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AN ECONOMIC AND FINANCIAL
PROJECTIONS MODEL OF THE
U.S. FARMING SECTOR

presented by

Timothy Guy Baker

has been accepted towards fulfillment
of the requirements for

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Major professor

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Submitted to
Michigan State University
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for the degree of

DOCTOR OF PHILOSOPHY

Department of Agricultural Economics

1978

AN ECONOMIC AND FINANCIAL

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U.S. FARMING SECTOR

By

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ABSTRACT

AN ECONOMIC AND FINANCIAL PROJECTIONS MODEL OF THE U.S. FARMING SECTOR

By

Timothy Guy Baker

Decisions affecting the financial structure of the U.S. farming sector are continually being made in the public and private sectors. Knowledge of the relationship among system variables, both controllable and uncontrollable, is necessary for informed decision making. Additionally, projections of system performance under alternative policies for controllable exogenous variables and under alternative scenarios for uncontrollable exogenous variables would be useful information for a large number of public and private decisions dependent upon or affected by the long-run outlook for the financial structure of the farming sector.

In this study a model of the aggregate U.S. farming sector is developed for use in making long run economic and financial projections. The performance variables focused on are those appearing on the financial statements of the farming sector. These include the Balance Sheet, Income Statement, and Sources and Uses of Funds Statement. Other financial statements developed and projected in the study include statements of capital gains and capital formation. Numerous analytical ratios are calculated from these financial data for evaluative purposes.

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The theoretical basis of the model is static economic theory with only minor modifications. Equations were estimated using econometric techniques when data were available to support these forms of estimation.

Endogenous variables in the model include the supply and utilization quantities and prices of aggregate crops and livestock. These variables are simultaneously determined. Crop imports and exports and livestock imports, exports, and inventories are exogenous. The quantities of farm inputs including nondurable inputs, durable assets, and the net flow of loan funds are also endogenous. The prices of most of the inputs, including interest rates, are exogenous.

The model includes equations for projecting intersector flows associated with entering and exiting proprietors. Consumption of nondurable goods and services by farm operator families and other uses of funds are also endogenous variables. These components are based on very weak data.

Important exogenous variables in addition to those mentioned above include the rate of inflation, gross national product, and U.S. population.

Projections are made under several scenarios. A scenario with exogenous variables at levels considered likely to occur is the base scenario. Alternative scenarios are generated by changing one exogenous variable at a time. The alternative projections give indications of the impacts of deviations of the exogenous variables from the levels in the base scenario.

Results from the projections show that the prices of crops and livestock, and therefore net farm income, are substantially increased under a level of

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under a level of crop production moderately lower than the 1977-78 crop year. In comparison to the base scenario, substantial reductions in crop and livestock prices and net farm income occur under low growth in real gross national product or no growth in livestock inventory.

Capital gains are projected to be large in future years relative to years before 1972. Higher levels of inflation result in substantially higher levels of capital gains. Moderately larger capital gains result under lower crop production.

The debt needs of the farming sector are projected to continue growing at a rate that results in increased leverage for the sector. The increase in leverage is less under higher rates of inflation.

Net capital formation for the sector is projected to be small. However, net capital formation for continuing farm proprietors is very large. This is a result of continued purchase of assets by continuing proprietors from proprietors exiting the sector. The resulting large savings by continuing proprietors is an indication of financial strength of firms making up the sector. However, as indicated above, the increase saving is not enough in relation to new debt to avoid increases in leverage for the sector.

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TABLE OF CONTENTS

Page

Table

LIST OF TABLES

Table

Table

Table

Table | Page

Table

APPENDICES

LIST OF FIGURES

CHAPTER I

Introduction

Justification

Decisions affected by the financial structure of the U.S. farming sector are continually being made. Implicit in the decision-making process are expectations of the future financial structure of the farming sector. Informed policy decisions require knowledge of relationships within the farming sector and an understanding of the effects of variables exogenous to the sector.

The impetus for this study is provided by a perceived usefulness in public and private decisions of economic projections for the U.S. farming sector. Specifically, it is believed that a computerized simulation model that emphasizes the financial structure of the farming sector, as represented by a set of sector financial statements, and that is capable of projecting complete financial statements, given levels of exogenous variables, would be of broad general use. A model such as this would not provide all of the information required to reach prescriptive knowledge for a particular problem. However, it could provide some of the information required for many public and private decisions.

