG.K}(\text{FF}) / \text{NPTL}(\text{FF}) \quad 8, \text{ A}$$

MLTG - MATURITY OF LOANS IN TEST GENERATOR
(DOLLARS/YEAR)

FF - INDEX FOR FINANCIAL FACTORS

LOTG - LOANS OUTSTANDING IN TEST GENERATOR
(DOLLARS)

NPTL - NORMAL PAYMENT TIME ON LOANS (YEARS)

Equation 9 accumulates arrivals of loans less repayments in a level of loans outstanding in test generator LOTG. The initial values are consistent with a system equilibrium and equal 148.5E9 for Bank loans, 100E9 for Corporate Lender credits, and 150E9 for mortgages.

$$\text{LOTG.K}(\text{FF}) = \text{LOTG.J}(\text{FF}) + (\text{DT})(\text{ALTG.J}(\text{FF}) - \text{RLOTG.J}(\text{FF}) - \text{DTG.J}(\text{FF})) \quad 9, \text{ L}$$
$$\text{LOTG}(\text{FF}) = \text{ILOTG}(\text{FF}) \quad 9.1, \text{ N}$$

LOTG - LOANS OUTSTANDING IN TEST GENERATOR
(DOLLARS)

FF - INDEX FOR FINANCIAL FACTORS

DT - TIME STEP FOR INTEGRATION (YEARS)

ALTG - ARRIVAL OF LOANS IN TEST GENERATOR
(DOLLARS/YEAR)

RLOTG - REPAYMENT OF LOANS OUTSTANDING IN TEST
GENERATOR (DOLLARS/YEAR)

DTG - DEFAULTS IN TEST GENERATOR (DOLLARS/YEAR)

ILOTG - INITIAL LOANS OUTSTANDING IN TEST GENERATOR
(DOLLARS)

Equation 10 denotes the repayment of loans outstanding in test generator RLOTG as maturities minus defaults.

$$\text{RLOTG.K}(\text{FF}) = \text{MLTG.K}(\text{FF}) - \text{DTG.K}(\text{FF}) \quad 10, \text{ A}$$

RLOTG - REPAYMENT OF LOANS OUTSTANDING IN TEST
GENERATOR (DOLLARS/YEAR)

FF - INDEX FOR FINANCIAL FACTORS

MLTG - MATURITY OF LOANS IN TEST GENERATOR
(DOLLARS/YEAR)

DTG - DEFAULTS IN TEST GENERATOR (DOLLARS/YEAR)

In Equation 11 defaults in test generator DTG are generated by applying the default fraction on accounts DFA to outstanding loans.

$$\text{DTG.K}(\text{FF}) = \text{LOTG.K}(\text{FF}) * \text{DFA.K}(\text{FF}) \quad 11, \text{ A}$$

DTG - DEFAULTS IN TEST GENERATOR (DOLLARS/YEAR)
FF - INDEX FOR FINANCIAL FACTORS
LOTG - LOANS OUTSTANDING IN TEST GENERATOR (DOLLARS)
DFA - DEFAULT FRACTION ON ACCOUNTS (FRACTION/YEAR)

The default fraction in Equation 12 simply equals a constant normal fraction (NDFAN = 0.01).

$$\text{DFA.K}(\text{FF}) = \text{NDFAN} \quad 12, \text{ A}$$

DFA - DEFAULT FRACTION ON ACCOUNTS (FRACTION/YEAR)
FF - INDEX FOR FINANCIAL FACTORS
NDFAN - NORMAL DEFAULT FRACTION ON ACCOUNTS IN NATION (FRACTION/YEAR)

In Equation 13, money in test generator MTG is a level that accumulates all of the money flows to and from the Financial Sector. This pool includes, therefore, the money of both private borrowers (eventually the production and household sectors) and public borrowers (the government sector). Initially, MTG equals 187.09E9.

$$\text{MTG.K} = \text{MTG.J} + (\text{DT})(\text{AMTG.J} - \text{RMTG.J}) \quad 13, \text{ L}$$

MTG-IMTG 13.1, N

MTG - MONEY IN TEST GENERATOR (DOLLARS)
DT - TIME STEP FOR INTEGRATION (YEARS)
AMTG - ADDITION TO MONEY IN TEST GENERATOR (DOLLARS/YEAR)
RMTG - REDUCTION IN MONEY IN TEST GENERATOR (DOLLARS/YEAR)
IMTG - INITIAL MONEY IN TEST GENERATOR (DOLLARS)

Equation 14 gathers all of the monetary flows from the Financial Sector to the rest of the economy in one variable, addition to money in test generator AMTG. This variable includes the arrival of loans in private sectors, the equivalent for the government sector (i.e., the purchase of bills and bonds by banks, fiduciaries, and the Monetary Authority), the payment of operating costs and taxes by the lending institutions, and the reduction in savings RSAV (effectively the withdrawal of private savings from the Financial Sector).

$$\text{AMTG.K} = \text{SUMV}(\text{ALTG.K}, 1, \text{TFF}) + \text{SUMV}(\text{PTB.K}, 1, \text{TFI}) + \text{PTBM.K} + 14, \text{A} \\ \text{SUMV}(\text{PGB.K}, 1, \text{TFI}) + \text{PGBM.K} + \text{SUMV}(\text{OCLI.K}, 1, \text{TL}) + \\ \text{RSAV.K} + \text{SUMV}(\text{TLI.K}, 1, \text{TL})$$

AMTG - ADDITION TO MONEY IN TEST GENERATOR
(DOLLARS/YEAR)
SUMV - FUNCTION FOR SUM OF VECTORS
ALTG - ARRIVAL OF LOANS IN TEST GENERATOR
(DOLLARS/YEAR)
TFF - TOTAL FINANCIAL FACTORS
PTB - PURCHASE OF TREASURY BILLS (DOLLARS/YEAR)
TFI - TOTAL FINANCIAL INSTITUTIONS
PTBM - PURCHASE OF TREASURY BILLS BY MONETARY
AUTHORITY (DOLLARS/YEAR)
PGB - PURCHASE OF GOVERNMENT BONDS (DOLLARS/YEAR)
PGBM - PURCHASE OF GOVERNMENT BONDS BY MONETARY
AUTHORITY (DOLLARS/YEAR)
OCLI - OPERATING COSTS OF LENDING INSTITUTION
(DOLLARS/YEAR)
TL - TOTAL LENDERS
RSAV - REDUCTION IN SAVINGS (DOLLARS/YEAR)
TLI - TAX ON LENDING INSTITUTION (DOLLARS/YEAR)

Equation 15 sums all the monetary flows from the test generator to the Financial Sector (and Monetary Authority). These flows include maturities of loans, bills, and bonds, as well as interest payments on all three types of debt, and the increase in savings ISAV, minus defaults. Note that the Treasury does not make interest payments

on securities held by the Monetary Authority, which is consistent with the Federal Reserve's usual practice of reimbursing the Treasury for its interest payments.

$$\begin{aligned} \text{RMTG.K} = & \text{SUMV}(\text{MLTG.K}, 1, \text{TFF}) + \text{SUMV}(\text{MTB.K}, 1, \text{TFI}) + \text{MTBM.K} + 15, \text{ A} \\ & \text{SUMV}(\text{MGB.K}, 1, \text{TFI}) + \text{MGBM.K} + \text{ISAV.K} + \text{SUMV}(\text{RITB.K}, 1, \\ & \text{TFI}) + \text{SUMV}(\text{RIGB.K}, 1, \text{TFI}) + \text{SUMV}(\text{PITG.K}, 1, \text{TFF}) - \\ & \text{SUMV}(\text{DTG.K}, 1, \text{TFF}) \end{aligned}$$

- RMTG - REDUCTION IN MONEY IN TEST GENERATOR (DOLLARS/YEAR)
- SUMV - FUNCTION FOR SUM OF VECTORS
- MLTG - MATURITY OF LOANS IN TEST GENERATOR (DOLLARS/YEAR)
- TFF - TOTAL FINANCIAL FACTORS
- MTB - MATURITY OF TREASURY BILLS (DOLLARS/YEAR)
- TFI - TOTAL FINANCIAL INSTITUTIONS
- MTBM - MATURITY OF TREASURY BILLS IN MONETARY AUTHORITY (DOLLARS/YEAR)
- MGB - MATURITY OF GOVERNMENT BONDS (DOLLARS/YEAR)
- MGBM - MATURITY OF GOVERNMENT BONDS IN MONETARY AUTHORITY (DOLLARS/YEAR)
- ISAV - INCREASE IN SAVINGS (DOLLARS/YEAR)
- RITB - RECEIPT OF INTEREST ON TREASURY BILLS (DOLLARS/YEAR)
- RIGB - RECEIPT OF INTEREST ON GOVERNMENT BONDS (DOLLARS/YEAR)
- PITG - PAYMENT OF INTEREST IN TEST GENERATOR (DOLLARS/YEAR)
- DTG - DEFAULTS IN TEST GENERATOR (DOLLARS/YEAR)

To derive payment of interest in test generator, Equation 16 applies the relevant interest rate realized in loans, which reflects rates that prevailed in the past.

$$\text{PITG.K}(\text{FF}) = \text{LOTG.K}(\text{FF}) * \text{IRRL.K}(\text{FF}) \quad 16, \text{ A}$$

- PITG - PAYMENT OF INTEREST IN TEST GENERATOR (DOLLARS/YEAR)
- FF - INDEX FOR FINANCIAL FACTORS
- LOTG - LOANS OUTSTANDING IN TEST GENERATOR (DOLLARS)
- IRRL - INTEREST RATE FOR REPAYMENT OF LOANS (FRACTION/YEAR)

The fourth accumulation in the test generator is defined in Equation 17 as savings SAV. Eventually, each production and household sector will have a similar account, which accumulates the net of each sector's increase in savings ISAV, accrued earnings on savings ESAV (defined later), and the reduction in savings RSAV. The level of private savings is initialized to equal the total assets of the Savings Investor. As the three equations that influence savings also simultaneously affect the assets of the Savings Investor, the level of total savings TSAV (defined in a coupling equation) always equals the sum of the Savings Investor's assets.

$$\begin{aligned} \text{SAV.K} &= \text{SAV.J} + (\text{DT})(\text{ISAV.J} + \text{ESAV.J} - \text{RSAV.J}) && 17, L \\ \text{SAV} &= \text{ILASI} + \text{GB}(\text{SI}) + \text{VCS} && 17.1, N \\ \text{SAV} & - \text{SAVINGS (DOLLARS)} \\ \text{DT} & - \text{TIME STEP FOR INTEGRATION (YEARS)} \\ \text{ISAV} & - \text{INCREASE IN SAVINGS (DOLLARS/YEAR)} \\ \text{ESAV} & - \text{EARNINGS ON SAVINGS (DOLLARS/YEAR)} \\ \text{RSAV} & - \text{REDUCTION IN SAVINGS (DOLLARS/YEAR)} \\ \text{ILASI} & - \text{INITIAL LIQUID ASSETS OF SAVINGS INVESTOR} \\ & \quad \text{(DOLLARS)} \\ \text{GB} & - \text{GOVERNMENT BONDS (DOLLARS)} \\ \text{SI} & - \text{INDEX FOR SAVINGS INVESTOR} \\ \text{VCS} & - \text{VALUE OF COMMON STOCK (DOLLARS)} \end{aligned}$$

Increase in savings ISAV (Equation 18) is another variable test input that can be set to zero (when the coefficient for increase in savings CISAV equals zero), adjusts savings to a desired level (when CISAV equals one), or reflects turnover and growth in savings. For the tests in Chapter IV, CISAV = NTSAV = NGSAV = 0. That is, ISAV equals zero and savings SAV remain constant. For the tests described in Chapter V, however, aggregate savings are assumed to turn over at an average normal turnover fraction (NTSAV) of 0.3 per year and to grow

through the input of new savings at a rate of 2.5% per year (NGSAV = 0.025). The multiplier from return on savings MRSAV influences the savings flow and reflects the relationship between returns generated by the model and actual returns from the data. This multiplier will be explained more fully below.

$$\text{ISAV.K} = \text{CISAV} * (\text{DSAV.K} - \text{SAV.K}) / \text{TASAV} + \text{SAV.K} * (\text{NTSAV} + \text{NGSAV}) * \text{MRSAV.K} \quad 18, A$$

ISAV - INCREASE IN SAVINGS (DOLLARS/YEAR)
CISAV - COEFFICIENT FOR INCREASE IN SAVINGS (DIMENSIONLESS)
DSAV - DESIRED SAVINGS (DOLLARS)
SAV - SAVINGS (DOLLARS)
TASAV - TIME TO ADJUST SAVINGS (YEARS)
NTSAV - NORMAL TURNOVER IN SAVINGS (FRACTION/YEAR)
NGSAV - NORMAL GROWTH IN SAVINGS (FRACTION/YEAR)
MRSAV - MULTIPLIER FROM RETURNS ON SAVINGS (DIMENSIONLESS)

Equation 19 defines desired savings DSAV as a constant value plus a possible step. When a non-zero step is used, a discrepancy between desired and actual savings causes a positive, or negative "increase" in savings ISAV. (When the coefficient shown in the previous equation, CISAV, equals one).

$$\text{DSAV.K} = \text{CDSAV} * \text{NDSAV.K} + \text{STEP}(\text{SDSAV}, \text{TSDSAV}) \quad 19, A$$

DSAV - DESIRED SAVINGS (DOLLARS)
CDSAV - CONSTANT DESIRED SAVINGS (DOLLARS)
NDSAV - NOISE IN DESIRED SAVINGS (DIMENSIONLESS)
STEP - FUNCTION TO GENERATE STEP INPUT
SDSAV - STEP IN DESIRED SAVINGS (DOLLARS)
TSDSAV - TIME TO STEP DESIRED SAVINGS (TIME)

Equation 20 permits one to test of system in response to noise in desired savings NDSAV. The mean and standard deviation equal zero unless otherwise stated.

$NDSAV.K=1+PKNS(MNDS,SDNDS,TNDS)$ 20, A
NDSAV - NOISE IN DESIRED SAVINGS (DIMENSIONLESS)
PKNS - FUNCTION TO GENERATE PINK NOISE
MNDS - MEAN OF NOISE IN DESIRED SAVINGS
(DIMENSIONLESS)
SDNDS - STANDARD DEVIATION OF NOISE IN DESIRED
SAVINGS (DIMENSIONLESS)
TNDS - TIME FOR NOISE IN DESIRED SAVINGS (YEARS)

The multiplier from return on savings MRS_{AV} was described in Chapter V and is specified in Equation 21. When the coefficient (CMRS_{AV}) equals zero, the multiplier equals one. But when CMRS_{AV} equals a positive value, the multiplier causes savings to grow (decline) when the index of returns from the model IRMOD exceeds (is less than) the index of returns from data IRDAT. The rationale behind this effective feedback from the model to the test generator, used in performing time-series tests, was provided in Chapter V.

$MRS_{AV}.K=1+(IRMOD.K/IRDAT.K-1)*CMRS_{AV}$ 21, A
MRS_{AV} - MULTIPLIER FROM RETURNS ON SAVING
(DIMENSIONLESS)
IRMOD - INDEX OF RETURNS FROM MODEL (FRACTION/YEAR)
IRDAT - INDEX OF RETURNS FROM DATA (FRACTION/YEAR)
CMRS_{AV} - COEFFICIENT FOR MULTIPLIER FROM RETURNS ON
SAVINGS (DIMENSIONLESS)

As an input to the previous multiplier, the index of return from the model IRMOD is a simple arithmetic average of the five primary interest rates generated in the Financial Sector.

$IRMOD.K=(SUMV(RLO.K,1,TL)+RTB.K+RGB.K)/5$ 22, A
IRMOD - INDEX OF RETURNS FROM MODEL (FRACTION/YEAR)
SUMV - FUNCTION FOR SUM OF VECTORS
RLO - RETURN ON LOANS OUTSTANDING (FRACTION/YEAR)
TL - TOTAL LENDERS
RTB - RETURN ON TREASURY BILLS (FRACTION/YEAR)
RGB - RETURN ON GOVERNMENT BONDS (FRACTION/YEAR)

The index of returns from the model is compared with its counterpart from reality, an index of returns from data IRDAT, calculated by Equation 23.

$$\text{IRDAT.K} = (\text{YTB.K} + \text{YGB.K} + \text{YBC.K} + \text{YCB.K} + \text{YMCH.K}) / 5 \quad 23, A$$

IRDAT - INDEX OF RETURNS FROM DATA (FRACTION/YEAR)
YTB - YIELD ON TREASURY BILLS (FRACTION/YEAR)
YGB - YIELD ON GOVERNMENT BONDS (FRACTION/YEAR)
YBC - YIELD ON BANK CREDIT (FRACTION/YEAR)
YCB - YIELD ON CORPORATE BONDS (FRACTION/YEAR)
YMCH - YIELD ON MORTGAGE CREDIT TO HOUSEHOLDS (FRACTION/YEAR)

Equation 24 expresses the reduction in savings R_{SAV} as earnings on savings E_{SAV} plus the normal (fractional) turnover in savings N_{TSAV} (when SWTS = 1). For the tests conducted in Chapter IV, the switch for time-series SWTS equals one and signifies that earnings received by the Savings Investor (acting on behalf of private savers) are simultaneously withdrawn from the Financial Sector. Also, N_{TSAV} = 0. For the time-series tests in Chapter V, savings are allowed to accrue in private savings, thereby providing additional growth in the Financial Sector; and N_{TSAV} = 0.3.

$$\text{RSAV.K} = \text{SWTS} * \text{ESAV.K} + \text{SAV.K} * \text{NTSAV} \quad 24, A$$

RSAV - REDUCTION IN SAVINGS (DOLLARS/YEAR)
SWTS - SWITCH FOR TIME SERIES (DIMENSIONLESS)
ESAV - EARNINGS ON SAVINGS (DOLLARS/YEAR)
SAV - SAVINGS (DOLLARS)
NTSAV - NORMAL TURNOVER IN SAVINGS (FRACTION/YEAR)

Earnings on savings E_{SAV} will appear in every production and household sector and represents each sector's claim to earnings of the Savings Investor. Equation 25 generates this flow of earnings by

applying the weighted return on savings WRS to the level of savings SAV.

ESAV.K=WRS.K*SAV.K 25, A
ESAV - EARNINGS ON SAVINGS (DOLLARS/YEAR)
WRS - WEIGHTED RETURN ON SAVINGS (FRACTION/YEAR)
SAV - SAVINGS (DOLLARS)

B. TEST GENERATOR FOR MONETARY AUTHORITY AND TREASURY (F-67)

This set of equations generates the desired and actual security transactions of the Treasury and the Monetary Authority. Equation 26 permits the Monetary Authority to purchase whatever Treasury bills it would like. That is, the purchase rate always equals the desired amount, and is not affected (as are other participants in the market) by the multiplier on purchase of Treasury bills MPTG described in Appendix 1. This deviation from the usual allocation scheme outlined previously permits a more straightforward analysis of test results in Chapter IV.*2*

PTEM.K=DPTBM.K 26, A
PTBM - PURCHASE OF TREASURY BILLS BY MONETARY
AUTHORITY (DOLLARS/YEAR)
DPTBM - DESIRED PURCHASE OF TREASURY BILLS BY
MONETARY AUTHORITY (DOLLARS/YEAR)

*2*Subjecting the monetary authority to the usual allocation mechanism (where desired and actual security purchases are not always in balance) produces small changes in owned reserves of Bank ORB due to "unintended" security transactions of the Monetary Authority (through the value of open-market operations VOMO). The resulting difference in behavior is minimal but shows slightly modified numerical results whose explanation seems more confusing than is warranted.