Some of the exogenous factors likely to influence the financial structure of the U.S. farming sector over the next several decades that a mode

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that a model could address are: the rate of growth in gross national product, population growth, technological change, prices of farm inputs, governmental farm price and income policies, export demand for farm products, and grain reserve policies. These factors are manifested through behavioral and economic relationships in the form of cash and noncash flows which, over time, affect the assets and liabilities of the farming sector. The relationships of interest can be specified largely through the use of economic theory and can be empirically estimated using econometric techniques.

Many of the factors affecting financial flows in the farming sector are determined, in part, by public policy. Knowledge of the relationships between system variables, both controllable and uncontrollable, is necessary for informed public and private decision making. In addition, projections of system performance under alternative policies (for controllable exogenous variables) and under alternative scenarios (for uncontrollable exogenous variables) would provide input into a large number of public and private decisions dependent upon or affected by the long-run outlook for the financial structure of the farming sector.

Decision makers who would be potential users of information proveded by the model are: the Farm Credit Adminstration and other credit-oriented clientele: public decision makers concerned with the welfare of farm proprietors (i.e., formulation of farm price and income policies); suppliers of farm inputs, including both durable and nondurable inputs; and those analysts wishing to compare the farming sector with nonfarm sectors.

Specific questions that an aggregate economic projections model could address can be posed in terms of the kinds of scenarios the model is designed to handle. Scenarios in this context are alternative projections of variable exogenous to the model. The usefulness of a model comes from its ability to predict the effects of alternative scenarios on endogenous variable. Endogenous variable of interest to policy makers are often called performance variables. In the model proposed here, these include: net farm income, the level of farm production, the price of farm products, capital gains, equity accumulation, debt flows, capital formation, savings, leverage, intersector flows, and consumption levels in the farming sector. Exogenous variables are often divided into the categories of variables controllable and uncontrollable by policy makers. Thus, information concerning effects of alternative policies (levels of controllable variables) on performance variables is particularly useful to public decision makers. In addition, levels of performance variables under projections based upon a "most likely" scenario have implications for such private decision makers as farmers, agricultural lenders, and input supply firms.

Furthermore, there is a continuing need to formulate, conceptualize, and study the structural interrelationships of the farming sector in order to better understand what is happening and why.

Purpose

With justification provided by the above factors, the purpose of this research is to design an aggregate U.S. farming sector economic projections model. The model will, in general, be of an aggregative nature, but will contain sufficient detail to handle a broad set of policy questions related to financing the aggregate farming sector. The focus of the model will be on making long-run projections.

Research Objectives

The proposed research is oriented toward policy decisions and disciplinary knowledge. With respect to policy, the intent is to contribute a portion of the information necessary for a class of policy decisions. Specifically, the class of policy decisions affecting or affected by the financial structure of the aggregate U.S. farming sector is of interest. The research is not problem solving per se in that all of the information necessary to make policy decisions will not be provided. That is, policy prescriptions cannot be reached without information in addition to that provided by this research.

The specific objectives of this project are as follows:

1) To develop a theoretical model of the aggregate U.S. farming sector in order to provide a conceptual framework for the estimation of an empirical model
2) To identify structural relationships among variables within the U.S. farming sector and the effects of variables exogenous to the sector through empirical investigation
3) To construct an operational aggregate economic projections model of the U.S. farming sector capable of making long-run projections of financial variables under alternative futures in order to provide input into public and private decision making

Dissertation Organization

Chapter II of this dissertation gives a short description of the methodological and philosophical approach of the research.

Chapter III is a broad review of previous studies relating to the research reported here. This includes economic modeling efforts at the farming sector level which are not necessarily focused on finance.

Chapter IV identifies the system to be modeled and develops the theoretical basis for equations to be estimated for the model.

Chapter V presents the empirical results from estimation of equations. This includes ancillary equations required for a complete model as well as structural equations. Statistical results for each individual equation are presented. Economic properties (i.e., price and income elasticities) of the individual equations are shown and discussed. Elasticities of the set of simultaneous equations are pursued further in Baker (1978).

Modifications to structural equations are discussed in Chapter VI. In addition, the model's ability to track the historical data is evaluated for a set of endogenous variables. The results of simulating over the historical period are presented numerically and graphically.

Chapter VII provides background for and develops the financial accounts and other financial data projected by the simulation model.

In Chapter VIII, results from the simulation model are presented. Additionally, the methods and assumptions used to project exogenous variables are explained.