Desired purchase of Treasury bills by Monetary Authority DPTBM equals maturities plus a correction term. In equilibrium, the correction term in Equation 27 equals zero and desired purchases just replace those bills that mature.

$$\text{DPTBM.K} = \text{MTBM.K} + \text{CTBM.K} \quad 27, \text{ A}$$

DPTBM - DESIRED PURCHASE OF TREASURY BILLS BY MONETARY AUTHORITY (DOLLARS/YEAR)
MTBM - MATURITY OF TREASURY BILLS IN MONETARY AUTHORITY (DOLLARS/YEAR)
CTBM - CORRECTION OF TREASURY BILLS IN MONETARY AUTHORITY (DOLLARS/YEAR)

Maturities, in Equation 28, equal the stock of bills in the Monetary Authority divided by the average life of Treasury bills ALTB (= 0.5 years).

$$\text{MTBM.K} = \text{TBM.K} / \text{ALTB} \quad 28, \text{ A}$$

MTBM - MATURITY OF TREASURY BILLS IN MONETARY AUTHORITY (DOLLARS/YEAR)
TBM - TREASURY BILLS IN MONETARY AUTHORITY (DOLLARS)
ALTB - AVERAGE LIFE OF TREASURY BILLS (YEARS)

Equation 29 accumulates the Monetary Authority's net bill purchases in a level of Treasury bills in Monetary Authority TBM.

$$\text{TBM.K} = \text{TBM.J} + (\text{DT})(\text{PTBM.J} - \text{MTBM.J}) \quad 29, \text{ L}$$
$$\text{TBM} = \text{ITBM} \quad 29.1, \text{ N}$$

TBM - TREASURY BILLS IN MONETARY AUTHORITY (DOLLARS)
DT - TIME STEP FOR INTEGRATION (YEARS)
PTBM - PURCHASE OF TREASURY BILLS BY MONETARY AUTHORITY (DOLLARS/YEAR)
MTBM - MATURITY OF TREASURY BILLS IN MONETARY AUTHORITY (DOLLARS/YEAR)
ITBM - INITIAL TREASURY BILLS IN MONETARY AUTHORITY (DOLLARS)

The correction term for bills is expressed in Equation 30 as the discrepancy between desired and actual Treasury bills in Monetary Authority, divided by the time to correct Treasury bills of Monetary Authority TCTBM (= 0.5).

$$CTBM.K = (DTBM.K - TBM.K) / TCTBM \quad 30, A$$

CTBM - CORRECTION OF TREASURY BILLS IN MONETARY AUTHORITY (DOLLARS/YEAR)
DTBM - DESIRED TREASURY BILLS IN MONETARY AUTHORITY (DOLLARS)
TBM - TREASURY BILLS IN MONETARY AUTHORITY (DOLLARS)
TCTBM - TIME TO CORRECT TREASURY BILLS IN MONETARY AUTHORITY (YEARS)

In Equation 31, desired Treasury bills in Monetary Authority DTBM equals a constant (CDTBM) when the switch equals one, or an exogenous time-series variable when the switch equals zero. For testing purposes, the desired amount can be stepped up or down to reflect an intended change in open-market operations.

$$DTBM.K = SWTS * CDTBM + (1 - SWTS) * XDTBM.K + STEP(SDTBM, TSDTBM) \quad 31, A$$

DTBM - DESIRED TREASURY BILLS IN MONETARY AUTHORITY (DOLLARS)
SWTS - SWITCH FOR TIME SERIES (DIMENSIONLESS)
CDTBM - CONSTANT DESIRED TREASURY BILLS IN MONETARY AUTHORITY (DOLLARS)
XDTBM - EXOGENOUS DESIRED TREASURY BILLS IN MONETARY AUTHORITY (DOLLARS)
STEP - FUNCTION TO GENERATE STEP INPUT
SDTBM - STEP IN DESIRED TREASURY BILLS IN MONETARY AUTHORITY (DOLLARS)
TSDTBM - TIME TO STEP DESIRED TREASURY BILLS IN MONETARY AUTHORITY (YEARS)

The next six equations determine the Monetary Authority's purchase of government bonds and follow the same pattern as Treasury bills. Purchases in Equation 32 equal the desired amount.

$$\text{PGBM.K} = \text{DPGBM.K} \quad 32, \text{ A}$$

PGBM - PURCHASE OF GOVERNMENT BONDS BY MONETARY AUTHORITY (DOLLARS/YEAR)
DPGBM - DESIRED PURCHASE OF GOVERNMENT BONDS BY MONETARY AUTHORITY (DOLLARS/YEAR)

In Equation 33, desired bond purchases, like bill purchases, equal maturities plus a correction term.

$$\text{DPGBM.K} = \text{MGBM.K} + \text{CGBM.K} \quad 33, \text{ A}$$

DPGBM - DESIRED PURCHASE OF GOVERNMENT BONDS BY MONETARY AUTHORITY (DOLLARS/YEAR)
MGBM - MATURITY OF GOVERNMENT BONDS IN MONETARY AUTHORITY (DOLLARS/YEAR)
CGBM - CORRECTION OF GOVERNMENT BONDS IN MONETARY AUTHORITY (DOLLARS/YEAR)

Equation 34 divides the stock of government bonds in the Monetary Authority GBM by the six-year average life of government bonds ALGB to produce maturities of government bonds in Monetary Authority MGBM.

$$\text{MGBM.K} = \text{GBM.K} / \text{ALGB} \quad 34, \text{ A}$$

MGBM - MATURITY OF GOVERNMENT BONDS IN MONETARY AUTHORITY (DOLLARS/YEAR)
GBM - GOVERNMENT BONDS IN MONETARY AUTHORITY (DOLLARS)
ALGB - AVERAGE LIFE OF GOVERNMENT BONDS (YEARS)

Equation 35 accumulates the difference between purchases and maturities to generate the level of government bonds in Monetary Authority.

$$\text{GBM.K} = \text{GBM.J} + (\text{DT})(\text{PGBM.J} - \text{MGBM.J}) \quad 35, \text{ L}$$
$$\text{GBM} = \text{IGBM} \quad 35.1, \text{ N}$$

GBM - GOVERNMENT BONDS IN MONETARY AUTHORITY (DOLLARS)

DT - TIME STEP FOR INTEGRATION (YEARS)

PGBM - PURCHASE OF GOVERNMENT BONDS BY MONETARY AUTHORITY (DOLLARS/YEAR)

MGBM - MATURITY OF GOVERNMENT BONDS IN MONETARY AUTHORITY (DOLLARS/YEAR)

IGBM - INITIAL GOVERNMENT BONDS IN MONETARY AUTHORITY (DOLLARS)

Equation 36 corrects the discrepancy between desired and actual bonds over a 6-month correction time.

$$\text{CGBM.K} = (\text{DGBM.K} - \text{GBM.K}) / \text{TCGBM} \quad 36, \text{ A}$$

CGBM - CORRECTION OF GOVERNMENT BONDS IN MONETARY AUTHORITY (DOLLARS/YEAR)

DGBM - DESIRED GOVERNMENT BONDS IN MONETARY AUTHORITY (DOLLARS)

GBM - GOVERNMENT BONDS IN MONETARY AUTHORITY (DOLLARS)

TCGBM - TIME TO CORRECT GOVERNMENT BONDS IN MONETARY AUTHORITY (YEARS)

Desired government bonds in Monetary Authority DGBM in Equation 37 either equals a constant amount (when SWTS = 1) or an exogenous time-series (when SWTS = 0).

$$\text{DGBM.K} = \text{SWTS} * \text{CDGBM} + (1 - \text{SWTS}) * \text{XDGBM.K} \quad 37, \text{ A}$$

DGBM - DESIRED GOVERNMENT BONDS IN MONETARY AUTHORITY (DOLLARS)

SWTS - SWITCH FOR TIME SERIES (DIMENSIONLESS)

CDGBM - CONSTANT DESIRED GOVERNMENT BONDS IN MONETARY AUTHORITY (DOLLARS)

XDGBM - EXOGENOUS DESIRED GOVERNMENT BONDS IN MONETARY AUTHORITY (DOLLARS)

Equation 38 generates the government's desired sales of Treasury bills DSTB, which equals total bill maturities plus a correction term.

$$\text{DSTB.K} = \text{SUMV}(\text{MTB.K}, 1, \text{TFI}) + \text{MTBM.K} + \text{CDTB.K} \quad 38, \text{ A}$$

DSTB - DESIRED SALE OF TREASURY BILLS (DOLLARS/YEAR)
SUMV - FUNCTION FOR SUM OF VECTORS
MTB - MATURITY OF TREASURY BILLS (DOLLARS/YEAR)
TFI - TOTAL FINANCIAL INSTITUTIONS
MTBM - MATURITY OF TREASURY BILLS IN MONETARY AUTHORITY (DOLLARS/YEAR)
CDTB - CORRECTION IN DESIRED TREASURY BILLS (DOLLARS/YEAR)

The correction term in Equation 39 expands desired sales when desired Treasury bills outstanding DTBO exceeds the actual stock of bills, and reduces sales when desired bills are less than actual outstanding. The time to correct Treasury bills TCTB equals 0.4 (years).

$$\text{CDTB.K} = (\text{DTBO.K} - \text{TBO.K}) / \text{TCTB} \quad 39, \text{ A}$$

CDTB - CORRECTION IN DESIRED TREASURY BILLS (DOLLARS/YEAR)
DTBO - DESIRED TREASURY BILLS OUTSTANDING (DOLLARS)
TBO - TREASURY BILLS OUTSTANDING (DOLLARS)
TCTB - TIME TO CORRECT TREASURY BILLS (YEARS)

Desired Treasury bills outstanding equals either a constant amount or an exogenously-determined time-series, depending on whether the switch in Equation 40 equals 1 or 0.

$$DTBO.K = SWTS * CDTBO + (1 - SWTS) * XDTBO.K \quad 40, A$$

DTBO - DESIRED TREASURY BILLS OUTSTANDING
(DOLLARS)

SWTS - SWITCH FOR TIME SERIES (DIMENSIONLESS)

CDTBO - CONSTANT DESIRED TREASURY BILLS OUTSTANDING
(DOLLARS)

XDTBO - EXOGENOUS DESIRED TREASURY BILLS
OUTSTANDING (DOLLARS)

Like desired sales of bills, the desired sale of government bonds DSGB in Equation 41 equals maturities plus a correction term.

$$DSGB.K = SUMV(MGB.K, 1, TFI) + MGBM.K + CDGB.K \quad 41, A$$

DSGB - DESIRED SALE OF GOVERNMENT BONDS (DOLLARS/
YEAR)

SUMV - FUNCTION FOR SUM OF VECTORS

MGB - MATURITY OF GOVERNMENT BONDS (DOLLARS/YEAR)

TFI - TOTAL FINANCIAL INSTITUTIONS

MGBM - MATURITY OF GOVERNMENT BONDS IN MONETARY
AUTHORITY (DOLLARS/YEAR)

CDGB - CORRECTION IN DESIRED GOVERNMENT BONDS
(DOLLARS/YEAR)

The correction term is defined in Equation 42 as the difference between the desired and actual stock of bonds divided by a 9-month (0.75-year) correction time.

$$CDGB.K = (DGBO.K - GBO.K) / TCGB \quad 42, A$$

CDGB - CORRECTION IN DESIRED GOVERNMENT BONDS
(DOLLARS/YEAR)

DGBO - DESIRED GOVERNMENT BONDS OUTSTANDING
(DOLLARS)

GBO - GOVERNMENT BONDS OUTSTANDING (DOLLARS)

TCGB - TIME TO CORRECT GOVERNMENT BONDS (YEARS)

In Equation 43 the desired stock of bonds equals a constant amount or an exogenous time series, depending on the value of the switch.

$$\text{DGBO.K} = \text{SWTS} * \text{CDGBO} + (1 - \text{SWTS}) * \text{XDGBO.K} \quad 43, A$$

DGBO - DESIRED GOVERNMENT BONDS OUTSTANDING
(DOLLARS)
SWTS - SWITCH FOR TIME SERIES (DIMENSIONLESS)
CDGBO - CONSTANT DESIRED GOVERNMENT BONDS
OUTSTANDING (DOLLARS)
XDGBO - EXOGENOUS DESIRED GOVERNMENT BONDS
OUTSTANDING (DOLLARS)

The next two equations provide the reserve ratios that are necessary to determine the Bank's required reserves. Equation 44 expresses required reserves in demand deposits RRDD as a constant fraction (CRRDD = 0.22) plus a possible step change, or as a moving time series (RR1), depending on whether the switch is set to 1 or 0.

$$\text{RRDD.K} = \text{SWTS} * (\text{IRRDD} + \text{STEP}(\text{RSH}, \text{RST})) + (1 - \text{SWTS}) * \text{RR1.K} \quad 44, A$$

RRDD - RESERVE RATIO ON DEMAND DEPOSITS (FRACTION)
SWTS - SWITCH FOR TIME SERIES (DIMENSIONLESS)
IRRDD - INITIAL RESERVE RATIO ON DEMAND DEPOSITS
(FRACTION)
STEP - FUNCTION TO GENERATE STEP INPUT
RSH - RESERVE STEP HEIGHT (FRACTION)
RST - RESERVE STEP TIME (TIME)
RR1 - RESERVE RATIO 1 (FRACTION)

Equation 45 sets the reserve ratio on (Bank) time deposits RRTD to a value of 0.1 or to a time series, again depending on the value of SWTS.

$$\text{RRTD.K} = \text{SWTS} * \text{IRRTD} + (1 - \text{SWTS}) * \text{RR2.K} \quad 45, A$$

RRTD - RESERVE RATIO ON TIME DEPOSITS (FRACTION)
SWTS - SWITCH FOR TIME SERIES (DIMENSIONLESS)
IRRTD - INITIAL RESERVE RATIO ON TIME DEPOSITS
(FRACTION)
RR2 - RESERVE RATIO 2 (FRACTION)

In Equation 46 the acceptable borrowing ratio ABR, which affects the loan extension rate LER through the multiplier from borrowed funds on lending MBFL, is set equal to borrowed reserves of bank BRB or

to a constant depending on the value of the coefficient (CTBRB). This is a temporary equation which represents an eventual output of the Monetary Authority in the model. For all but one of the tests in Chapter IV, acceptable and actual borrowed reserves are equal, so that the multiplier from borrowed funds on lending MBFL equals 1 and has no restraining impact on lending.

$$ABR.K = CTBRB * BRB.K + (1 - CTBRB) * IBRB \quad 46, A$$

ABR - ACCEPTABLE BORROWED RESERVES (DOLLARS)
CTBRB - COEFFICIENT FOR TESTING BORROWED RESERVES
OF BANK (DIMENSIONLESS)
BRB - BORROWED RESERVES OF BANK (DOLLARS)
IBRB - INITIAL BORROWED RESERVES OF BANK (DOLLARS)

The next two equations, which specify permissible ceiling returns, normally do not affect yields generated by demand, liquidity, and other internal financial conditions. With these equations, however, one can test the model's response to ceilings that restrain the upward movement of interest rates. Equation 47 defines the permissible return on loans outstanding PRLO as a constant (= 1).

$$PRLO.K(L) = CPRLO(L) \quad 47, A$$

PRLO - PERMISSIBLE RETURN ON LOANS OUTSTANDING
(FRACTION/YEAR)
L - INDEX FOR LENDERS
CPRLO - CONSTANT PERMISSIBLE RETURN ON LOANS
OUTSTANDING (FRACTION/YEAR)

Equation 48 also sets the permissible return on savings deposits PRSD to a constant value (= 1).

$$PRSD.K(L)=CPRSD(L) \quad 48, A$$

PRSD - PERMISSIBLE RETURN ON SAVINGS DEPOSITS
(FRACTION/YEAR)

L - INDEX FOR LENDERS

CPRSD - CONSTANT PERMISSIBLE RETURN ON SAVINGS
DEPOSITS (FRACTION/YEAR)

The next two equations are used for plotting only and do not appear in other equations of the National Model. To compare short-term interest rates with the change in money in Chapter IV, we need the change in total money CTM, a value determined by Equation 49. The result is not strictly the difference in total money TM over one computation interval DT, but a close approximation. Like the trend TRND generator described earlier, the change in total money CTM divides the difference between current and average values by the product of the averaged value and the associated time constant.

$$CTM.K=(TM.K-ATM.K)/(ATM.K*TATM) \quad 49, S$$

CTM - CHANGE IN TOTAL MONEY (DOLLARS/YEAR)

TM - TOTAL MONEY (DOLLARS)

ATM - AVERAGE TOTAL MONEY (DOLLARS)

TATM - TIME TO AVERAGE TOTAL MONEY (YEARS)

Equation 50 expresses average total money ATM as an exponential smoothing (over TATM = 0.15 year) of total money TM.

$$ATM.K=ATM.J+(DT/TATM)(TM.J-ATM.J) \quad 50, L$$

ATM=TM 50.1, N

ATM - AVERAGE TOTAL MONEY (DOLLARS)

DT - TIME STEP FOR INTEGRATION (YEARS)

TATM - TIME TO AVERAGE TOTAL MONEY (YEARS)

TM - TOTAL MONEY (DOLLARS)

The last four equations in this block are required to compare model variables with time-series data in Chapter V. Equation 51 uses the "SAMPLE" function available in DYNAMO III to define sampled loan

extension rate SLER. The function picks values of the loan extension rate LER, holds it over the specified sampling period for first difference SPFD (= 0.25), and then picks and holds the next value. As the loan extension rate (in dollars/year) is to be compared with quarterly lending rates from the data, LER is multiplied by SPFD to produce dollars per quarter.

```
SLER.K(L)=SAMPLE(LER.K(L),SPFD,LER.K(L))*SPFD      51, A
SLER      - SAMPLED LOAN EXTENSION RATE (DOLLARS/YEAR)
L         - INDEX FOR LENDERS
LER       - LOAN EXTENSION RATE (DOLLARS/YEAR)
SPFD     - SAMPLING PERIOD FOR FIRST DIFFERENCE
          (YEARS)
```

Equation 52 employs a special first-difference "macro" FIDIF which appears near the beginning of the program listing in Appendix 3 and is designed to generate a quarterly first difference (assuming SPFD = 0.25) in outstanding loan levels from the data. Thus the first part of the equation for short-term lending of Bank STLB (in dollars/quarter) takes the quarterly difference between the value of actual short-term credit STC three months previously and the current value. To this amount is added (quarterly) replacements of maturing short-term loans, which are assumed to mature at a fixed fraction (= 1/NALL(1)) per year. The term "SMOOTH(STC.K,STSTC)/NALL(1)" represents the assumed annual replacements. The SMOOTH function, another "macro" available in DYNAMO, takes an exponential average of short-term credit STC over a smoothing time for short-term credit STSTC, so as to reduce the observed seasonal pattern in the quarterly data on short-term credit outstanding. This function is not used for long-term

credit (see the next two equations) because long-term credit is taken from annual, rather than quarterly data. Multiplying the term for annual replacements in Equation 52 by SPFD yields an assumed quarterly replacement volume. The rationale for this procedure is explained in the chapter on time-series testing.

$$\text{STLB.K} = \text{FIDIF}(\text{STC.K}, \text{SPFD}) + \text{SPFD} * \text{SMOOTH}(\text{STC.K}, \text{STSTC}) / \text{NALL}(1) \quad 52, \text{ A}$$

STLB - SHORT-TERM LENDING OF BANKS (DOLLARS/YEAR)
STC - SHORT-TERM CREDIT (DOLLARS)
SPFD - SAMPLING PERIOD FOR FIRST DIFFERENCE (YEARS)
STSTC - SMOOTHING TIME FOR SHORT-TERM CREDIT (YEARS)
NALL - NORMAL AVERAGE LIFE OF LOANS (YEARS)

Equation 53 denotes a similar procedure for long-term (gross) lending of Corporate Lender LTLCL--that is, a quarterly first difference in outstanding long-term corporate loans plus an assumed quarterly replacement volume.

$$\text{LTLCL.K} = \text{FIDIF}(\text{LTC.K}, \text{SPFD}) + \text{SPFD} * \text{LTC.K} / \text{NALL}(2) \quad 53, \text{ A}$$

LTLCL - LONG-TERM LENDING OF CORPORATE LENDER (DOLLARS/YEAR)
LTC - LONG-TERM CREDIT (DOLLARS)
SPFD - SAMPLING PERIOD FOR FIRST DIFFERENCE (YEARS)
NALL - NORMAL AVERAGE LIFE OF LOANS (YEARS)

Finally, Equation 54 provides the same information for mortgage credit.

LTLML.K=FIDIF(MCH.K,SPFD)+SPFD*MCH.K/NALL(3) 54, A
LTLML - LONG-TERM LENDING OF MORTGAGE LENDER
(DOLLARS/YEAR)
MCH - MORTGAGE CREDIT TO HOUSEHOLDS (DOLLARS)
SPFD - SAMPLING PERIOD FOR FIRST DIFFERENCE
(YEARS)
NALL - NORMAL AVERAGE LIFE OF LOANS (YEARS)

As shown in the complete program listing contained in Appendix 3 (but not in a flow diagram), a group of equations using time-series data also appears in the test generator. These equations are used to simulate the Financial Sector in Chapter V, and all follow the same format. In each case, the exogenous values, described in Chapter V, are produced by interpolating from a table function of values obtained on a quarterly, bi-annual, or annual basis. As an example, exogenous desired loans in test generator XDLTG are defined for the Bank from a table function (TSTC) whose values are expressed in billions. The table ranges over 15 years and contains quarterly values. The values of XDLTG are picked off the table TSTC at the current time plus the lead in short-term credit LSTC (= 0.75 years), as explained in Chapter V. The equations appear below without further comment.

XDLTG.K(1)=1E9*TABHL(TSTC,TIME.K+LSTC,ITIME, 55, A
ITIME+15,.25)
XDLTG - EXOGENOUS DESIRED LOANS IN TEST GENERATOR
(DOLLARS)
TSTC - TABLE FOR SHORT-TERM CREDIT
LSTC - LEAD IN SHORT-TERM CREDIT (YEARS)

XDLTG.K(2)=1E9*TABHL(TLTC,TIME.K+LLTC,ITIME, 56, A
ITIME+15,1)
XDLTG - EXOGENOUS DESIRED LOANS IN TEST GENERATOR
(DOLLARS)
TLTC - TABLE FOR LONG-TERM CREDIT
LLTC - LEAD IN LONG-TERM CREDIT (YEARS)

XDLTG.K(3)=1E9*[#]TABHL(TMCH, TIME.K+LMCH, ITIME, 57, A
ITIME+15, 1)

XDLTG - EXOGENOUS DESIRED LOANS IN TEST GENERATOR
(DOLLARS)

TMCH - TABLE FOR MORTGAGE CREDIT TO HOUSEHOLDS

LMCH - LEAD IN MORTGAGE CREDIT TO HOUSEHOLDS
(YEARS)

XDTBM.K=1E6*[#]TABHL(TTBM, TIME.K+LGSM, ITIME, ITIME+15, 58, A
.25)

XDTBM - EXOGENOUS DESIRED TREASURY BILLS IN
MONETARY AUTHORITY (DOLLARS)

TTBM - TABLE FOR TREASURY BILLS IN MONETARY
AUTHORITY

LGSM - LEAD FOR GOVERNMENT SECURITIES IN MONETARY
AUTHORITY (YEARS)

XDGBM.K=1E6*[#]TABHL(TGBM, TIME.K+LGSM, ITIME, ITIME+15, 59, A
.25)

XDGBM - EXOGENOUS DESIRED GOVERNMENT BONDS IN
MONETARY AUTHORITY (DOLLARS)

TGBM - TABLE FOR GOVERNMENT BONDS IN MONETARY
AUTHORITY

LGSM - LEAD FOR GOVERNMENT SECURITIES IN MONETARY
AUTHORITY (YEARS)

XDTBO.K=1E9*[#]TABHL(TSTB, TIME.K+LDTBO, ITIME, ITIME+15, 60, A
.25)

XDTBO - EXOGENOUS DESIRED TREASURY BILLS
OUTSTANDING (DOLLARS)

TSTB - TABLE FOR SHORT-TERM BONDS

LDTBO - LEAD FOR DESIRED TREASURY BILLS OUTSTANDING
(YEARS)

XDGBO.K=1E9*[#]TABHL(TLTB, TIME.K+LDGBO, ITIME, ITIME+15, 61, A
.25)

XDGBO - EXOGENOUS DESIRED GOVERNMENT BONDS
OUTSTANDING (DOLLARS)

TLTB - TABLE FOR LONG-TERM BONDS

LDGBO - LEAD FOR DESIRED GOVERNMENT BONDS
OUTSTANDING (YEARS)

YFF.K=.01*[#]TABHL(TYFF, TIME.K, ITIME, ITIME+15, .25) 62, A

YFF - YIELD ON FEDERAL FUNDS (FRACTION/YEAR)

TYFF - TABLE FOR YIELD ON FEDERAL FUNDS

YTB.K=.01*TABHL(TYTB, TIME.K, ITIME, ITIME+15, .25) 63, A
YTB - YIELD ON TREASURY BILLS (FRACTION/YEAR)
TYTB - TABLE FOR YIELD ON TREASURY BILLS

YGB.K=.01*TABHL(TYGB, TIME.K, ITIME, ITIME+15, .25) 64, A
YGB - YIELD ON GOVERNMENT BONDS (FRACTION/YEAR)
TYGB - TABLE FOR YIELD ON GOVERNMENT BONDS

YBC.K=.01*TABHL(TYBC, TIME.K, ITIME, ITIME+15, .25) 65, A
YBC - YIELD ON BANK CREDIT (FRACTION/YEAR)
TYBC - TABLE FOR YIELD ON BANK CREDIT

YCB.K=.01*TABHL(TYCB, TIME.K, ITIME, ITIME+15, .25) 66, A
YCB - YIELD ON CORPORATE BONDS (FRACTION/YEAR)
TYCB - TABLE FOR YIELD ON CORPORATE BONDS
TYCB - TABLE FOR YIELD ON CORPORATE BONDS

YMCH.K=.01*TABHL(TYMCH, TIME.K, ITIME, ITIME+15, .25) 67, A
YMCH - YIELD ON MORTGAGE CREDIT TO HOUSEHOLDS
(FRACTION/YEAR)
TYMCH - TABLE FOR YIELD ON MORTGAGE CREDIT TO
HOUSEHOLDS

STC.K=1E9*TABHL(TSTC, TIME.K, ITIME, ITIME+15, .25) 68, A
STC - SHORT-TERM CREDIT (DOLLARS)
TSTC - TABLE FOR SHORT-TERM CREDIT

LTC.K=1E9*TABHL(TLTC, TIME.K, ITIME, ITIME+15, 1) 69, A
LTC - LONG-TERM CREDIT (DOLLARS)
TLTC - TABLE FOR LONG-TERM CREDIT

RR1.K=TABHL(TRR1, TIME.K, ITIME, ITIME+15, .5) 70, A
RR1 - RESERVE RATIO 1 (FRACTION)
TRR1 - TABLE FOR RESERVE RATIO ONE

RR2.K=TABHL(TRR2, TIME.K, ITIME, ITIME+15, .5) 71, A
RR2 - RESERVE RATIO 2 (FRACTION)
TRR2 - TABLE FOR RESERVE RATIO TWO

MCH.K=1E9*TABHL(TMCH, TIME.K, ITIME, ITIME+15, 1) 72, A
MCH - MORTGAGE CREDIT TO HOUSEHOLDS (DOLLARS)
TMCH - TABLE FOR MORTGAGE CREDIT TO HOUSEHOLDS

C. COUPLING EQUATIONS

Equation 73 adds all of the money pools in the economy. Here the equation sums money in the Financial Sector and the large pool of money in test generator MTG to derive total money TM. For technical reasons, however, the formulation cannot simply add together the cash funds in the non-Bank financial institutions; but, instead, depends on the various levels that make up the non-cash liquid assets (e.g., Treasury bills TB) in the Financial Sector.*3*

$$TM.K = \text{SUMV}(NBLA.K, 2, TL) - \text{SUMV}(TB.K, 2, TL) + \text{LASI.K} - \text{TB.K}(SI) - \text{SUMV}(SD.K, 1, TL) + \text{MTG.K} \quad 73, A$$

- TM - TOTAL MONEY (DOLLARS)
- SUMV - FUNCTION FOR SUM OF VECTORS
- NBLA - NON-BANK LIQUID ASSETS (DOLLARS)
- TL - TOTAL LENDERS
- TB - TREASURY BILLS (DOLLARS)
- LASI - LIQUID ASSETS OF SAVINGS INVESTOR (DOLLARS)
- SI - INDEX FOR SAVINGS INVESTOR
- SD - SAVINGS DEPOSITS (DOLLARS)
- MTG - MONEY IN TEST GENERATOR (DOLLARS)

Many of the coupling equations defined in this section simply serve to convert information that passes between the Financial Sector and other sectors of the economy (here the test generator) from one set

*3*In the Financial Sector, only the second and third lending institutions hold money (CFFI(2) and CFFI(3)). The analogy of money for the Bank (CFFI(1)) is based on excess reserves of Bank ERB which, as we have seen, depends on the amount of total money TM outstanding. In calculating TM, we cannot use cash funds of financial institution CFFI summed over the second and third institutions. This problem arises because CFFI for the Bank is proportional to excess reserves, which depend on TM; and the DYNAMO III compiler would signal a simultaneous-equation relationship if TM were defined in terms of CFFI, even though CFFI(BK) would not appear in the equation.

of subscripts to another. Equations 74-76, for example, define the delivery delay for factor DDF which appears with an "FF" subscript in the test generator, in terms of the loan extension delay LED which has an "L" subscript. A general variable name is used because delivery delay for factor DDF appears as an input in the production sectors for all factors, including credit, that are acquired by the generalized ordering function. For the lending institutions, the "L" subscript represents the Bank (L = 1), Corporate Lender (L = 2), and Mortgage Lender (L = 3). For the test generator the FF subscripts equal 1 for Bank loans, 2 for long-term business loans, and 3 for mortgage credits.

DDF.K(1)=LED.K(1)	74, A
DDF - DELIVERY DELAY FOR FACTOR (YEARS)	
LED - LOAN EXTENSION DELAY (YEARS)	
DDF.K(2)=LED.K(2)	75, A
DDF - DELIVERY DELAY FOR FACTOR (YEARS)	
LED - LOAN EXTENSION DELAY (YEARS)	
DDF.K(3)=LED.K(3)	76, A
DDF - DELIVERY DELAY FOR FACTOR (YEARS)	
LED - LOAN EXTENSION DELAY (YEARS)	

In order to calculate the payment of interest on loans, a set of coupling equations (#77-79) is required to translate the average return on loans outstanding, subscripted L, into interest rate for repayment of loans IRRL, subscripted here with FF.

IRRL.K(1)=ARLO.K(1)	77, A
IRRL - INTEREST RATE FOR REPAYMENT OF LOANS (FRACTION/YEAR)	
ARLO - AVERAGE RETURN ON LOANS OUTSTANDING (FRACTION/YEAR)	
IRRL.K(2)=ARLO.K(2)	78, A
IRRL - INTEREST RATE FOR REPAYMENT OF LOANS (FRACTION/YEAR)	
ARLO - AVERAGE RETURN ON LOANS OUTSTANDING (FRACTION/YEAR)	
IRRL.K(3)=ARLO.K(3)	79, A
IRRL - INTEREST RATE FOR REPAYMENT OF LOANS (FRACTION/YEAR)	
ARLO - AVERAGE RETURN ON LOANS OUTSTANDING (FRACTION/YEAR)	

The backlog of loan requests BLR is subscripted L and appears in the Financial Sector in the calculations for indicated loan extension rate ILER and loan extension delay LED. Equations 80-82 equate this backlog of loan "orders" with the equivalent backlog levels generated by borrowers in the test generator.

BLR.K(1)=BLTG.K(1)	80, A
BLR - BACKLOG OF LOAN REQUESTS (DOLLARS)	
BLTG - BACKLOG OF LOANS IN TEST GENERATOR (DOLLARS)	
BLR.K(2)=BLTG.K(2)	81, A
BLR - BACKLOG OF LOAN REQUESTS (DOLLARS)	
BLTG - BACKLOG OF LOANS IN TEST GENERATOR (DOLLARS)	
BLR.K(3)=BLTG.K(3)	82, A
BLR - BACKLOG OF LOAN REQUESTS (DOLLARS)	
BLTG - BACKLOG OF LOANS IN TEST GENERATOR (DOLLARS)	

Equations 83-85 couple the repayment of loans RPYL, which appears in the Financial Sector as an input to the liquidity levels of

non-Bank lenders, with the repayment of loans outstanding in test generator RLOTG(FF).

RPYL.K(1)=RLOTG.K(1) 83, A
RPYL - REPAYMENT OF LOANS (DOLLARS/YEAR)
RLOTG - REPAYMENT OF LOANS OUTSTANDING IN TEST
GENERATOR (DOLLARS/YEAR)

RPYL.K(2)=RLOTG.K(2) 84, A
RPYL - REPAYMENT OF LOANS (DOLLARS/YEAR)
RLOTG - REPAYMENT OF LOANS OUTSTANDING IN TEST
GENERATOR (DOLLARS/YEAR)

RPYL.K(3)=RLOTG.K(3) 85, A
RPYL - REPAYMENT OF LOANS (DOLLARS/YEAR)
RLOTG - REPAYMENT OF LOANS OUTSTANDING IN TEST
GENERATOR (DOLLARS/YEAR)

Loans outstanding LO, like the backlog of loan requests BLR, is an auxiliary that will sum up all of the appropriate levels contained in the borrowing sectors of the National Model. In the test generator used here, only one level exists for each type of loan outstanding, and that loan level has an FF subscript. Equations 86-88 make the conversion.

LO.K(1)=LOTG.K(1) 86, A
LO - LOANS OUTSTANDING (DOLLARS)
LOTG - LOANS OUTSTANDING IN TEST GENERATOR
(DOLLARS)

LO.K(2)=LOTG.K(2) 87, A
LO - LOANS OUTSTANDING (DOLLARS)
LOTG - LOANS OUTSTANDING IN TEST GENERATOR
(DOLLARS)

LO.K(3)=LOTG.K(3) 88, A
LO - LOANS OUTSTANDING (DOLLARS)
LOTG - LOANS OUTSTANDING IN TEST GENERATOR
(DOLLARS)

One of the flows that increases liquid assets of lending institutions is the receipt of interest on loans outstanding RILO, which in Equations 89-91 is coupled with the payment of interest in test generator PITG.

RILO.K(1)=PITG.K(1) 89, A
RILO - RECEIPT OF INTEREST ON LOANS OUTSTANDING
(DOLLARS/YEAR)
PITG - PAYMENT OF INTEREST IN TEST GENERATOR
(DOLLARS/YEAR)

RILO.K(2)=PITG.K(2) 90, A
RILO - RECEIPT OF INTEREST ON LOANS OUTSTANDING
(DOLLARS/YEAR)
PITG - PAYMENT OF INTEREST IN TEST GENERATOR
(DOLLARS/YEAR)

RILO.K(3)=PITG.K(3) 91, A
RILO - RECEIPT OF INTEREST ON LOANS OUTSTANDING
(DOLLARS/YEAR)
PITG - PAYMENT OF INTEREST IN TEST GENERATOR
(DOLLARS/YEAR)

Defaults on loans outstanding DLO eventually will reflect a weighted average of current defaults in each borrowing sector. As the current test generator has only one loan level for each loan category, however, defaults on loans outstanding DLO(L) simply equal defaults in test generator DTG(FF), as shown in Equations 92-94.

DLO.K(1)=DTG.K(1) 92, A
DLO - DEFAULTS ON LOANS OUTSTANDING (DOLLARS/
YEAR)
DTG - DEFAULTS IN TEST GENERATOR (DOLLARS/YEAR)

DLO.K(2)=DTG.K(2) 93, A
DLO - DEFAULTS ON LOANS OUTSTANDING (DOLLARS/
YEAR)
DTG - DEFAULTS IN TEST GENERATOR (DOLLARS/YEAR)

DLO.K(3)=DTG.K(3) 94, A
DLO - DEFAULTS ON LOANS OUTSTANDING (DOLLARS/
YEAR)
DTG - DEFAULTS IN TEST GENERATOR (DOLLARS/YEAR)

Equation 95 sums up the levels of savings SAV in each household and business sector to derive total savings TSAV. For now there is only one accumulation of savings, in the test generator.

TSAV.K=SAV.K 95, A
TSAV - TOTAL SAVINGS (DOLLARS)
SAV - SAVINGS (DOLLARS)

Each level of savings grows with the increase in savings ISAV, which is summed in the coupling equation for total increase in savings TIS.

TIS.K=ISAV.K 96, A
TIS - TOTAL INCREASE IN SAVINGS (DOLLARS/YEAR)
ISAV - INCREASE IN SAVINGS (DOLLARS/YEAR)

In a similar fashion, Equation 97 adds together the reduction in savings RSAV that affects each sector's accumulation of savings.