Chapter IX presents a summary and conclusions.

The appendices include both explanations of the construction of several data series and statistical factors relating to equations estimated.

A glossary of variables used in equations, financial statements, and elsewhere in the simulation model is published in Baker (1978). The glossary is arranged in alphabetical order by variable name (the symbols used in equations and/or computer variable names). The glossary should be used by the reader to obtain additional information on the following: alternative variable names, descriptions of the variables, units of measurement, variable type (i.e., endogenous or exogenous), historical data source, and sources of the variables in the simulation model.

CHAPTER II

Methodology

Methodological Approach

The methodological approach to this study follows a modification of the system's problem-solving methodology outlined by Manetsch and Park (1974, Chapter II). The methodology described by Manetsch and Park can be viewed as a decision-making process encompassing the steps from problem recognition through implementation and system operation with resulting feedback. The process is conceptually similar to the decision-making process discussed in farm management. Figure 2.1 illustrates the process as typically presented by farm management researchers (Bradford and Johnson, 1953; Hopkin, Baker, and Barry, 1973; and Johnson, 1954 and 1961).

The approach here is not identical to the problem-solving process for it is only a subset of the process. In addition, the research reported here is intended to be applicable to a large number of problems pertaining to the topic researched. However, the purpose of emphasizing, here at the outset, the "problem-solving process" or "the decision process" is to place the research explicitly within a policy framework--even though the information assembled in this

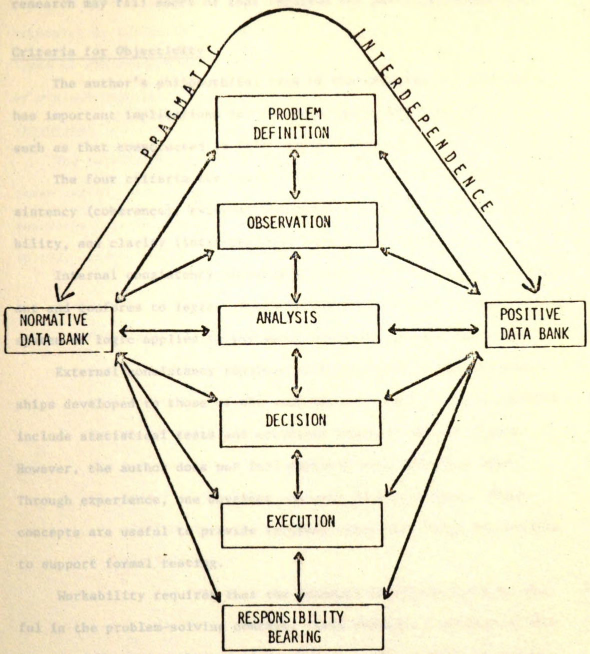

Figure 2.1

The Decision Process

research may fall short of that required for policy prescription.

Criteria for Objectivity

The author's philosophical view of the criteria for objectivity has important implications for the development and testing of a model such as that constructed in this research project.

The four criteria for truth[1/] of a concept are: internal consistency (coherence), external consistency (correspondence), workability, and clarity (inter-personal transmissability).

Internal consistency requires an analytical system that is coherant and conforms to logic. Economic theory provides the basis for the system of logic applied to the model developed in this research.

External consistancy requires correspondence of the relationships developed to those of the real world. Tests of correspondence include statistical tests and estimates based on empirical data. However, the author does not feel confined to statistical tests. Through experience, one develops concepts of what exists. These concepts are useful to provide informal tests when there are no data to support formal testing.

Workability requires that the concepts being developed be useful in the problem-solving context. This provides a portion of the impetus for putting the equations developed into a model to use in policy analysis.

1/ One may substitute "objectivity" or "validity" for the word "truth" in this sentence.

The final criterion of clarity requires that others be able to interpret or follow the reasoning and results of the research. The tests of coherence and correspondence are not possible for ambiguous or unclear statements.

Procedures

The research procedures for this project have been divided into three parts: premodeling analysis, system modeling, and postmodeling analysis. The following is an outline of the research process relevant to this study:

A. Premodeling analysis

1. Needs analysis. Identify and examine the consistency of the needs of public and private decision makers and other system participants.