TRS.K=RSAB.K 97, A
TRS - TOTAL REDUCTION IN SAVINGS (DOLLARS/YEAR)
RSAB - REDUCTION IN SAVINGS (DOLLARS/YEAR)

In Equation 98, the flow of dividend payments by the financial institutions (and, later, the production sectors) are summed to produce total dividends on common stock TDCS. This rate, like the total increase in Savings TIS, adds to the Savings Investor's liquid assets.

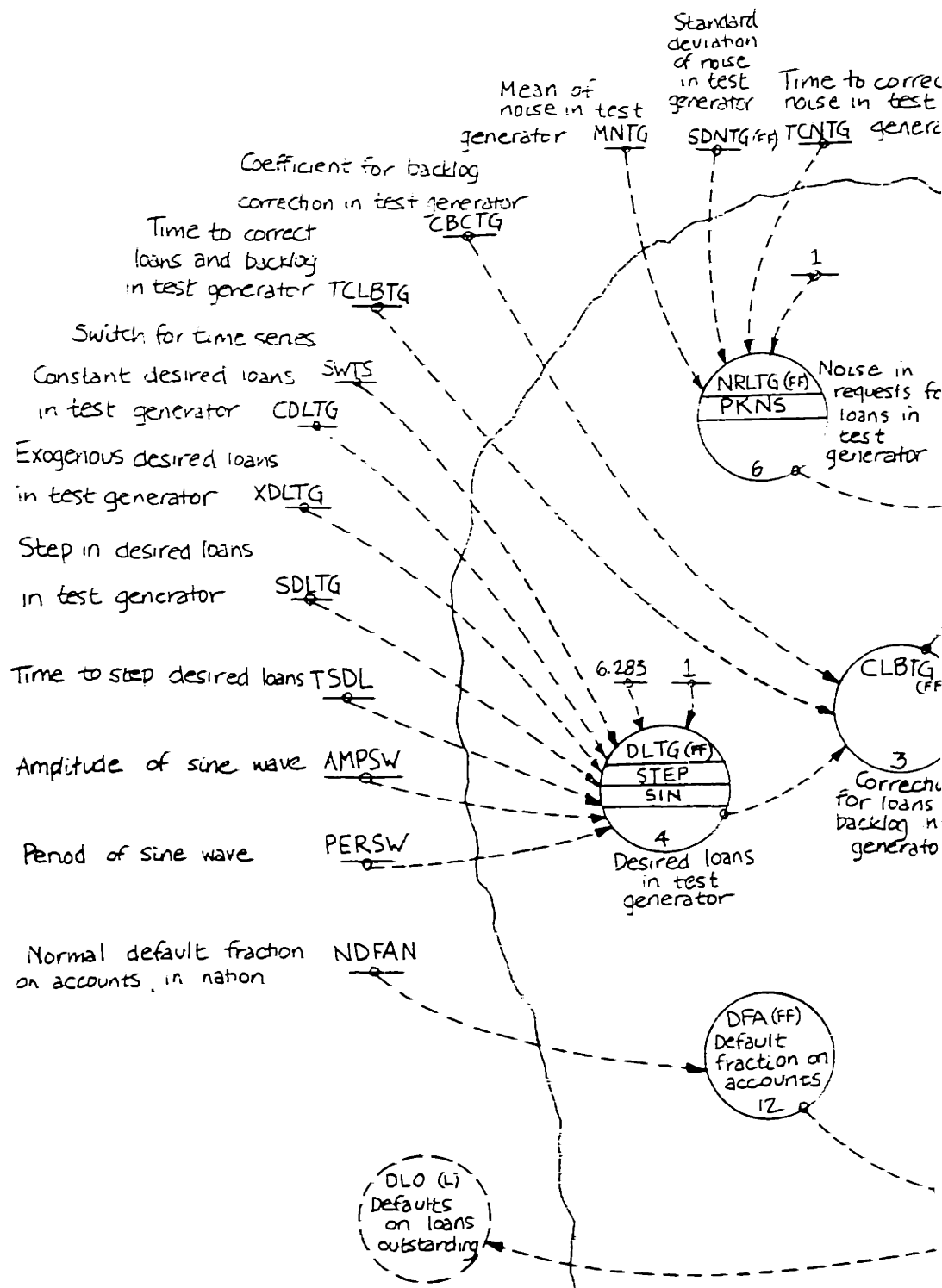
$$\text{TDCS.K} = \text{SUMV}(\text{PDLI.K}, 1, \text{TL}) \quad 98, \text{ A}$$

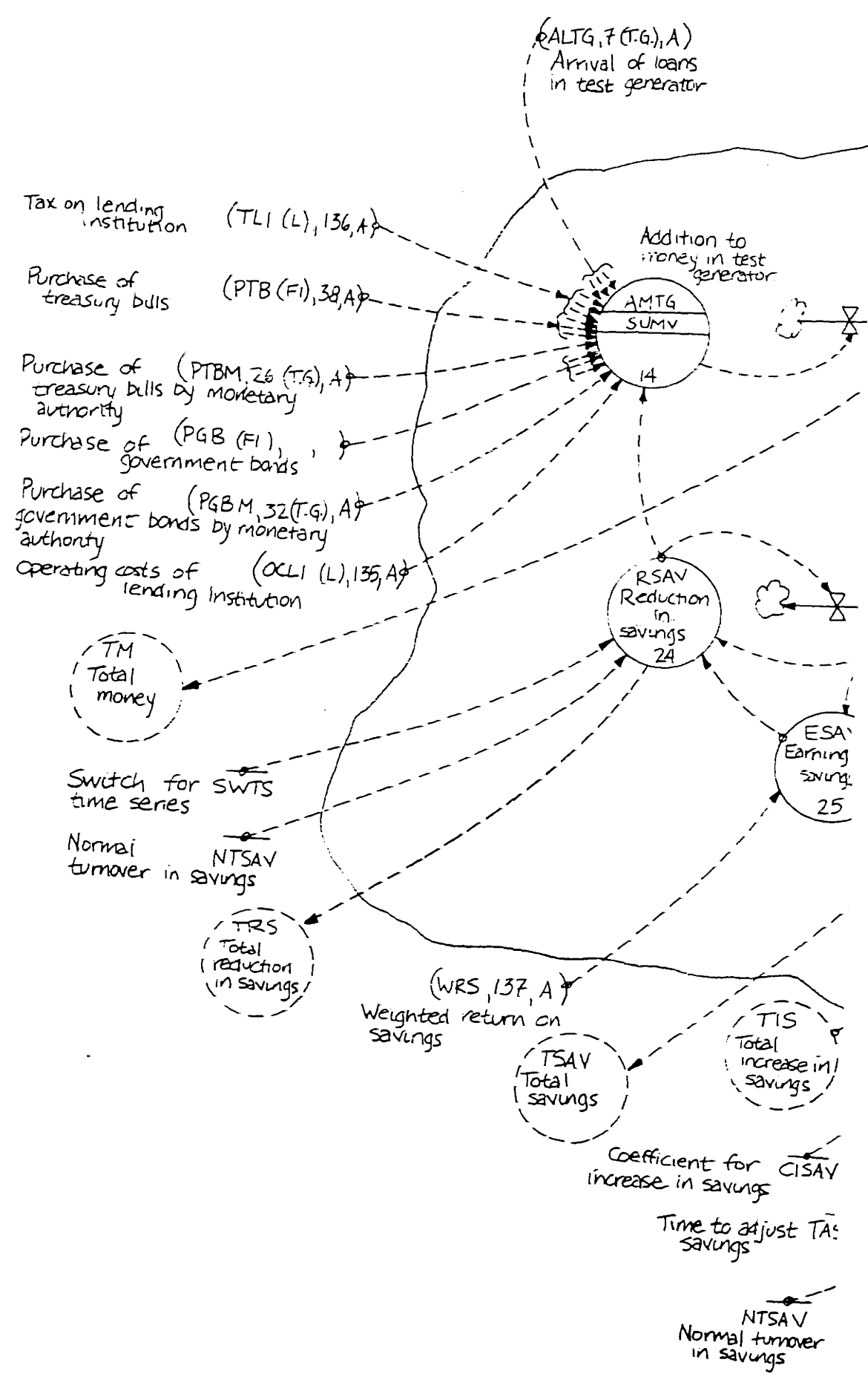
TDCS - TOTAL DIVIDENDS ON COMMON STOCK (DOLLARS/
YEAR)
SUMV - FUNCTION FOR SUM OF VECTORS
PDLI - PAYMENT OF DIVIDENDS BY LENDING INSTITUTION
(DOLLARS/YEAR)
TL - TOTAL LENDERS

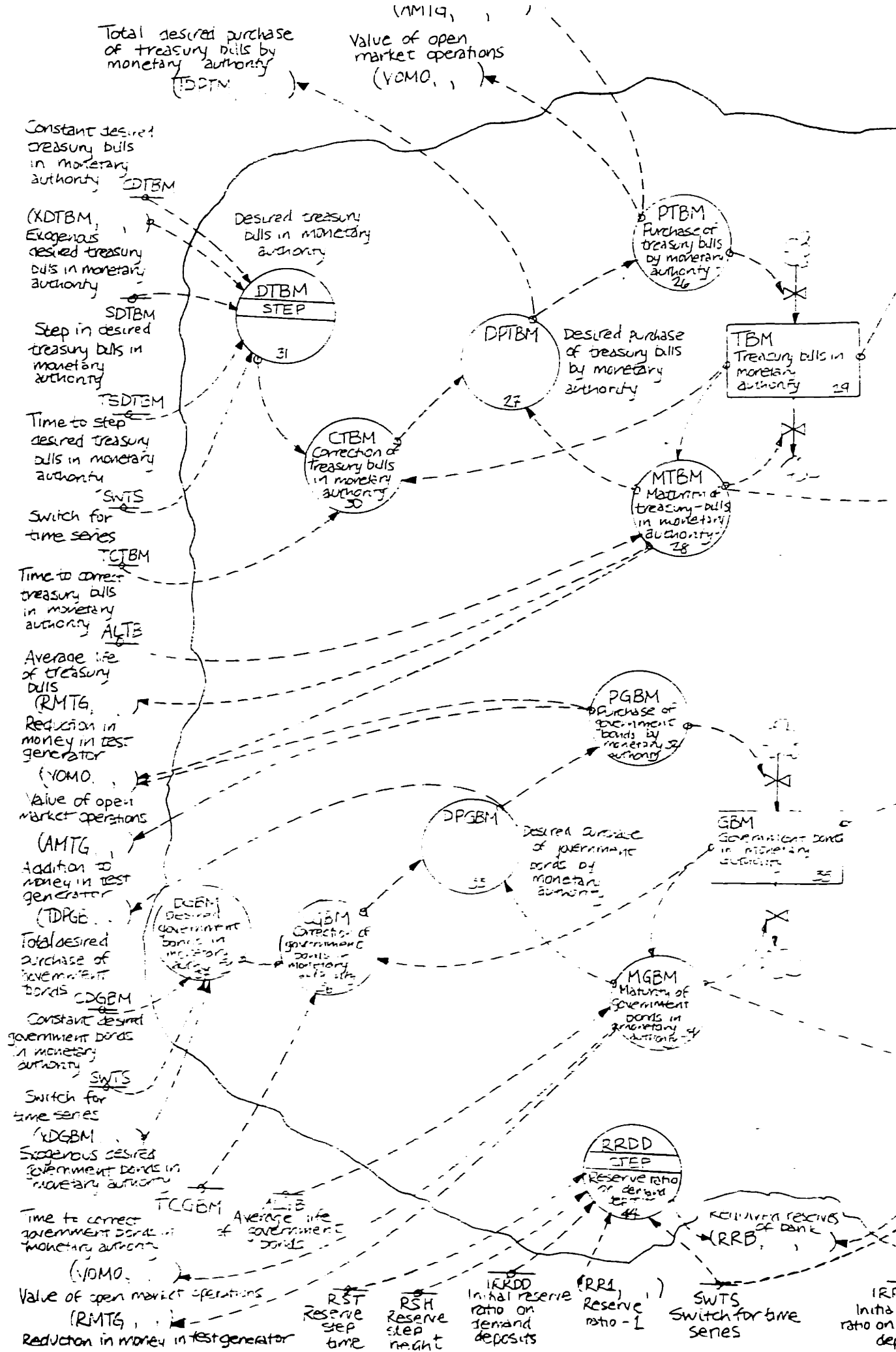
In calculating the standard currency turnover SCT (see Equation 124 in Appendix 1), an indication of the economy's transactions volume was required. Coupling Equation 99 indicates these current transactions as total payments TPAY, which eventually will draw on information from the various household and production sectors of the National Model. For now TPAY equals a constant one trillion (dollars/year), but appears as a coupling equation because of its eventual use in later model configurations.

$$\text{TPAY.K} = 1\text{E}12 \quad 99, \text{ A}$$

TPAY - TOTAL PAYMENTS (DOLLARS/YEAR)







APPENDIX 3

THE FINANCIAL SECTOR MODEL (N201)

A. Equations

* N201 FINANCIAL SECTOR MODEL

NOTE ** N201, WHICH SUCCEEDS N190 (FINANCIAL SECTOR LINKED **

NOTE ** WITH FINANCIAL TEST GENERATOR), ELIMINATES UNUSED **

NOTE ** OPTIONAL FORMULATIONS, CHANGES MCFL FROM EXPONENTIAL **

NOTE ** FORM TO TABLE, EXTENDS RANGE OF MPGS, AND MAKES **

NOTE ** SEVERAL CHANGES IN ORGANIZATION AND NOMENCLATURE. **

NOTE MACR9, FEBRUARY 24, 1977

NOTE

NOTE TREND MACRO

NOTE

MACRO TRND(INPUT, TERC, ITRND)

A TRND.K=(\$PPC.K-\$RC.K)/(\$RC.K*TERC)

L \$PPC.K=\$PPC.J+(DT/\$TPPC)(INPUT.J-\$PPC.J)

N \$PPC=INPUT/(1+\$TPPC*ITRND)

N \$TPPC=\$FTERC*TERC

N \$FTERC=.5

L \$RC.K=\$RC.J+(DT/TERC)(\$PPC.J-\$RC.J)

N \$RC=\$PPC/(1+TERC*ITRND)

MEND

NOTE

NOTE PINK NOISE MACRO

NOTE

MACRO PKNS(MNSE, SDN, TCN)

L PKNS.K=PKNS.J+(DT/TCN)(\$SFN*NOISE()+MNSE-PKNS.J)

N PKNS=MNSE

N \$SFN=SDN*SQRT(24*TCN/DT)

MEND

NOTE

NOTE FMACR3, FEBRUARY 3, 1977

NOTE

NOTE STATISTICS MACRO FOR FINANCIAL SECTOR

NOTE

NOTE THE FOLLOWING SHOULD BE ADDED AFTER

NOTE THE USUAL NATIONAL ECONOMIC MODEL MACROS

NOTE WHEN ASSEMBLING A MODEL WITH THE FINANCIAL SECTOR.

NOTE

FNCTN CORF(14)

MACRO COR(X, Y, FIRST, LAST, INT)

NOTE

A COR.K=CORF(Y, X, INT, FIRST, LAST, \$SUMX, \$SUMY, \$SUMXY, \$SSQX,
X \$SSQY, \$SSQE, \$ETM1, \$NEXT, \$NUM)

N \$SUMX=0

N \$SUMY=0

N \$SUMXY=0

```
N $SSQX=0
N $SSQY=0
N $NEXT=-1
N $NUM=0
N $SSQE=0
N $ETM1=0
MEND
NOTE
MACRO FIDIF(INPUT,SPFD)
A $SIN.K=SAMPLE(INPUT,SPFD,INPUT)
L $LIN.K=$LIN.J+($SIN.J-$LIN.J)
N $LIN=INPUT
A FIDIF.K=$SIN.K-$LIN.K
MEND
NOTE
C BK=1
C SI=4
C TFI=4
C TL=3
C TFF=3
NOTE
NOTE          FOR VARIABLES
NOTE
FOR    L=1,TL
FOR    FI=1,TFI
FOR    NBL=2,TL
FOR    FF=1,TFF
NOTE          F10, MARCH 16, 1977
NOTE          FINANCIAL SECTOR EQUATIONS
NOTE
NOTE
NOTE PRIMARY LENDING
NOTE
A LED.K(L)=BLR.K(L)/LER.K(L)
A LER.K(L)=ILER.K(L)*MLER.K(L)
A ILER.K(L)=BLR.K(L)/NLED(L)
A MLER.K(L)=MLAL.K(L)*MCFL.K(L)*MBFL.K(L)
X *MRRL.K(L)*CTFS(L)+(1-CTFS(L))
A MLAL.K(L)=EXP(EMLAL*LOGN(LAR.K(L)))
A LAR.K(L)=LA.K(L)/DLA.K(L)
A LA.K(BK)=CFRB.K*ERB.K+TB.K(BK)
A CFRB.K=1/(RRDD.K+DRCM.K-RRDD.K*DRCM.K)
A LA.K(NBL)=NBLA.K(NBL)
L NBLA.K(NBL)=NBLA.J(NBL)+(DT)(INBL.J(NBL)-RNBL.J(NBL))
N NBLA(L)=INBLA(L)
A INBL.K(NBL)=RILO.K(NBL)+RITB.K(NBL)+RIGB.K(NBL)+RPYL.K(NBL)
X +MGB.K(NBL)+PDSI.K(NBL)
A RNBL.K(NBL)=LER.K(NBL)+PGB.K(NBL)+WDSI.K(NBL)+OCLI.K(NBL)
X +PDLI.K(NBL)+TLI.K(NBL)
A DLA.K(L)=NLCL(L)*ILER.K(L)
A MCFL.K(L)=TABLE(TMCFL,RCF.K(L),0,2,.25)
```

A MBFL.K(L)=TABLE(TMBFL,CBF.K(L)/ILER.K(L),-.2,.2,.1)
A CBF.K(BK)=((ABR.K-BRB.K)/NTABF)*CFRB.K
A CBF.K(NBL)=0
A MRRL.K(L)=TABLE(TMRR,RRL.K(L),0,3,.5)
A RRL.K(L)=(ERLO.K(L)-RCPL(L))/ARA.K(L)
A ERLO.K(L)=RLO.K(L)-DFL.K(L)
A DFL.K(L)=DLO.K(L)/LO.K(L)
A ARA.K(L)=(ERLO.K(L)+RTB.K+ERGB.K)/ACFI(L)