2. System identification. In a general way, identify and define the system, including classification of variables.

   a) System inputs

      (1) Exogenous

      (2) Endogenous

         (a) Controllable by policy makers

         (b) Not controllable by policy makers

   b) System Outputs

      (1) Desired

      (2) Undesired

   c) System design parameters

3. Problem formulation

   a) Develop an explicit statement of what the system must do in order to satisfy the determined needs

b) Develop performance criteria and determine performance variables

4. Generation of system alternatives

a) Alternative management strategies or policies

b) Alternative models that might be constructed to address policy questions

5. Select a subset of feasible system alternatives

B. System modeling

1. Select a final subset of system alternatives to model

2. Develop a conceptual model in the form of equations and/or explicit block diagrams

a) Determine the hypothesized relationships between the variables

b) Check for internal consistency in the model formulation

c) Check for external consistency where possible

3. Computer implementation

a) Estimate parameters

b) Develop a computer model using analytical and numerical techniques

c) Test the viability of concepts used in developing the model

4. Validation

a) Use statistical tests where possible

b) Check model consistency and performance with historical data

5. Sensitivity tests

    a) Carry out "sensitivity tests" on the model coefficients for which accurate estimates are not available

    b) Establish priorities for further information-gathering and model refinements

6. Stability analysis

    a) Identify the stability boundaries of the model

    b) Test for stability based on stability theory, use of repeated simulation runs, or both

C. Postmodeling analysis

1. Use the model to describe past system behavior

2. Examine the effects on system variables of alternative policies through simulation runs

3. Project future system performance under alternative scenarios

Concluding Remarks

The procedures of this research have been affected by the philosophical orientation of the author--hence the need for this chapter. It should be emphasized that the research approach is iterative. One is not likely to follow directly through the procedures outlined above without frequent backtracking and reconsideration of previous work.

CHAPTER III

Literature Review

Introduction

The body of literature relevant to this study is extensive and diverse. This chapter will review previous research in areas related to this study on a general basis. In later sections, more specific references will be made to previous studies as they pertain to the particular topic being considered.

Aggregate Financial Analysis

Financial analysis of the aggregate farming sector differs from what one might refer to more generally as economic analysis in that there is usually a focus on the financial aspects of the results of economic activities. The major focus is typically on capital formation and its financing, saving, and demand for loan funds. A review of studies focusing on these and related finance issues follows in this section.

Flow of Funds

One of the earlier studies of capital formation and its financing was by Tostlebe (1957). Tostlebe constructed an account for sources and uses of capital for five year periods from 1900 to 1949

(Tostlebe, Tables 35 and 36, pp. 136-139). The approach was to estimate the uses of capital (land and buildings, machinery and motor vehicles, inventories of crops and livestock, and cash working balances) and estimate the external sources of capital (loans, credit, and financial reserves) in order to derive the implied internal sources. Also constructed were two sets of ratios of the following variables: Savings to income, savings to capital formation, and capital formation to income. One set of ratios is on a net basis, the other on a gross basis (Tostlebe, Table 38, p. 146).

The formulation of the account by Tostlebe is consistent with the type of account one might initially deem appropriate as a sector disaggregation of a national account. In a closed national economy, the financing task can be reduced to diverting just enough funds from current income to equal total gross capital expenditures on new tangible assets. Tostlebe's disaggregation includes the addition of financial assets and liabilities to the account. However, for a particular economic unit, the task is larger than simply including financial assets and liabilities, since other intersector flows must be financed. The flows omitted by Tostlebe and others doing the early flow of funds research were those related to proprietors entering and leaving the sector.

D. Gale Johnson (1963) updated Tostlebe's accounts through 1958, based on data published annually in the Farm Income Situation and The Balance Sheet of the Farming Sector. The research was similar to Tostlebe's in that it was basically an examination of historical trends.

Brake (1966) used a flow of funds model as the basis for projecting increases in farm debt. Brake's approach combined current flows (operating income and expenses, consumption, taxes, etc.) into a savings variable and included a flow for real estate.

In other research, Brake (1970) conducted a more extensive examination of fund flows in the Canadian agricultural sector. Projections of capital and credit needs to 1980 were made. The method used was similar to Brake's previous work with the addition of a detailed breakdown of capital and current flows.

Melichar (1973) estimated equations to project capital flows for real estate transfers, machinery and motor vehicles, buildings and land improvements, livestock and crop inventories, and financial assets. Internal financing was determined by projecting net cash flow from operating, then multiplying by a savings rate. Credit needs were then determined residually. Melichar's flow of funds account extended Tostlebe's and modified the Brake account by including an important intersector flow, purchases of real estate from discontinuing proprietors.