NOTE

NOTE RETURN ON LOANS OUTSTANDING

NOTE

L ARLO.K(L)=ARLO.J(L)+(DT/ATRLO(L))(RLO.J(L)-ARLO.J(L))
N ARLO(L)=RLO(L)
A RLO.K(L)=MIN(SRLO.K(L),PRLO.K(L))
L SRLO.K(L)=SRLO.J(L)+(DT)(CRLO.JK(L))
N SRLO(L)=IRLO(L)
R CRLO.K(L)=CTFS(L)*(DRLO.K(L)-SRLO.K(L))/TARLO(L)
A DRLO.K(L)=(ARA.K(L)+RCPL(L)+DFL.K(L))
X *MDRL.K(L)*MPRL.K(L)*MSRL.K(L)
A MDRL.K(L)=TABLE(TMDRL,LED.K(L)/NLED(L),0,3,.5)
A MPRL.K(L)=TABLE(TMPRL,RPLI.K(L),-1,3,1)
A RPLI.K(L)=RALI.K(L)/RRA.K(L)
A RALI.K(L)=PLI.K(L)/TALI.K(L)
A PLI.K(L)=RILO.K(L)+RITB.K(L)+RIGB.K(L)-ESD.K(L)+DSDL.K(L)
X -OCLI.K(L)-TLI.K(L)-DLO.K(L)
A MSRL.K(L)=TABLE(TMSRL,RCAS.K(L),-1,3,1)
A RCAS.K(L)=CRSR.K(L)/ARSR.K(L)
A CRSR.K(L)=(ARA.K(L)-ERSD.K(L))/ERSD.K(L)
A ARSR.K(L)=TRSR.K(L)+(NRSR(L)-TRSR.K(L))*WFSR
L TRSR.K(L)=TRSR.J(L)+(DT/TTSR)(CRSR.J(L)-TRSR.J(L))
N TRSR(L)=CRSR(L)

NOTE

NOTE INVESTMENT IN GOVERNMENT SECURITIES -- TREASURY BILLS

NOTE

A PTB.K(FI)=DPTB.K(FI)*(MPTB.K*CTFS(FI)+(1-CTFS(FI)))
A DPTB.K(FI)=MTB.K(FI)*(MCTB.K(FI)*MRTB.K(FI)*CTFS(FI)+(1-CTFS(FI)))
A MTB.K(FI)=TB.K(FI)/ALTB
L TB.K(FI)=TB.J(FI)+(DT)(PTB.J(FI)-MTB.J(FI))
N TB(FI)=ITB(FI)
A MPTB.K=TABLE(TMPSGS,DSTB.K/TDPTB.K,0,2,.25)
A TDPTB.K=SUMV(DPTB.K,1,TFI)+DPTBM.K
A MCTB.K(FI)=TABLE(TMCTB,RCF.K(FI),0,2,.25)
A RCF.K(FI)=CTRCF(FI)*(CFFI.K(FI)/DCF.K(FI))+(1-CTRCF(FI))
A CFFI.K(BK)=CFRB.K*ERB.K
A CFFI.K(NBL)=LA.K(NBL)-TB.K(NBL)
A CFFI.K(SI)=LA.K(SI)-TB.K(SI)-SUMV(SD.K,1,TL)
A DCF.K(FI)=NCFLA(FI)*DLA.K(FI)
A MRTB.K(FI)=TABLE(TMRR,RRTB.K(FI),0,3,.5)
A RRTB.K(FI)=(RTB.K-RCPTB(FI))/ARA.K(FI)
L RTB.K=RTB.J+(DT)(CRTB.JK)
N RTB=IRTB

R CRTB.KL=FCRTB.K*RTB.K
A FCRTB.K=TABLE(TFCR,RDTB.K,-1,2,.5)
A RDTB.K=(DSTB.K-TDPTB.K)/TBO.K
A TBO.K=SUMV(TB.K,1,TFI)+TBM.K
A RITB.K(FI)=ARTB.K*TB.K(FI)
L ARTB.K=ARTB.J+(DT/ALTB)(RTB.J-ARTB.J)
N ARTB=RTB

NOTE

NOTE INVESTMENT IN GOVERNMENT SECURITIES -- GOVERNMENT BONDS

NOTE

A PGB.K(FI)=DPGB.K(FI)*(MPGB.K*CTFS(FI)+(1-CTFS(FI)))
A DPGB.K(FI)=MGB.K(FI)*(MLGB.K(FI)*MCGB.K(FI)*MRGB.K(FI)
X *CTFS(FI)+(1-CTFS(FI)))
A MGB.K(FI)=GB.K(FI)/ALGB
L GB.K(FI)=GB.J(FI)+(DT)(PGB.J(FI)-MGB.J(FI))
N GB(FI)=IGB(FI)
A MPGB.K=TABLE(TMPGS,DSGB.K/TDPGB.K,0,2,.25)
A TDPGB.K=SUMV(DPGB.K,1,TFI)+DPGBM.K
A MLGB.K(FI)=TABLE(TMLGB,CLA.K(FI)/MGB.K(FI),-1.5,2,.5)
A CLA.K(FI)=(LA.K(FI)-DLA.K(FI))/NTAL(FI)
A LA.K(SI)=LASI.K
A LASI.K=TSAV.K-GB.K(SI)-VCS.K
A DLA.K(SI)=DLFS.K*TSAV.K
A MCGB.K(FI)=TABLE(TMCGB,RCF.K(FI),0,2,.25)
A MRGB.K(FI)=TABLE(TMRR,RRGB.K(FI),0,3,.5)
A RRGB.K(FI)=(ERGB.K-RCPGB(FI))/ARA.K(FI)
A ERGB.K=(1-ECRB.K*PHPB)*RGB.K
A ECRB.K=TRND(RGB.K,TARB,IECR)
L RGB.K=RGB.J+(DT)(CRGB.JK)
N RGB=IRGB
R CRGB.KL=FCRGB.K*RGB.K
A FCRGB.K=TABLE(TFCR,RDGB.K,-1,2,.5)
A RDGB.K=(DSGB.K-TDPGB.K)/GBO.K
A GBO.K=SUMV(GB.K,1,TFI)+GBM.K
A RIGB.K(FI)=ARGB.K*GB.K(FI)
L ARGB.K=ARGB.J+(DT/ALGB)(RGB.J-ARGB.J)
N ARGB=RGB

NOTE

NOTE LIABILITIES -- SAVINGS DEPOSITS

NOTE

A ESD.K(L)=RSD.K(L)*SD.K(L)
L SD.K(L)=SD.J(L)+(DT)(PDSI.J(L)-WDSI.J(L)+ESD.J(L)-DSDL.J(L))
N SD(L)=ISD(L)
A PDSI.K(L)=MSD.K(L)*(MCSL.K*MRSK(L)*CTSD(L)+(1
X -CTSD(L)))
A WDSI.K(L)=MSD.K(L)-DSDL.K(L)+CWESD*ESD.K(L)
A MSD.K(L)=SD.K(L)/ALSD
A DSDL.K(L)=DFSD.K(L)*SD.K(L)
A DFSD.K(L)=TABHL(TDFSD,CREA.K(L)/AREA.K(L),0,1,.25)
A MCSL.K=TABLE(TMCSL,RCF.K(SI),0,2,.25)
A MRSK(L)=TABLE(TMRSK,RRSK(L),0,3,.5)

A RRSD.K(L)=(ERSD.K(L)-RCPSD(L))/ARA.K(SI)
A ERSD.K(L)=RSD.K(L)-DFSD.K(L)
A RSD.K(L)=MIN(SRSD.K(L), PRSD.K(L))
L SRSD.K(L)=SRSD.J(L)+(DT)(CRSD.JK(L))
N SRSD(L)=IRSD(L)
R CRSD.K(L)=CTFS(L)*(DRSD.K(L)-SRSD.K(L))/TARSD(L)
A DRSD.K(L)=(ARA.K(L)-ASRA.K(L))*MLRD.K(L)*MPRD.K(L)
A ASRA.K(L)=ARSR.K(L)*RSD.K(L)
A MLRD.K(L)=TABLE(TMLRD, LAR.K(L), 0, 3, .5)
A MPRD.K(L)=TABLE(TMPRD, RPLI.K(L), -1, 3, 1)

NOTE

NOTE LIABILITIES -- EQUITY

NOTE

A ELI.K(BK)=TALI.K(BK)-SD.K(BK)-DDEP.K-BRB.K
A ELI.K(NBL)=TALI.K(NBL)-SD.K(NBL)
A TALI.K(BK)=RB.K+TB.K(BK)+GB.K(BK)+LO.K(BK)
A TALI.K(NBL)=LA.K(NBL)+GB.K(NBL)+LO.K(NBL)
A PDLI.K(L)=TDLI.K(L)*MPPD.K(L)*MCPD.K(L)*MEPD.K(L)
L TDLI.K(L)=TDLI.J(L)+(DT/TTDLI)(PDLI.J(L)-TDLI.J(L))
N TDLI(L)=PLI(L)
A MPPD.K(L)=TABLE(TMPPD, PLI.K(L)/TDLI.K(L), -1, 3, .5)
A MCPD.K(L)=TABLE(TMCPD, RCF.K(L), 0, 3, .5)
A MEPD.K(L)=TABLE(TMEPD, CREA.K(L)/AREA.K(L), 0, 2, .5)
A CREA.K(L)=ELI.K(L)/TALI.K(L)
A AREA.K(L)=IREA(L)
A RRA.K(L)=TRA.K(L)+(NRA(L)-TRA.K(L))*WFRA
L TRA.K(L)=TRA.J(L)+(DT/TARA)(RALI.J(L)-TRA.J(L))
N TRA(L)=RALI(L)

NOTE

NOTE BANK RESERVES AND CURRENCY

NOTE

A ERB.K=RB.K-RRB.K
A RB.K=BRB.K+ORB.K
A BRB.K=SBRB.K*MRBR.K
A SBRB.K=NBF*RRB.K
A RRB.K=RRDD.K*DDEP.K+RRTD.K*SD.K(BK)
A DDEP.K=TM.K-TCP.K
A MRBR.K=TABLE(TMRBR, RBRR.K, -4, 10, 2)
A RBRR.K=(RRB.K-ORB.K)/SBRB.K
L ORB.K=ORB.J+(DT)(VOMO.JK+CDR.J-CWR.J)
N ORB=RRB+IERB-SBRB
R VOMO.KL=PTBM.K+PGBM.K-MTBM.K-MGBM.K
A CDR.K=SCT.K*MCCD.K
A SCT.K=DRCM.K*TPAY.K
A MCCD.K=TABHL(TMCCD, TCP.K/DCP.K, 0, 1, .25)
L TCP.K=TCP.J+(DT)(CWR.J-CDR.J)
N TCP=DCP
A DCP.K=DRCM.K*TM.K
A CWR.K=(SCT.K+CCP.K)*MCCW.K*MRRW.K
A CCP.K=(DCP.K-TCP.K)/NTCA
A MCCW.K=TABHL(TMCCW, CCP.K/SCT.K, -1, 0, .25)

A MRRW.K=TABHL(TMRRW,ORB.K/RRB.K,0,1,.25)

NOTE FVNS6, FEBRUARY 3, 1977

NOTE FINANCIAL VARIABLES NOT DEFINED IN SECTOR

NOTE

NOTE

NOTE TEMPORARY EQUATIONS

NOTE

A DLFS.K=NLFS

A ARA.K(SI)=(RTB.K+ERGB.K+SUMV(ERSD.K,1,TL))/ACFI(SI)

A VCS.K=CVCS

A OCLI.K(L)=PCA(L)*TALI.K(L)+PCT(L)*(LER.K(L)+PTB.K(L)+PGB.K(L))

A TLI.K(L)=0

A WRS.K=TES.K/TSAV.K

A TES.K=RITB.K(SI)+RIGB.K(SI)+SUMV(ESD.K,1,TL)-SUMV(DSDL.K,1,TL)+

X SUMV(PDLI.K,1,TL)

A DRCM.K=.2

A RFF.K=RTB.K*MRFF.K

A MRFF.K=TABLE(TMRFF,SBRB.K/BRB.K,0,5,1)

NOTE

NOTE PARAMETERS FOR TEMPORARY EQUATIONS

NOTE

C NLFS=.8325834

C CVCS=10E9

T TMRFF=2/1/.7/.6/.55/.53

C PCA(1)=0

C PCA(2)=0

C PCA(3)=0

C PCT(1)=0

C PCT(2)=0

C PCT(3)=0

NOTE FSCE2, JANUARY 6, 1977

NOTE FINANCIAL SECTOR COUPLING EQUATIONS

NOTE

A TM.K=SUMV(NBLA.K,2,TL)-SUMV(TB.K,2,TL)+LASI.K-TB.K(SI)

X -SUMV(SD.K,1,TL)+MTG.K

A DDF.K(1)=LED.K(1)

A DDF.K(2)=LED.K(2)

A DDF.K(3)=LED.K(3)

A IRRL.K(1)=ARLO.K(1)

A IRRL.K(2)=ARLO.K(2)

A IRRL.K(3)=ARLO.K(3)

A BLR.K(1)=BLTG.K(1)

A BLR.K(2)=BLTG.K(2)

A BLR.K(3)=BLTG.K(3)

A RPYL.K(1)=RLOTG.K(1)

A RPYL.K(2)=RLOTG.K(2)

A RPYL.K(3)=RLOTG.K(3)

A LO.K(1)=LOTG.K(1)

A LO.K(2)=LOTG.K(2)

A LO.K(3)=LOTG.K(3)

A RILO.K(1)=PITG.K(1)

A RILO.K(2)=PITG.K(2)
A RILO.K(3)=PITG.K(3)
A DLO.K(1)=DTG.K(1)
A DLO.K(2)=DTG.K(2)
A DLO.K(3)=DTG.K(3)
A TSAV.K=SAV.K
A TIS.K=ISAV.K
A TRS.K=RSAV.K
A TDCS.K=SUMV(PDLI.K, 1, TL)
A TPAY.K=1E12

NOTE FTG8, MARCH 16, 1977
NOTE TEST GENERATOR FOR FINANCIAL SECTOR

NOTE
NOTE
NOTE TEST GENERATOR FOR BORROWING SECTOR

NOTE
L BLTG.K(FF)=BLTG.J(FF)+(DT)(RLTG.J(FF)-ALTG.J(FF))
N BLTG(FF)=(LOTG(FF)/NPTL(FF))*NDDF(FF)
A RLTG.K(FF)=(MLTG.K(FF)+CLBTG.K(FF))*NRLTG.K(FF)
A CLBTG.K(FF)=(DLTG.K(FF)-LOTG.K(FF))
X +CBCTG*(DBTG.K(FF)-BLTG.K(FF))/TCLBTG(FF)
A DLTG.K(FF)=SWTS*(CDLTG(FF)+STEP(SDLTG(FF), TSDL))
X +AMPSW(FF)*SIN(6.283*TIME.K/PERSW))
X +(1-SWTS)*XDLTG.K(FF)
A DBTG.K(FF)=NDDF(FF)*MLTG.K(FF)
A NRLTG.K(FF)=1+PKNS(MNTG, SDNTG(FF), TCNTG)
A ALTG.K(FF)=BLTG.K(FF)/DDF.K(FF)
A MLTG.K(FF)=LOTG.K(FF)/NPTL(FF)
L LOTG.K(FF)=LOTG.J(FF)+(DT)(ALTG.J(FF)-RLOTG.J(FF)-DTG.J(FF))
N LOTG(FF)=ILOTG(FF)
A RLOTG.K(FF)=MLTG.K(FF)-DTG.K(FF)
A DTG.K(FF)=LOTG.K(FF)*DFA.K(FF)
A DFA.K(FF)=NDFAN
L MTG.K=MTG.J+(DT)(AMTG.J-RMTG.J)
N MTG=IMTG
A AMTG.K=SUMV(ALTG.K, 1, TFF)+SUMV(PTB.K, 1, TFI)+PTBM.K
X +SUMV(PGB.K, 1, TFI)+PGBM.K+SUMV(OCLI.K, 1, TL)+RSAV.K
X +SUMV(TLI.K, 1, TL)
A RMTG.K=SUMV(MLTG.K, 1, TFF)+SUMV(MTB.K, 1, TFI)+MTBM.K
X +SUMV(MGB.K, 1, TFI)+MGBM.K+ISAV.K+SUMV(RITB.K, 1, TFI)
X +SUMV(RIGB.K, 1, TFI)+SUMV(PITG.K, 1, TFF)-SUMV(DTG.K, 1, TFF)
A PITG.K(FF)=LOTG.K(FF)*IRRL.K(FF)
L SAV.K=SAV.J+(DT)(ISAV.J+ESAV.J-RSAV.J)
N SAV=ILASI+GB(SI)+VCS
A ISAV.K=CISAV*(DSAV.K-SAV.K)/TASAV+SAV.K*(NTSAV
X +NGSAV)*MRSAV.K
A DSAV.K=CDSAV*NDSAV.K+STEP(SDSAV, TSDSAV)
A NDSAV.K=1+PKNS(MNDS, SDNDS, TNDS)
A MRSAV.K=1+(IRMOD.K/IRDAT.K-1)*CMRSAV
A IRMOD.K=(SUMV(RLO.K, 1, TL)+RTB.K+RGB.K)/5
A IRDAT.K=(YTB.K+YGB.K+YBC.K+YCB.K+YMCH.K)/5

A RSAV.K=SWTS*ESAV.K+SAV.K*NTSAV

A ESAV.K=WRS.K*SAV.K

NOTE

NOTE TEST GENERATOR FOR MONETARY AUTHORITY AND TREASURY

NOTE

A PTBM.K=DPTBM.K

A DPTBM.K=MTBM.K+CTBM.K

A MTBM.K=TBM.K/ALTB

L TBM.K=TBM.J+(DT)(PTBM.J-MTBM.J)

N TBM=ITBM

A CTBM.K=(DTBM.K-TBM.K)/TCTBM

A DTBM.K=SWTS*CDTBM+(1-SWTS)*XDTBM.K+STEP(SDTBM, TSDTBM)

A PGBM.K=DPGBM.K

A DPGBM.K=MGBM.K+CGBM.K

A MGBM.K=GBM.K/ALGB

L GBM.K=GBM.J+(DT)(PGBM.J-MGBM.J)

N GBM=IGBM

A CGBM.K=(DGBM.K-GBM.K)/TCGBM

A DGBM.K=SWTS*CDGBM+(1-SWTS)*XDGBM.K

A DSTB.K=SUMV(MTB.K, 1, TFI)+MTBM.K+CDTB.K

A CDTB.K=(DTBO.K-TBO.K)/TCTB

A DTBO.K=SWTS*CDTBO+(1-SWTS)*XDTBO.K

A DSGB.K=SUMV(MGB.K, 1, TFI)+MGBM.K+CDGB.K

A CDGB.K=(DGBO.K-GBO.K)/TCGB

A DGBO.K=SWTS*CDGBO+(1-SWTS)*XDGBO.K

A RRDD.K=SWTS*(IRRDD+STEP(RSH, RST))+(1-SWTS)*RR1.K

A RRTD.K=SWTS*IRRDT+(1-SWTS)*RR2.K

A ABR.K=CTBRB*BRB.K+(1-CTBRB)*IBRB

A PRLO.K(L)=CPRLO(L)

A PRSD.K(L)=CPRSD(L)

S CTM.K=(TM.K-ATM.K)/(ATM.K*TATM)

L ATM.K=ATM.J+(DT/TATM)(TM.J-ATM.J)

N ATM=TM

A SLER.K(L)=SAMPLE(LER.K(L), SPFD, LER.K(L))*SPFD

A STLK.K=FIDIF(STC.K, SPFD)+SPFD*SMOOTH(STC.K, STSTC)/NALL(1)