The Brake and Melichar models project credit needs, but do not provide a great deal in the way of structural parameters. Melichar pointed to the need for building structural models in which independent financial variables are simultaneously determined and to the need for examination of the factors determining internal financing.

While the accounts used by Tostlebe and Melichar focused entirely on capital formation and the sources of its financing, the later Brake account moved in the direction of including all cash flows.

During this period, an effort was underway in the USDA to construct a flow of funds social account for the farming sector to serve as a basis for examining financial aspects of policy questions (Penson, Lins, and Irwin, 1971). This account was designed to link Balance Sheets.

The Penson, Lins, and Irwin account may have grown out of the use of the Sources and Uses of Funds (SAUF) statement at the firm level. Van Horne (1971) describes sources and uses of funds for a cash basis statement as follows:

Sources:

1. A net decrease in any asset other than cash
2. A net increase in any liability
3. Proceeds from the sale of preferred or common stock
4. Funds provided by operation[1/]

Uses:

1. A net increase in any asset other than cash or fixed assets
2. A gross increase in fixed assets
3. A net decrease in any liability
4. A retirement or purchase of stock
5. Cash dividends

The majority of firm level accounting is done on a historical cost basis. In a cost accounting system, a cash basis SAUF statement will account for all changes on the Balance Sheet between periods.

1/ Funds provided by operation are defined by Van Horne as net income after taxes plus noncash expenses (e.g., depreciation).

Much of the social accounting for the farming sector values assets at current price levels (e.g., values of real estate and inventories of crops and livestock published in the Balance Sheet of the Farming Sector). Thus, if one requires that a SAUF statement account for all changes on the Balance Sheet, it will include a mixure of cash and noncash flows. This view has been taken by researchers dealing with the nonfarm as well as farm sectors.

Hendershott has viewed the SAUF statement as the link between two Balance Sheets when doing financial modeling for nonfarm sectors. He hypothesized the following financial statements:

Hypothetical Balance Sheet		Hypothetical SAUF Statement	
FA_1	FL_1	ΔFA_1	ΔFL_1
FA_2	FL_2	ΔFA_2	ΔFL_2
.	.	.	.
.	.	.	.
.	.	.	.
FA_n	FL_r	$\Delta FA_n - CG$	ΔFL_r
RA_1	NW	INV_1	SAV
RA_2		INV_2	
.		.	
.		.	
.		.	
RA_m		INV_m	

FA_i = the ith financial asset.

FL_i = the ith financial liability.

RA_i = the ith real assets.

NW = net worth.

Δ $\Rightarrow$ change

CG_n = capital gain on the nth financial asset.

SAV = savings.

INV_i=net investment in the ith real asset.

The sectors which Hendershott consideres endogenous are households, nonfinancial businesses, state and local governments, commercial banks, other savings institutions, sponsored federal agencies, and other finance. Three exogenous sectors are the federal government, the monetary authority, and the rest of the world.

Hendershott has concentrated research efforts on financial assets and liabilities. In general, he treats investment in real assets and savings exogenously. His approach is "general equilibrium" in nature (with respect to financial markets) in that all interest rates are determined by the direct interaction of demand and supply in the financial markets.[1/]

The modeling by Hendershott differs substantially from the research proposed and reviewed here due to its multi-sector general equilibrium approach for financial markets. The approach normally taken for farming sector models is that the farming sector does not have a great influence on the money markets and that the key endogenous variables should be investement in real assets and internal financing.

The Penson, Lins, and Irwin account for the farming sector was criticized by Brake and Barry (1971). Brake and Barry objected to the conception of the SAUF statement as completely bridging Balance Sheets between two periods. The SAUF statement resulting from this view included a mixture of cash and noncash flows which Brake and

---

1/ The majority of present day financial models explain a short-term rate of interest by analyzing a bank reserve market and then determining long-term rates through a term structure relationship.

Barry felt was conceptually incorrect. They, in turn, proposed a SAUF statement on a cash basis that included gross flows where possible. The cash basis account is appealing because it is limited to and includes all items that require financing and the sources of their financing.

Extensive modeling of fund flows in the farming sector has been completed by Lins (1972 and 1973) and Penson (1973). Lins developed a model concentrating on sources of external funds, including extensive disaggregation by lender groups.