A LTLCL.K=FIDIF(LTC.K, SPFD)+SPFD*LTC.K/NALL(2)

A LTLML.K=FIDIF(MCH.K, SPFD)+SPFD*MCH.K/NALL(3)

NOTE

NOTE -- EQUATIONS USING TIME SERIES DATA

NOTE

A XDLTG.K(1)=1E9*TABHL(TSTC, TIME.K+LSTC, ITIME, ITIME+15, .25)

A XDLTG.K(2)=1E9*TABHL(TLTC, TIME.K+LLTC, ITIME, ITIME+15, 1)

A XDLTG.K(3)=1E9*TABHL(TMCH, TIME.K+LMCH, ITIME, ITIME+15, 1)

A XDTBM.K=1E6*TABHL(TTBM, TIME.K+LGSM, ITIME, ITIME+15, .25)

A XDGBM.K=1E6*TABHL(TGBM, TIME.K+LGSM, ITIME, ITIME+15, .25)

A XDTBO.K=1E9*TABHL(TSTB, TIME.K+LDTBO, ITIME, ITIME+15, .25)

A XDGBO.K=1E9*TABHL(TLTB, TIME.K+LDGBO, ITIME, ITIME+15, .25)

A YFF.K=.01*TABHL(TYFF, TIME.K, ITIME, ITIME+15, .25)

A YTB.K=.01*TABHL(TYTB, TIME.K, ITIME, ITIME+15, .25)

A YGB.K=.01*TABHL(TYGB, TIME.K, ITIME, ITIME+15, .25)

A YBC.K=.01*TABHL(TYBC, TIME.K, ITIME, ITIME+15, .25)

A YCB.K=.01*TABHL(TYCB, TIME.K, ITIME, ITIME+15, .25)
A YMCH.K=.01*TABHL(TYMCH, TIME.K, ITIME, ITIME+15, .25)
A STC.K=1E9*TABHL(TSTC, TIME.K, ITIME, ITIME+15, .25)
A LTC.K=1E9*TABHL(TLTC, TIME.K, ITIME, ITIME+15, 1)
A RR1.K=TABHL(TRR1, TIME.K, ITIME, ITIME+15, .5)
A RR2.K=TABHL(TRR2, TIME.K, ITIME, ITIME+15, .5)
A MCH.K=1E9*TABHL(TMCH, TIME.K, ITIME, ITIME+15, 1)

NOTE FPS8, MARCH 16, 1977
NOTE FINANCIAL PARAMETERS FOR SECTOR
NOTE
NOTE PARAMETERS FOR PRIMARY LENDING
NOTE

C NLED(1)=.25
C NLED(2)=.25
C NLED(3)=.25
C CTFS(1)=1
C CTFS(2)=1
C CTFS(3)=1
C CTFS(4)=1
C INBLA(1)=0
C INBLA(2)=5.1428570E9
C INBLA(3)=4.5E9
N INBL(1)=0
N RNBL(1)=0
C NLCL(1)=.11
C NLCL(2)=.36
C NLCL(3)=.36
C RCPL(1)=.002334
C RCPL(2)=.0063334
C RCPL(3)=.0043334

NOTE
NOTE PARAMETERS FOR RETURN ON LOANS OUTSTANDING
NOTE

N ATRLO(L)=CATRL(L)*NALL(L)
C CATRL(1)=.5
C CATRL(2)=.5
C CATRL(3)=.5
C NALL(1)=1
C NALL(2)=7
C NALL(3)=12
C IRLO(1)=.063
C IRLO(2)=.069
C IRLO(3)=.066
C TARLO(1)=.3
C TARLO(2)=.3
C TARLO(3)=.3
N NRSR(L)=CRSR(L)

NOTE
NOTE PARAMETERS FOR INVESTMENT IN TREASURY BILLS
NOTE

C ITB(1)=15.189999E9

C ITB(2)=1.2857143E9
C ITB(3)=1.125E9
C ITB(4)=40E9
C CTRCF(1)=1
C CTRCF(2)=1
C CTRCF(3)=1
C CTRCF(4)=1
C NCFLA(1)=.07
C NCFLA(2)=.75
C NCFLA(3)=.75
C NCFLA(4)=.0326756
C ACFI(1)=3
C ACFI(2)=3
C ACFI(3)=3
C ACFI(4)=5
C RCPTB(1)=-.0006667
C RCPTB(2)=-.0026667
C RCPTB(3)=-.0016667
C RCPTB(4)=.0035

NOTE
NOTE
NOTE

PARAMETERS FOR INVESTMENT IN GOVERNMENT BONDS

C IGB(1)=40E9
C IGB(2)=30E9
C IGB(3)=10E9
C IGB(4)=70E9
C NTAL(1)=2
C NTAL(2)=2
C NTAL(3)=2
C NTAL(4)=2
C RCPGB(1)=-.0016667
C RCPGB(2)=-.0036667
C RCPGB(3)=-.0026667
C RCPGB(4)=.0025

NOTE
NOTE
NOTE

PARAMETERS FOR LIABILITIES -- SAVINGS DEPOSITS

C ISD(1)=65E9
C ISD(2)=126.3E9
C ISD(3)=153.55E9
C CTSD(1)=1
C CTSD(2)=1
C CTSD(3)=1
C RCPSD(1)=-.002
C RCPSD(2)=-.002
C RCPSD(3)=-.002
C IRSD(1)=.045
C IRSD(2)=.045
C IRSD(3)=.045
C TARSD(1)=1
C TARSD(2)=1

C TARS(3)=1
NOTE
NOTE PARAMETERS FOR LIABILITIES -- EQUITY
NOTE
N IREA(L)=CREA(L)
N NRA(L)=RALI(L)
NOTE FPN9, MARCH 16, 1977
NOTE FINANCIAL PARAMETERS IN NATION
NOTE
NOTE PARAMETERS FOR PRIMARY LENDING
NOTE
C EMLAL=.25
T TMCFL=0/.4/.7/.88/1/1.09/1.13/1.15/1.16
T TMBFL=.3/.7/1/1.09/1.12
C NTABF=.25
T TMRR=0/.3/1/2/3.5/5.5/8
NOTE
NOTE PARAMETERS FOR RETURN ON LOANS OUTSTANDING
NOTE
T TMDRL=.2/.6/1/1.4/1.7/1.9/2
T TMPRL=1.6/1.2/1/.9/.85
T TMSRL=1.6/1.2/1/.9/.85
C TTSR=15
C WFSR=1
NOTE
NOTE PARAMETERS FOR INVESTMENT IN
NOTE TREASURY BILLS
NOTE
C ALTB=.5
T TMPGS=0/.32/.6/.82/1/1.07/1.12/1.13/1.14
T TMCTB=0/.4/.7/.88/1/1.09/1.13/1.15/1.16
C IRTB=.05
T TFCR=-2/-1.5/0/1.5/2/2.3/2.5
NOTE
NOTE PARAMETERS FOR INVESTMENT IN
NOTE GOVERNMENT BONDS
NOTE
C ALGB=6
T TMLGB=.2/.3/.5/1/1.5/2/2.5/3
T TMCGB=0/.4/.7/.88/1/1.09/1.13/1.15/1.16
C IRGB=.049
C TARB=1
C IECR=0
C PHPB=.25
NOTE
NOTE PARAMETERS FOR LIABILITIES
NOTE
C ALSD=.5
T TMCSD=0/.4/.7/.88/1/1.09/1.13/1.15/1.16
T TDFSD=.4/.1/.02/.001/.0005
T TMLRD=1.8/1.3/1/.85/.78/.75/.74

T TMPRD=.3/.7/1/1.12/1.15
T TMRSD=0/.3/1/2/3.5/5.5/8
C CWESD=1
C TTDLI=1
T TMPPD=.05/.1/.25/.6/1/1.25/1.45/1.6/1.7
T TMCPCD=0/.6/1/1.25/1.35/1.45/1.5
T TMEPCD=0/.6/1/1.35/1.5
C TARA=10
C WFRA=1

NOTE

NOTE PARAMETERS FOR BANK RESERVES AND CURRENCY

NOTE

C NBF=.01
C IERB=.4298931E9
T TMRBR=.1/.4/1/2.5/4.3/6.1/8.05/10
T TMCCW=.1/.15/.3/.6/1
T TMCCD=0/.5/.8/.95/1
C NTCA=1
T TMRRW=0/.6/.9/1/1
C TATM=.15

NOTE FPTG8, MARCH 16, 1977

NOTE FINANCIAL PARAMETERS FOR TEST GENERATOR

NOTE

N NDDF(1)=NLED(1)
N NDDF(2)=NLED(2)
N NDDF(3)=NLED(3)
C NPTL(1)=1
C NPTL(2)=7
C NPTL(3)=12
C TCLBTG(1)=.75
C TCLBTG(2)=1.5
C TCLBTG(3)=1.5
C CBCTG=1
N CDLTG(FF)=LOTG(FF)
C SDLTG(1)=0
C SDLTG(2)=0
C SDLTG(3)=0
C AMPSW(1)=0
C AMPSW(2)=0
C AMPSW(3)=0
C PERSW=4
C MNTG=0
C SDNTG(1)=0
C SDNTG(2)=0
C SDNTG(3)=0
C TCNTG=1
C TSDL=0
C IMTG=187.09348E9
C ILOTG(1)=148.4848E9
C ILOTG(2)=100E9
C ILOTG(3)=150E9

C NDFAN=.01
C SWTS=1
C TASAV=2
C ILASI=397.85E9
N CDSAV=SAV
C SDSAV=0
C TSDSAV=.5
C MNDS=0
C SDNDS=0
C TNDS=1
C NTSAV=0
C NGSAV=0
C CMRSAV=0
C TCTBM=.5
N CDTBM=TBM
C SDTBM=0
C TSDTBM=.5
C ITEM=18E9
C TCGBM=.5
N CDGBM=GBM
C IGBM=8E9
C TCTB=.4
N CDTBO=TBO
C TCGB=.75
N CDGBO=GBO
C IRRDD=.22
C IRRTD=.1
C RSH=0
C RST=0
C CTBRB=1
N IBRB=BRB
C CPRLO(1)=1
C CPRLO(2)=1
C CPRLO(3)=1
C CPRSD(1)=1
C CPRSD(2)=1
C CPRSD(3)=1
C LSTC=.75
C LLTC=1.5
C LMCH=1.5
C INT=0
C LGSM=.5
C LDTBO=.4
C LDGBO=.75
C CISAV=0
C SPFD=.25
C STSTC=1
C ESPTS=1974
C TASTC=1

NOTE
NOTE

FSTAT4, MARCH 16, 1977
COMPUTATION OF FINANCIAL STATISTICS

NOTE

NOTE

- S C1.K=COR(LO.K(1),STC.K,ITIME,ESPTS,INT) 1: LO(1) VS. STC
- S C2.K=COR(LO.K(2),LTC.K,ITIME,ESPTS,INT) 2: LO(2) VS. LTC
- S C3.K=COR(LO.K(3),MCH.K,ITIME,ESPTS,INT) 3: LO(3) VS. MCH
- S C4.K=COR(SLER.K(1),STLB.K,ITIME,ESPTS,INT) 4: SLER(1) VS. STLB
- S C5.K=COR(SLER.K(2),LTLCL.K,ITIME,ESPTS,INT) 5: SLER(2) VS. LTLCL
- S C6.K=COR(SLER.K(3),LTLML.K,ITIME,ESPTS,INT) 6: SLER(3) VS. LTLML
- S C7.K=COR(RFF.K,YFF.K,ITIME,ESPTS,INT) 7: RFF VS. YFF
- S C8.K=COR(RTB.K,YTB.K,ITIME,ESPTS,INT) 8: RTB VS. YTB
- S C9.K=COR(RGB.K,YGB.K,ITIME,ESPTS,INT) 9: RGR VS. YGB
- S C10.K=COR(RLO.K(1),YBC.K,ITIME,ESPTS,INT) 10: RLO(1) VS. YBC
- S C11.K=COR(RLO.K(2),YCB.K,ITIME,ESPTS,INT) 11: RLO(2) VS. YCB
- S C12.K=COR(RLO.K(3),YMCH.K,ITIME,ESPTS,INT) 12: RLO(3) VS. YMCH

NOTE

FTS5, MARCH 16, 1977

NOTE

TIME SERIES DATA FOR FINANCIAL SECTOR

NOTE

NOTE

- T TYFF=2.25/2.42/2.36/2.30/2.60/2.72/2.73/
- X 2.78/2.87/2.89/2.99/3.38/3.38/3.43/3.50/3.45/3.85/
- X 4.04/4.04/4.01/4.32/4.65/5.17/5.40/5.40/4.53/3.98/4.00/4.51/
- X 5.05/6.07/5.78/6.02/6.79/8.90/9.15/8.97/7.76/7.60/6.29/4.90/
- X 3.71/4.91/5.55/4.14/3.83/4.46/4.87/5.33/7.09/8.49/10.78/9.95/
- X 9.35/11.93/11.34/8.53/5.54/5.55/6.24/5.20
- T TYTB=2.50/2.54/2.54/2.68/2.88/2.87/
- X 2.80/2.93/2.91/2.95/3.08/3.50/3.66/3.72/3.56/3.68/3.94/
- X 4.00/3.86/4.07/4.54/4.78/4.65/5.79/4.98/4.22/3.88/4.96/5.49/
- X 5.33/5.64/5.26/6.05/6.16/6.75/7.31/7.89/6.59/6.86/6.47/
- X 4.89/3.50/4.95/4.97/4.23/4.12/4.35/5.13/5.30/6.51/7.23/8.45/
- X 7.56/7.83/8.12/8.53/7.11/5.62/5.61/6.92/5.85
- T TYGB=3.88/3.78/3.88/4.02/4.06/4.01/
- X 3.90/3.94/3.87/3.93/4.00/4.04/4.14/4.18/4.13/4.16/4.14/
- X 4.15/4.14/4.25/4.43/4.63/4.63/4.79/4.65/4.45/4.86/4.99/5.36/
- X 5.39/5.23/5.09/5.65/6.05/6.06/6.32/6.81/6.39/6.99/6.63/5.97/
- X 5.71/5.94/5.56/5.62/5.66/5.59/5.70/5.63/6.20/6.32/6.42/6.35/
- X 6.81/7.03/7.30/6.78/6.73/6.86/7.29/7.17
- T TYBC=4.99/4.97/4.97/4.99/4.96/
- X 4.98/5.01/4.99/5.02/5.00/5.01/5.01/5.00/4.99/
- X 4.99/4.98/5.00/4.97/4.99/5.00/5.27/5.55/5.82/
- X 6.30/6.31/6.13/5.95/5.94/5.96/6.36/6.84/6.89/
- X 6.61/7.32/7.86/8.82/8.83/8.86/8.49/8.50/8.07/
- X 6.58/6.00/6.51/6.18/5.52/5.59/5.84/6.33/6.52/
- X 7.35/9.24/10.08/9.91/11.15/12.40/11.64/9.94/8.16/8.24/8.29
- T TYCB=5.10/5.02/5.03/5.12/5.10/
- X 5.04/5.02/5.03/4.92/4.88/4.86/4.84/4.85/4.83/4.85/4.82/4.81/
- X 4.78/4.85/4.91/5.02/5.32/5.58/6.09/6.18/5.85/6.15/6.40/6.93/
- X 6.85/7.07/6.79/7.23/7.51/7.70/8.05/8.65/8.63/9.25/9.39/9.12/
- X 8.46/8.75/8.59/8.38/8.24/8.20/8.09/7.93/8.03/8.13/8.63/8.48/
- X 8.65/9.34/10.12/10.55/10.29/10.40/10.38/10.35
- T TYMCH=5.98/5.98/5.98/5.98/5.98/5.98/5.98/5.98/
- X 5.93/5.84/5.82/5.81/5.80/5.79/5.76/5.77/5.76/5.72/5.76/5.75/5.78

X /6.15/6.40/6.65/6.65/6.45/6.50/6.55/6.70/6.80/7.25/7.30/7.40/
X 7.65/8.00/8.25/8.35/8.55/8.55/8.50/8.30/7.60/7.70/7.85/7.70/
X 7.55/7.60/7.70/7.70/7.80/8.05/8.95/8.75/8.60/9.25/9.80/9.45/
X 8.90/9.00/9.25/9.15
T TSTB=77.1/78.5/83.1/83.4/88.1/
X 89.4/90.8/88.4/91.3/85.8/89.6/87.5/94.0/88.8/
X 86.4/87.8/93.7/92.7/92.9/97.9/99.1/97.6/95.2/
X 98.9/111.7/108.9/96.6/102.7/112.0/122.6/114.8/115.3/
X 117.9/113.0/114.0/123.2/129.3/133.0/117.7/121.7/137.1/
X 129.4/128.0/133.0/134.5/141.8/137.6/137.0/146.2/146.0/
X 139.7/145.0/157.6/161.5/155.9/159.3/164.1/174.0/179.9/
X 196.2/215.7
T TLTB=184.4/181.8/179.0/185.0/186.0/
X 186.8/186.4/192.3/196.0/203.6/201.4/205.4/203.4/210.4/
X 212.3/215.3/214.7/217.5/215.3/211.9/218.8/222.8/221.0/
X 221.6/216.6/222.9/227.7/231.3/231.8/228.3/232.9/242.5/
X 246.3/254.8/245.7/244.1/245.3/246.3/258.5/265.0/261.8/
X 273.2/276.3/279.6/294.1/294.1/294.1/298.6/304.8/308.8/
X 311.8/309.2/307.9/310.8/312.7/318.8/327.8/338.5/351.9/
X 362.2/373.5
T TTBM=15223/15511/14677/13387/17650/
X 16120/17197/17200/17741/17691/21490/19219/22580/19312/
X 18029/19954/21388/23573/27100/29456/24842/25771/26878/
X 27619/35360/33489/31781/30588/31484/39411/38436/34522/
X 28503/19822/32295/32685/36023/34244/26381/28390/36338/
X 33416/35117/37914/36032/36468/40085/37259/37750/40268/
X 37106/42494/46189/47032/50132/47881/45388/47019/45953/
X 46641/46845
T TGBM=12161/11177/12576/14412/11231/
X 12941/12466/12625/13079/13272/10537/13344/11013/14458/
X 16765/15396/15656/14018/12000/10318/15926/14963/15291/
X 15288/8922/11419/14937/16328/17628/10280/13794/18757/
X 24434/32583/21800/21449/21131/21541/31333/31585/25804/
X 30744/30401/29652/34186/33460/31271/32475/32156/34008/
X 37916/33723/32327/32451/30353/33154/35113/34399/38796/
X 40357/41089
T TSTC=109.1/107.7/108.8/110.9/115.4/
X 115.5/118.6/121.6/128.4/127.2/131.9/135.1/142.0/142.4/
X 149.5/151.8/159.5/162.5/171.6/173.7/183.3/184.0/191.8/
X 191.7/197.6/195.2/201.8/203.7/212.5/210.1/220.6/227.3/
X 240.1/238.6/257.3/257.7/269.3/261.6/270.1/274.5/281.7/
X 280.4/291.8/297.8/310.3/312.3/328.8/336.8/367.0/378.7/
X 403.2/410.1/435.6/438.0/463.5/466.3/481.2/462.9/466.8/
X 454.9/474.9
T TLTC=107.7/116.4/125.6/134.6/142.4/152.3/168.1/187.5/
X 207.0/224.5/249.6/278.5/305.8/332.2/363.5/403.1
T TRR1=.165/.165/.165/.165/.165/.165/.165/.165/.165/
X .165/.165/.165/.165/.165/.165/.17/.17/.175/.175/.175/
X .175/.175/.175/.175/.175/.175/.18/.18/.175/.165/.165
T TRR2=.05/.05/.05/.05/.04/.04/.04/.04/.04/
X .04/.04/.04/.06/.06/.06/.06/.06/.06/.06/


```
X      .05/.05/.05/.05/.05/.05/.05/.05/.06/.06/.06
T      TMCH=161.6/176.0/192.3/211.2/231.2/250.1/263.9/280.0/
X      298.5/319.0/338.2/374.6/425.9/476.1/514.0/560.3
NOTE   FPLOT3, MARCH 16, 1977
NOTE   FINANCIAL SECTOR PLOT STATEMENTS
NOTE
OPT    R,PLT=25,SVALL,DBG=1,PRL=10
SPEC   LENGTH=10
PRINT  LED
C      PRTPER=0
A      PLTPER.K=STEP(PLTP1,PLTS1)-STEP(PLTP1,PLTS2)
N      PLTPER=SWITCH(PLTP1,0,PLTS1)
C      PLTP1=.25
C      PLTS1=0
C      PLTS2=999
C      DT=.03125
N      TIME=ITIME
C      ITIME=0
RUN
```