Penson viewed the flow of funds in the farming sector as resulting from adjustments in the portfolio of farmers from actual to desired asset levels. The theory of portfolio balance suggests that the desired balance between physical and financial assets in the portfolio depends upon relative pecuniary and nonpecuniary services and, hence, utility provided by the asset. This reasoning led Penson to a set of structural equations, simultaneously determining the year-end stocks of physical and financial assets. Coefficients of stock variables indicate complementarity (positive sign) or substitutability (negative sign) in determination of year-end stocks. The empirical model of Penson is the basis of an aggregative income and wealth (AIW) simulation model (Penson, 1973).

Penson used a modification of the SAUF statement for the farming sector proposed by Penson, Lins, and Irwin. The proposed SAUF statement was designed to be consistent with USDA income and balance sheet series, thus making it useful in terms of facilitating financial analysis of the farming sector. Cash and noncash flows are included in the simluaiton model developed here. However, only cash flows are inculeded in the SAUF statement. The AIW simulation model includes gross flows where data are available. Gross income and gross cash expenses are included rather than net income, capital consumption allowances, and net change in inventories of crops and livestock. Data needs and limitations are pointed out by Penson, Lins, and Irwin and are major factors in the development of their SAUF statement.

Emphasis of This Research

The research reported here differs from earlier financial studies in one broad area. The economic relationships underlying the financial accounts are modeled to the extent possible, based on standard theoretical relationships suggested by static economic theory. The model differs from the AIW simulator in its theoretical basis and in the variables endogenous to the model. The model here includes as endogenous variables the supply and demand for aggregate farm output, including price determination. In addition, the demand for durable and nondurable farm inputs is included in the model. The approach was to provide a complete set of equations in sufficient detail to project an Income Statement, Balance Sheet, and cash basis Sources and Uses of Funds Statement for the sector. The information required for these accounts is sufficient to construct any of the accounts discussed earlier, as well as the Capital Finance and Capital Flows accounts proposed by Simunek (1976).

Economic Models of the Aggregate Farming Sector

The emphasis of this study on supply and demand for farm output and on demand for farm inputs (the factors relating to internal financing) leads to examination of complete models and component studies of previous researchers.

The concept of aggregate supply is especially important for this study. Early developments of the concept of aggretate supply in the agricultural sector include articles by D. Gale Johnson (1956), T. W. Shultz (1956), and W. W. Cochrane (1955).

Among the more complete studies of the farming sector is that of Heady and Tweeten (1963). Their study included extensive estimation of structural equations for durable and nondurable inputs and aggregate suply.

Earlier studies of factor markets include the demand for farm machinery by Griliches (1959, 1960, 1962) and Cromarty (1959), an analysis of the farm labor market by Schuh (1962) and Tyrchniewicz and Schuh (1969), and studies of farmland prices by Herdt and Cochrane (1966) and Tweeten and Martin (1966).

Policy-oriented aggretate models have been developed by Tyner and Tweeten (1968), Ray and Heady (1972), and Nelson (1975). These models have not focused on the financial implications of economic activities and policies.

Long-run projection models have been compiled into a national interregional projections (NIRAP) system by the Economic Projections and Analytical Systems program area in the National Economic Analysis

Division of Economic Research Service, USDA. The capacity of the system includes the ability to make projections of aggregate output, prices, and net farm income. However, a complete set of financial flows is not provided.

Concluding Remarks

It is hoped that the reader perceives the gap in previous research at which this project is aimed. It is intended that this research will differ from previous financial modeling in terms of theoretical basis, structure modeled, and variables that are endogenous. The inclusion of variables such as farm prices and quantities of output as endogenous variables is intended to make the model useful for longer-run projections. The research differs from other farming sector studies which have endogenized input and output prices and quantities in that it goes one step further to trace the impacts of these economic activities on sector financial statements.

CHAPTER IV

System Definition and Theoretical Model

Definition of the Farming Sector

Defining the farming sector is not an easy task. Any workable definition must be conditioned on the availability of data and the use or purpose and must fit into one's conceptual framework. The definition used here is best described by Figure 4.1. The individuals included are farm operator families and nonoperator landlords. The decision-making units included are farming businesses, farm operator households, and the farm investment portion of nonoperator landlord households.

The definition is based in part upon data. The individuals included are those whose assets appear in the Balance Sheet of the Farming Sector and whose income is reported in the farm income accounts of the USDA (see Farm Income Statistics).