B. Definitions

ABR	ACCEPTABLE BORROWED RESERVES (DOLLARS)
ACFI	ASSET CATEGORIES IN FINANCIAL INSTITUTION (DIMENSIONLESS)
ALGB	AVERAGE LIFE OF GOVERNMENT BONDS (YEARS)
ALSD	AVERAGE LIFE OF SAVINGS DEPOSITS (YEARS)
ALTB	AVERAGE LIFE OF TREASURY BILLS (YEARS)
ALTG	ARRIVAL OF LOANS IN TEST GENERATOR (DOLLARS/YEAR)
AMPSW	AMPLITUDE OF SINE WAVE (DOLLARS)
AMTG	ADDITION TO MONEY IN TEST GENERATOR (DOLLARS/YEAR)
ARA	AVERAGE RETURN ON ASSETS (FRACTION/YEAR)
AREA	ACCEPTABLE RATIO OF EQUITY TO ASSETS (DIMENSIONLESS)
ARGB	AVERAGE RETURN ON GOVERNMENT BONDS (FRACTION/YEAR)
ARLO	AVERAGE RETURN ON LOANS OUTSTANDING (FRACTION/YEAR)
ARSR	ACCEPTABLE RELATIVE SPREAD IN RETURNS (DIMENSIONLESS)
ARTB	AVERAGE RETURN ON TREASURY BILLS (FRACTION/ YEAR)
ASRA	ACCEPTABLE SPREAD IN RETURN ON ASSETS (FRACTION/YEAR)
ATM	AVERAGE TOTAL MONEY (DOLLARS)
ATRLO	ADJUSTMENT TIME FOR RETURN ON LOANS OUTSTANDING (YEARS)
BK	INDEX FOR BANK
BLR	BACKLOG OF LOAN REQUESTS (DOLLARS)
BLTG	BACKLOG OF LOANS IN TEST GENERATOR (DOLLARS)
BRB	BORROWED RESERVES OF BANK (DOLLARS)
CATRL	COEFFICIENT FOR ADJUSTMENT TIME FOR RETURN ON LOANS (DIMENSIONLESS)
CBCTG	COEFFICIENT FOR BACKLOG CORRECTION IN TEST GENERATOR (DIMENSIONLESS)
CBF	CORRECTION IN BORROWED FUNDS (DOLLARS/YEAR)
CCP	CORRECTION IN CURRENCY OF PUBLIC (DOLLARS/ YEAR)
CDGB	CORRECTION IN DESIRED GOVERNMENT BONDS (DOLLARS/YEAR)
CDGBM	CONSTANT DESIRED GOVERNMENT BONDS IN MONETARY AUTHORITY (DOLLARS)
CDGBO	CONSTANT DESIRED GOVERNMENT BONDS OUTSTANDING (DOLLARS)
CDLTG	CONSTANT DESIRED LOANS IN TEST GENERATOR (DOLLARS)
CDR	CURRENCY DEPOSIT RATE (DOLLARS/YEAR)
CDSAV	CONSTANT DESIRED SAVINGS (DOLLARS)

CDTB	CORRECTION IN DESIRED TREASURY BILLS (DOLLARS/YEAR)
CDTBM	CONSTANT DESIRED TREASURY BILLS IN MONETARY AUTHORITY (DOLLARS)
CDTBO	CONSTANT DESIRED TREASURY BILLS OUTSTANDING (DOLLARS)
CFFI	CASH FUNDS OF FINANCIAL INSTITUTION (DOLLARS)
CFRB	CONVERSION FACTOR FOR RESERVES OF BANK (DIMENSIONLESS)
CGBM	CORRECTION OF GOVERNMENT BONDS IN MONETARY AUTHORITY (DOLLARS/YEAR)
CISAV	COEFFICIENT FOR INCREASE IN SAVINGS (DIMENSIONLESS)
CLA	CORRECTION IN LIQUID ASSETS (DOLLARS/YEAR)
CLBTG	CORRECTION OF LOANS AND BACKLOG IN TEST GENERATOR (DOLLARS/YEAR)
CMRSAV	COEFFICIENT FOR MULTIPLIER FROM RETURNS ON SAVINGS (DIMENSIONLESS)
COR	CORRELATION MACRO
CORF	FUNCTION TO GENERATE TIME SERIES CORRELATION
CPRLO	CONSTANT PERMISSIBLE RETURN ON LOANS OUTSTANDING (FRACTION/YEAR)
CPRSD	CONSTANT PERMISSIBLE RETURN ON SAVINGS DEPOSITS (FRACTION/YEAR)
CREA	CURRENT RATIO OF EQUITY TO ASSETS (DIMENSIONLESS)
CRGB	CHANGE IN RETURN ON GOVERNMENT BONDS (FRACTION/YEAR/YEAR)
CRLO	CHANGE IN RETURN ON LOANS OUTSTANDING (FRACTION/YEAR/YEAR)
CRSD	CHANGE IN RETURN ON SAVINGS DEPOSITS (FRACTION/YEAR/YEAR)
CRSR	CURRENT RELATIVE SPREAD IN RETURNS (DIMENSIONLESS)
CRTB	CHANGE IN RETURN ON TREASURY BILLS (FRACTION/YEAR/YEAR)
CTBM	CORRECTION OF TREASURY BILLS IN MONETARY AUTHORITY (DOLLARS/YEAR)
CTBRB	COEFFICIENT FOR TESTING BORROWED RESERVES OF BANK (DIMENSIONLESS)
CTFS	COEFFICIENT FOR TESTING FINANCIAL SECTOR (DIMENSIONLESS)
CTM	CHANGE IN TOTAL MONEY (DOLLARS/YEAR)
CTRCF	COEFFICIENT FOR TESTING RELATIVE CASH FUNDS (DIMENSIONLESS)
CTSD	COEFFICIENT FOR TESTING SAVINGS DEPOSITS (DIMENSIONLESS)
CVCS	CONSTANT VALUE OF COMMON STOCK (DOLLARS)
CWESD	COEFFICIENT FOR WITHDRAWAL OF EARNINGS ON

	SAVINGS DEPOSITS (DIMENSIONLESS)
CWR	CURRENCY WITHDRAWAL RATE (DOLLARS/YEAR)
DBTG	DESIRED BACKLOG IN TEST GENERATOR (DOLLARS)
DCF	DESIRED CASH FUNDS (DOLLARS)
DCP	DESIRED CURRENCY IN PUBLIC (DOLLARS)
DDEP	DEMAND DEPOSITS (DOLLARS)
DDF	DELIVERY DELAY FOR FACTOR (YEARS)
DFA	DEFAULT FRACTION ON ACCOUNTS (FRACTION/ YEAR)
DFL	DEFAULT FRACTION ON LOANS (FRACTION/YEAR)
DFSD	DEFAULT FRACTION ON SAVINGS DEPOSITS (FRACTION/YEAR)
DGBM	DESIRED GOVERNMENT BONDS IN MONETARY AUTHORITY (DOLLARS)
DGBO	DESIRED GOVERNMENT BONDS OUTSTANDING (DOLLARS)
DLA	DESIRED LIQUID ASSETS (DOLLARS)
DLFS	DESIRED LIQUID FRACTION OF SAVINGS (FRACTION)
DLO	DEFAULTS ON LOANS OUTSTANDING (DOLLARS/ YEAR)
DLTG	DESIRED LOANS IN TEST GENERATOR (DOLLARS)
DPGB	DESIRED PURCHASE OF GOVERNMENT BONDS (DOLLARS/YEAR)
DPGBM	DESIRED PURCHASE OF GOVERNMENT BONDS BY MONETARY AUTHORITY (DOLLARS/YEAR)
DPTB	DESIRED PURCHASE OF TREASURY BILLS (DOLLARS/YEAR)
DPTBM	DESIRED PURCHASE OF TREASURY BILLS BY MONETARY AUTHORITY (DOLLARS/YEAR)
DRCM	DESIRED RATIO OF CURRENCY TO MONEY (DIMENSIONLESS)
DRLO	DESIRED RETURN ON LOANS OUTSTANDING (FRACTION/YEAR)
DRSD	DESIRED RETURN ON SAVINGS DEPOSITS (FRACTION/YEAR)
DSAV	DESIRED SAVINGS (DOLLARS)
DSDL	DEFAULTS ON SAVINGS DEPOSITS OF LENDER (DOLLARS/YEAR)
DSGB	DESIRED SALE OF GOVERNMENT BONDS (DOLLARS/ YEAR)
DSTB	DESIRED SALE OF TREASURY BILLS (DOLLARS/ YEAR)
DT	TIME STEP FOR INTEGRATION (YEARS)
DTBM	DESIRED TREASURY BILLS IN MONETARY AUTHORITY (DOLLARS)
DTBO	DESIRED TREASURY BILLS OUTSTANDING (DOLLARS)
DTG	DEFAULTS IN TEST GENERATOR (DOLLARS/YEAR)
ECRB	EXPECTED CHANGE IN RETURN ON BONDS (FRACTION/YEAR)

ELI	EQUITY IN LENDING INSTITUTION (DOLLARS)
EMLAL	EXPONENT FOR MULTIPLIER FROM LIQUID ASSETS ON LENDING (DIMENSIONLESS)
ERB	EXCESS RESERVES OF BANK (DOLLARS)
ERGB	EFFECTIVE RETURN ON GOVERNMENT BONDS (FRACTION/YEAR)
ERLO	EFFECTIVE RETURN ON LOANS OUTSTANDING (FRACTION/YEAR)
ERSD	EFFECTIVE RETURN ON SAVINGS DEPOSITS (FRACTION/YEAR)
ESAV	EARNINGS ON SAVINGS (DOLLARS/YEAR)
ESD	EARNINGS ON SAVINGS DEPOSITS (DOLLARS/YEAR)
ESPTS	END OF SAMPLING PERIOD FOR TIME SERIES (TIME)
FCRGB	FRACTIONAL CHANGE IN RETURN ON GOVERNMENT BONDS (FRACTION/YEAR)
FCRTB	FRACTIONAL CHANGE IN RETURN ON TREASURY BILLS (FRACTION/YEAR)
FF	INDEX FOR FINANCIAL FACTORS
FI	INDEX FOR FINANCIAL INSTITUTIONS
GB	GOVERNMENT BONDS (DOLLARS)
GBM	GOVERNMENT BONDS IN MONETARY AUTHORITY (DOLLARS)
GBO	GOVERNMENT BONDS OUTSTANDING (DOLLARS)
IBRB	INITIAL BORROWED RESERVES OF BANK (DOLLARS)
IECR	INITIAL EXPECTED CHANGE IN RETURN (FRACTION/YEAR)
IERB	INITIAL EXCESS RESERVES OF BANK (DOLLARS)
IGB	INITIAL GOVERNMENT BONDS (DOLLARS)
IGBM	INITIAL GOVERNMENT BONDS IN MONETARY AUTHORITY (DOLLARS)
ILASI	INITIAL LIQUID ASSETS OF SAVINGS INVESTOR (DOLLARS)
ILER	INDICATED LOAN EXTENSION RATE (DOLLARS/ YEAR)
ILOTG	INITIAL LOANS OUTSTANDING IN TEST GENERATOR (DOLLARS)
IMTG	INITIAL MONEY IN TEST GENERATOR (DOLLARS)
INBL	INCREASE IN NON-BANK LIQUIDITY (DOLLARS/ YEAR)
INBLA	INITIAL NON-BANK LIQUID ASSETS (DOLLARS)
INPUT	INPUT TO TRND MACRO
INT	INTERVAL FOR CORRELATION FUNCTION (YEARS)
IRDAT	INDEX OF RETURNS FROM DATA (FRACTION/YEAR)
IREA	INITIAL RATIO OF EQUITY TO ASSETS (DIMENSIONLESS)
IRGB	INITIAL RETURN ON GOVERNMENT BONDS (FRACTION/YEAR)
IRLO	INITIAL RETURN ON LOANS OUTSTANDING (FRACTION/YEAR)
IRMOD	INDEX OF RETURNS FROM MODEL (FRACTION/YEAR)

IRRDD	INITIAL RESERVE RATIO ON DEMAND DEPOSITS (FRACTION)
IRRL	INTEREST RATE FOR REPAYMENT OF LOANS (FRACTION/YEAR)
IRRTD	INITIAL RESERVE RATIO ON TIME DEPOSITS (FRACTION)
IRSD	INITIAL RETURN ON SAVINGS DEPOSITS (FRACTION/YEAR)
IRTB	INITIAL RETURN ON TREASURY BILLS (FRACTION/ YEAR)
ISAV	INCREASE IN SAVINGS (DOLLARS/YEAR)
ISD	INITIAL SAVINGS DEPOSITS (DOLLARS)
ITB	INITIAL TREASURY BILLS (DOLLARS)
ITBM	INITIAL TREASURY BILLS IN MONETARY AUTHORITY (DOLLARS)
L	INDEX FOR LENDERS
LA	LIQUID ASSETS (DOLLARS)
LAR	LIQUID ASSETS RATIO (DIMENSIONLESS)
LASI	LIQUID ASSETS OF SAVINGS INVESTOR (DOLLARS)
LDGBO	LEAD FOR DESIRED GOVERNMENT BONDS OUTSTANDING (YEARS)
LDTBO	LEAD FOR DESIRED TREASURY BILLS OUTSTANDING (YEARS)
LED	LOAN EXTENSION DELAY (YEARS)
LER	LOAN EXTENSION RATE (DOLLARS/YEAR)
LGSM	LEAD FOR GOVERNMENT SECURITIES IN MONETARY AUTHORITY (YEARS)
LLTC	LEAD IN LONG-TERM CREDIT (YEARS)
LMCH	LEAD IN MORTGAGE CREDIT TO HOUSEHOLDS (YEARS)
LO	LOANS OUTSTANDING (DOLLARS)
LOTG	LOANS OUTSTANDING IN TEST GENERATOR (DOLLARS)
LSTC	LEAD IN SHORT-TERM CREDIT (YEARS)
LTC	LONG-TERM CREDIT (DOLLARS)
LTLCL	LONG-TERM LENDING OF CORPORATE LENDER (DOLLARS/YEAR)
LTLML	LONG-TERM LENDING OF MORTGAGE LENDER (DOLLARS/YEAR)
MBFL	MULTIPLIER FROM BORROWED FUNDS ON LENDING (DIMENSIONLESS)
MCCD	MULTIPLIER FROM CURRENCY ON CURRENCY DEPOSITS (DIMENSIONLESS)
MCCW	MULTIPLIER FROM CURRENCY CORRECTION ON WITHDRAWALS (DIMENSIONLESS)
MCFL	MULTIPLIER FROM CASH FUNDS ON LENDING (DIMENSIONLESS)
MCGB	MULTIPLIER FROM CASH ON GOVERNMENT BONDS (DIMENSIONLESS)
MCH	MORTGAGE CREDIT TO HOUSEHOLDS (DOLLARS)
MCPD	MULTIPLIER FROM CASH ON PAYMENT OF

	DIVIDENDS (DIMENSIONLESS)
MCSD	MULTIPLIER FROM CASH ON SAVINGS DEPOSITS (DIMENSIONLESS)
MCTB	MULTIPLIER FROM CASH ON PURCHASE OF TREASURY BILLS (DIMENSIONLESS)
MDRL	MULTIPLIER FROM DEMAND ON RETURN ON LOANS (DIMENSIONLESS)
MEPD	MULTIPLIER FROM EQUITY ON PAYMENT OF DIVIDENDS (DIMENSIONLESS)
MGB	MATURITY OF GOVERNMENT BONDS (DOLLARS/YEAR)
MGBM	MATURITY OF GOVERNMENT BONDS IN MONETARY AUTHORITY (DOLLARS/YEAR)
MIN	FUNCTION FOR MINIMUM VALUE
MLAL	MULTIPLIER FROM LIQUID ASSETS ON LENDING (DIMENSIONLESS)
MLER	MULTIPLIER ON LOAN EXTENSION RATE (DIMENSIONLESS)
MLGB	MULTIPLIER FROM LIQUIDITY ON GOVERNMENT BONDS (DIMENSIONLESS)
MLRD	MULTIPLIER FROM LIQUIDITY ON RETURN ON DEPOSITS (DIMENSIONLESS)
MLTG	MATURITY OF LOANS IN TEST GENERATOR (DOLLARS/YEAR)
MNDS	MEAN OF NOISE IN DESIRED SAVINGS (DIMENSIONLESS)
MNTG	MEAN OF NOISE IN TEST GENERATOR (DIMENSIONLESS)
MPGB	MULTIPLIER ON PURCHASE OF GOVERNMENT BONDS (DIMENSIONLESS)
MPPD	MULTIPLIER FROM PROFIT ON PAYMENT OF DIVIDENDS (DIMENSIONLESS)
MPRD	MULTIPLIER FROM PROFIT ON RETURN ON DEPOSITS (DIMENSIONLESS)
MPRL	MULTIPLIER FROM PROFIT ON RETURN ON LOANS (DIMENSIONLESS)
MPTB	MULTIPLIER ON PURCHASE OF TREASURY BILLS (DIMENSIONLESS)
MRBR	MULTIPLIER FROM RELATIVE BORROWED RESERVES (DIMENSIONLESS)
MRFF	MULTIPLIER FOR RETURN ON FEDERAL FUNDS (DIMENSIONLESS)
MRGB	MULTIPLIER FROM RETURN ON GOVERNMENT BONDS (DIMENSIONLESS)
MRRL	MULTIPLIER FROM RELATIVE RETURN ON LENDING (DIMENSIONLESS)
MRRW	MULTIPLIER FROM RELATIVE RESERVES ON WITHDRAWALS (DIMENSIONLESS)
MRSV	MULTIPLIER FROM RETURNS ON SAVING (DIMENSIONLESS)
MRS	MULTIPLIER FROM RETURN ON SAVINGS DEPOSITS (DIMENSIONLESS)

MRTB MULTIPLIER FROM RETURN ON TREASURY BILLS
(DIMENSIONLESS)

MSD MATURITY OF SAVINGS DEPOSITS (DOLLARS/YEAR)

MSRL MULTIPLIER FROM SPREAD ON RETURN ON LOANS
(DIMENSIONLESS)

MTB MATURITY OF TREASURY BILLS (DOLLARS/YEAR)

MTBM MATURITY OF TREASURY BILLS IN MONETARY
AUTHORITY (DOLLARS/YEAR)

MTG MONEY IN TEST GENERATOR (DOLLARS)

NALL NORMAL AVERAGE LIFE OF LOANS (YEARS)

NBF NORMAL BORROWING FRACTION (FRACTION)

NBL INDEX FOR NON-BANK LENDERS

NBLA NON-BANK LIQUID ASSETS (DOLLARS)

NCFLA NORMAL CASH FRACTION OF LIQUID ASSETS
(FRACTION)

NDDF NORMAL DELIVERY DELAY FOR FACTOR (YEARS)

NDFAN NORMAL DEFAULT FRACTION ON ACCOUNTS IN
NATION (FRACTION/YEAR)

NDSAV NOISE IN DESIRED SAVINGS (DIMENSIONLESS)

NGSAV NORMAL GROWTH IN SAVINGS (FRACTION/YEAR)

NLCL NORMAL LIQUIDITY COVERAGE FOR LENDING
(YEARS)

NLED NORMAL LOAN EXTENSION DELAY (YEARS)

NLFS NORMAL LIQUID FRACTION OF SAVINGS
(FRACTION)

NPTL NORMAL PAYMENT TIME ON LOANS (YEARS)

NRA NORMAL RETURN ON ASSETS (FRACTION/YEAR)

NRLTG NOISE IN REQUEST FOR LOANS IN TEST
GENERATOR (DIMENSIONLESS)

NRSR NORMAL RELATIVE SPREAD ON RETURNS
(DIMENSIONLESS)

NTABF NORMAL TIME TO ADJUST BORROWED FUNDS
(YEARS)

NTAL NORMAL TIME TO ADJUST LIQUIDITY (YEARS)

NTCA NORMAL TIME FOR CURRENCY ADJUSTMENT (YEARS)

NTSAV NORMAL TURNOVER IN SAVINGS (FRACTION/YEAR)

OCLI OPERATING COSTS OF LENDING INSTITUTION
(DOLLARS/YEAR)

ORB OWNED RESERVES OF BANK (DOLLARS)

PCA PARAMETER FOR COST OF ASSETS (FRACTION/
YEAR)

PCT PARAMETER FOR COST OF TRANSACTIONS
(DIMENSIONLESS)

PDLI PAYMENT OF DIVIDENDS BY LENDING INSTITUTION
(DOLLARS/YEAR)

PDSI PURCHASE OF DEPOSITS BY SAVINGS INVESTOR
(DOLLARS/YEAR)

PERSW PERIOD OF SINE WAVE (YEARS)

PGB PURCHASE OF GOVERNMENT BONDS (DOLLARS/YEAR)

PGBM PURCHASE OF GOVERNMENT BONDS BY MONETARY
AUTHORITY (DOLLARS/YEAR)

PHPB	PLANNING HORIZON FOR PURCHASE OF BONDS (YEARS)
PITG	PAYMENT OF INTEREST IN TEST GENERATOR (DOLLARS/YEAR)
PKNS	FUNCTION TO GENERATE PINK NOISE
PLI	PROFIT OF LENDING INSTITUTION (DOLLARS/ YEAR)
PLTPER	PLOT PERIOD (YEARS)
PLTP1	PLOT PERIOD ONE (YEARS)
PLTS1	PLOT PERIOD SWITCH ONE (TIME)
PLTS2	PLOT PERIOD SWITCH TWO (TIME)
PRLO	PERMISSIBLE RETURN ON LOANS OUTSTANDING (FRACTION/YEAR)
PRSD	PERMISSIBLE RETURN ON SAVINGS DEPOSITS (FRACTION/YEAR)
PTB	PURCHASE OF TREASURY BILLS (DOLLARS/YEAR)
PTBM	PURCHASE OF TREASURY BILLS BY MONETARY AUTHORITY (DOLLARS/YEAR)
RALI	RETURN ON ASSETS OF LENDING INSTITUTION (FRACTION/YEAR)
RB	RESERVES OF BANK (DOLLARS)
RBRR	RELATIVE BORROWED RESERVE RATIO (DIMENSIONLESS)
RCAS	RATIO OF CURRENT TO ACCEPTABLE SPREAD (DIMENSIONLESS)
RCF	RELATIVE CASH FUNDS (DIMENSIONLESS)
RCPGB	RISK AND COST PREMIUM ON GOVERNMENT BONDS (FRACTION/YEAR)
RCPL	RISK AND COST PREMIUM ON LOANS (FRACTION/ YEAR)
RCPSD	RISK AND COST PREMIUM ON SAVINGS DEPOSITS (FRACTION/YEAR)
RCPTB	RISK AND COST PREMIUM ON TREASURY BILLS (FRACTION/YEAR)
RDGB	RELATIVE DESIRED GOVERNMENT BONDS (FRACTION/YEAR)
RDTB	RELATIVE DESIRED TREASURY BILLS (FRACTION/ YEAR)
RFF	RETURN ON FEDERAL FUNDS (FRACTION/YEAR)
RGB	RETURN ON GOVERNMENT BONDS (FRACTION/YEAR)
RIGB	RECEIPT OF INTEREST ON GOVERNMENT BONDS (DOLLARS/YEAR)
RILO	RECEIPT OF INTEREST ON LOANS OUTSTANDING (DOLLARS/YEAR)
RITB	RECEIPT OF INTEREST ON TREASURY BILLS (DOLLARS/YEAR)
LO	RETURN ON LOANS OUTSTANDING (FRACTION/YEAR)
RLOTG	REPAYMENT OF LOANS OUTSTANDING IN TEST GENERATOR (DOLLARS/YEAR)
RLTG	REQUESTS FOR LOANS IN TEST GENERATOR (DOLLARS/YEAR)

RMTG	REDUCTION IN MONEY IN TEST GENERATOR (DOLLARS/YEAR)
RNBL	REDUCTION IN NON-BANK LIQUIDITY (DOLLARS/ YEAR)
RPLI	RELATIVE PROFIT OF LENDING INSTITUTION (DIMENSIONLESS)
RPYL	REPAYMENT OF LOANS (DOLLARS/YEAR)
RRA	REQUIRED RETURN ON ASSETS (FRACTION/YEAR)
RRB	REQUIRED RESERVES OF BANK (DOLLARS)
RRDD	RESERVE RATIO ON DEMAND DEPOSITS (FRACTION)
RRGB	RELATIVE RETURN ON GOVERNMENT BONDS (DIMENSIONLESS)
RRL	RELATIVE RETURN ON LOANS (DIMENSIONLESS)
RRSD	RELATIVE RETURN ON SAVINGS DEPOSITS (DIMENSIONLESS)
RRTB	RELATIVE RETURN ON TREASURY BILLS (DIMENSIONLESS)
RRTD	RESERVE RATIO ON TIME DEPOSITS (FRACTION)
RR1	RESERVE RATIO 1 (FRACTION)
RR2	RESERVE RATIO 2 (FRACTION)
RSV	REDUCTION IN SAVINGS (DOLLARS/YEAR)
RSD	RETURN ON SAVINGS DEPOSITS (FRACTION/YEAR)
RSH	RESERVE STEP HEIGHT (FRACTION)
RST	RESERVE STEP TIME (TIME)
RTB	RETURN ON TREASURY BILLS (FRACTION/YEAR)
SAV	SAVINGS (DOLLARS)
SBRB	STANDARD BORROWED RESERVES OF BANK (DOLLARS)
SCT	STANDARD CURRENCY TURNOVER (DOLLARS/YEAR)
SD	SAVINGS DEPOSITS (DOLLARS)
SDLTG	STEP IN DESIRED LOANS IN TEST GENERATOR (DOLLARS)
SDNDS	STANDARD DEVIATION OF NOISE IN DESIRED SAVINGS (DIMENSIONLESS)
SDNTG	STANDARD DEVIATION OF NOISE IN TEST GENERATOR (DIMENSIONLESS)
SDSAV	STEP IN DESIRED SAVINGS (DOLLARS)
SDBTM	STEP IN DESIRED TREASURY BILLS IN MONETARY AUTHORITY (DOLLARS)
SI	INDEX FOR SAVINGS INVESTOR
SIN	FUNCTION TO GENERATE SINE WAVE INPUT
SLER	SAMPLED LOAN EXTENSION RATE (DOLLARS/YEAR)
SPFD	SAMPLING PERIOD FOR FIRST DIFFERENCE (YEARS)
SRLO	STANDARD RETURN ON LOANS OUTSTANDING (FRACTION/YEAR)
SRSD	STANDARD RETURN ON SAVINGS DEPOSITS (FRACTION/YEAR)
STC	SHORT-TERM CREDIT (DOLLARS)
STEP	FUNCTION TO GENERATE STEP INPUT
STLB	SHORT-TERM LENDING OF BANKS (DOLLARS/YEAR)

STSTC	SMOOTHING TIME FOR SHORT-TERM CREDIT (YEARS)
SUMV	FUNCTION FOR SUM OF VECTORS
SWTS	SWITCH FOR TIME SERIES (DIMENSIONLESS)
TALI	TOTAL ASSETS OF LENDING INSTITUTION (DOLLARS)
TARA	TIME TO AVERAGE RETURN ON ASSETS (YEARS)
TARB	TIME TO AVERAGE RETURN ON BONDS (YEARS)
TARLO	TIME TO ADJUST RETURN ON LOANS OUTSTANDING (YEARS)
TARSD	TIME TO ADJUST RETURN ON SAVINGS DEPOSITS (YEARS)
TASAV	TIME TO ADJUST SAVINGS (YEARS)
TASTC	TIME TO AVERAGE SHORT-TERM CREDIT (YEARS)
TATM	TIME TO AVERAGE TOTAL MONEY (YEARS)
TB	TREASURY BILLS (DOLLARS)
TBM	TREASURY BILLS IN MONETARY AUTHORITY (DOLLARS)
TBO	TREASURY BILLS OUTSTANDING (DOLLARS)
TCGB	TIME TO CORRECT GOVERNMENT BONDS (YEARS)
TCGBM	TIME TO CORRECT GOVERNMENT BONDS IN MONETARY AUTHORITY (YEARS)
TCLBTG	TIME TO CORRECT LOANS AND BACKLOG IN TEST GENERATOR (YEARS)
TCNTG	TIME CONSTANT OF NOISE IN TEST GENERATOR (YEARS)
TCP	TOTAL CURRENCY IN PUBLIC (DOLLARS)
TCTB	TIME TO CORRECT TREASURY BILLS (YEARS)
TCTBM	TIME TO CORRECT TREASURY BILLS IN MONETARY AUTHORITY (YEARS)
TDCS	TOTAL DIVIDENDS ON COMMON STOCK (DOLLARS/ YEAR)
TDFSD	TABLE FOR DEFAULT FRACTION ON SAVINGS DEPOSITS
TDLI	TRADITIONAL DIVIDENDS OF LENDING INSTITUTION (DOLLARS/YEAR)
TDPGB	TOTAL DESIRED PURCHASE OF GOVERNMENT BONDS (DOLLARS/YEAR)
TDPTB	TOTAL DESIRED PURCHASE OF TREASURY BILLS (DOLLARS/YEAR)
TES	TOTAL EARNINGS ON SAVINGS (DOLLARS/YEAR)
TFCR	TABLE FOR FRACTIONAL CHANGE IN RETURN
TFE	TOTAL FINANCIAL FACTORS
TFI	TOTAL FINANCIAL INSTITUTIONS
TGBM	TABLE FOR GOVERNMENT BONDS IN MONETARY AUTHORITY
TIS	TOTAL INCREASE IN SAVINGS (DOLLARS/YEAR)
TL	TOTAL LENDERS
TLI	TAX ON LENDING INSTITUTION (DOLLARS/YEAR)
TLTB	TABLE FOR LONG-TERM BONDS
TLTC	TABLE FOR LONG-TERM CREDIT

TM	TOTAL MONEY (DOLLARS)
TMBFL	TABLE FOR MULTIPLIER FROM BORROWED FUNDS ON LENDING
TMCCD	TABLE FOR MULTIPLIER FROM CORRECTION IN CURRENCY ON DEPOSITS
TMCCW	TABLE FOR MULTIPLIER FROM CURRENCY CORRECTION ON WITHDRAWALS
TMCFL	TABLE FOR MULTIPLIER FROM CASH FUNDS ON LENDING
TMCGB	TABLE FOR MULTIPLIER FROM CASH ON GOVERNMENT BONDS
TMCH	TABLE FOR MORTGAGE CREDIT TO HOUSEHOLDS
TMCPD	TABLE FOR MULTIPLIER FROM CASH ON PAYMENT OF DIVIDENDS
TMCSO	TABLE FOR MULTIPLIER FROM CASH ON SAVINGS DEPOSITS
TMCTB	TABLE FOR MULTIPLIER FROM CASH ON PURCHASE OF TREASURY BILLS
TMDRL	TABLE FOR MULTIPLIER FROM DEMAND ON RETURN ON LOANS
TMEPD	TABLE FOR MULTIPLIER FROM EQUITY ON PAYMENT OF DIVIDENDS
TMLGB	TABLE FOR MULTIPLIER FROM LIQUIDITY ON GOVERNMENT BONDS
TMLRD	TABLE FOR MULTIPLIER FROM LIQUIDITY ON RETURN ON DEPOSITS
TMPGS	TABLE FOR MULTIPLIER ON PURCHASE OF GOVERNMENT SECURITIES
TMPPD	TABLE FOR MULTIPLIER FROM PROFIT ON PAYMENT OF DIVIDENDS
TMPRD	TABLE FOR MULTIPLIER FROM PROFIT ON RETURN ON DEPOSITS
TMPRL	TABLE FOR MULTIPLIER FROM PROFIT ON RETURN ON LOANS
TMRBR	TABLE FOR MULTIPLIER FROM RESERVES ON BORROWED RESERVES
TMRF	TABLE FOR MULTIPLIER ON RETURN ON FEDERAL FUNDS (DIMENSIONLESS)
TMRR	TABLE FOR MULTIPLIER FROM RELATIVE RETURNS
TMRRW	TABLE FOR MULTIPLIER FROM RELATIVE RESERVES ON WITHDRAWALS
TMRSD	TABLE FOR MULTIPLIER FROM RETURN ON SAVINGS DEPOSITS
TMSRL	TABLE FOR MULTIPLIER FROM SPREAD ON RETURN ON LOANS
TNDS	TIME FOR NOISE IN DESIRED SAVINGS (YEARS)
TPAY	TOTAL PAYMENTS (DOLLARS/YEAR)
TRA	TRADITIONAL RETURN ON ASSETS (DOLLARS/YEAR)
TRND	FUNCTION TO GENERATE TREND
TRR1	TABLE FOR RESERVE RATIO ONE
TRR2	TABLE FOR RESERVE RATIO TWO

TRS	TOTAL REDUCTION IN SAVINGS (DOLLARS/YEAR)
TRSR	TRADITIONAL RELATIVE SPREAD IN RETURNS (DIMENSIONLESS)
TSAV	TOTAL SAVINGS (DOLLARS)
TSDL	TIME TO STEP DESIRED LOANS (TIME)
TSDSAV	TIME TO STEP DESIRED SAVINGS (TIME)
TSDTBM	TIME TO STEP DESIRED TREASURY BILLS IN MONETARY AUTHORITY (YEARS)
TSTB	TABLE FOR SHORT-TERM BONDS
TSTC	TABLE FOR SHORT-TERM CREDIT
TTBM	TABLE FOR TREASURY BILLS IN MONETARY AUTHORITY
TTDLI	TIME FOR TRADITIONAL DIVIDENDS OF LENDING INSTITUTION (YEARS)
TTSR	TIME FOR TRADITIONAL SPREAD IN RETURNS (YEARS)
TYBC	TABLE FOR YIELD ON BANK CREDIT
TYCB	TABLE FOR YIELD ON CORPORATE BONDS
TYFF	TABLE FOR YIELD ON FEDERAL FUNDS
TYGB	TABLE FOR YIELD ON GOVERNMENT BONDS
TYMCH	TABLE FOR YIELD ON MORTGAGE CREDIT TO HOUSEHOLDS
TYTB	TABLE FOR YIELD ON TREASURY BILLS
VCS	VALUE OF COMMON STOCK (DOLLARS)
VOMO	VALUE OF OPEN MARKET OPERATIONS (DOLLARS/ YEAR)
WDSI	WITHDRAWAL OF DEPOSITS BY SAVINGS INVESTOR (DOLLARS/YEAR)
WFRA	WEIGHTING FACTOR FOR RETURN ON ASSETS (DIMENSIONLESS)
WFSR	WEIGHTING FACTOR FOR SPREAD IN RETURNS (DIMENSIONLESS)
WRS	WEIGHTED RETURN ON SAVINGS (FRACTION/YEAR)
XDGBM	EXOGENOUS DESIRED GOVERNMENT BONDS IN MONETARY AUTHORITY (DOLLARS)
XDGBO	EXOGENOUS DESIRED GOVERNMENT BONDS OUTSTANDING (DOLLARS)
XDLTG	EXOGENOUS DESIRED LOANS IN TEST GENERATOR (DOLLARS)
XDSAV	EXOGENOUS DESIRED SAVINGS (DOLLARS)
XDTBM	EXOGENOUS DESIRED TREASURY BILLS IN MONETARY AUTHORITY (DOLLARS)
XDTBO	EXOGENOUS DESIRED TREASURY BILLS OUTSTANDING (DOLLARS)
YBC	YIELD ON BANK CREDIT (FRACTION/YEAR)
YCB	YIELD ON CORPORATE BONDS (FRACTION/YEAR)
YFF	YIELD ON FEDERAL FUNDS (FRACTION/YEAR)
YGB	YIELD ON GOVERNMENT BONDS (FRACTION/YEAR)
YMCH	YIELD ON MORTGAGE CREDIT TO HOUSEHOLDS (FRACTION/YEAR)
YTB	YIELD ON TREASURY BILLS (FRACTION/YEAR)

APPENDIX 4

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