Conceptual difficulty occurs to the extent that the three decision-making units are not distinct. This is troublesome with respect to the interrelated nature of farm operator business-household decisions. It is felt that decisions of nonoperator landlords are made in a somewhat different manner than decisions made by operators. Therefore, the sector could not be considered farm operator households

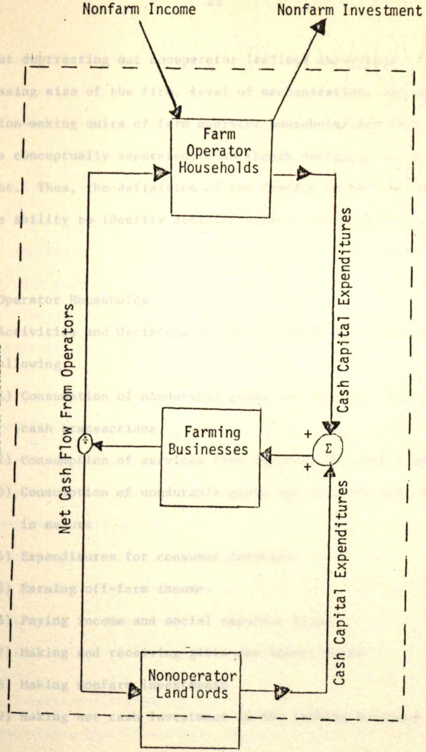

Figure 4.1

The Farming Sector

without subtracting out nonoperator landlord activities. With the increasing size of the firm, level of mechanization, and income, the decision-making units of farm operator households and farm businesses can be conceptually separated, even though decisions may be interdependent. Thus, the definition of the farming sector was based largely on the ability to identify decision-making units and the activities of each.

Farm Operator Households

Activities and decisions of farm operator households will include the following:

1) Consumption of nondurable goods and services requiring cash transactions
2) Consumption of services from durables (no cash transaction)
3) Consumption of nondurable goods and services that are noncash in nature
4) Expenditures for consumer durables
5) Earning off-farm income
6) Paying income and social security taxes
7) Making and receiving gifts and inheritances
8) Making nonfarm investments
9) Making net cash investment in the farming business

Many of the above decisions will be made simultaneously with or be dependent upon farm business decisions.

Nonoperator Landlords

Nonoperator landlords are not treated as extensively as operators. Nonoperator landlords are included in the farming sector only to the extent of their farm business activities. Income of nonoperator landlords other than from farming is not considered to be income of the farming sector.

A portion of the net cash flow from farming goes to and a portion of net cash capital expenditures comes from nonoperator landlords. The difference, net cash investment, is determined by the investment alternatives available and by consumption patterns.

Farming Businesses

Decisions made by the farm business decision-making unit are based upon costs and returns in farming. Produciton and distribution theory will be used extensively in deriving relationships.

Decisions will include those related to current flows, such as crop and livestock sales, government payments, and operating expenses. Capital flows for purchases of real estate, machinery, motor vehicles, new buildings, and improvements will also be included. Debt acquired and retired will be considered activities of farm business.

Sector Interface (Intersector Flows)

Over time, individuals move into and out of the farm sector as defined herein. This entry and exit is partially voluntary as in instances of labor migration off farms, and partially involuntary as in the case of death. There are fund flows associated with entry and exit. These include the following cash flows:

1) Cash inheritance and gifts (in and out)

2) Equity introduced by new proprietors

3) Equity removed by discontinuing proprietors

It is reasonably clear that the net flow of these items is a deficit for the farming sector. That is, more cash leaves the sector via the above flows than enters.

Derivation of equations explaining the flows for inheritances, gifts, and equity accompanying entry and exit is conceptually difficult. Some portion of the reduction of human resources in agriculture can be explained via relative returns to labor. It is not clear to the author how one theoretically explains the equity captial flows associated with the human resource flows.

Data series for these variables are in general nonexistent. It was mentioned earlier that the anticipated net flow is out of the sector. Thus, ignoring flows associated with sector interface will bias a residual factor substantially.

The concept of the farming sector described here is a combination of establishment and product concepts.

A Systems View of the Farming Sector

Figure 4.2 is a general block diagram for the farming sector. The purpose of the diagram is to give an overview of the farm sector as a system. Major physical and behavioral processes are indicated by blocks. Inputs (stimuli) are indicated by arrows into blocks, and outputs (responses) are indicated by arrows out of blocks. Much of the detail has been excluded, but major linkages have been retained.

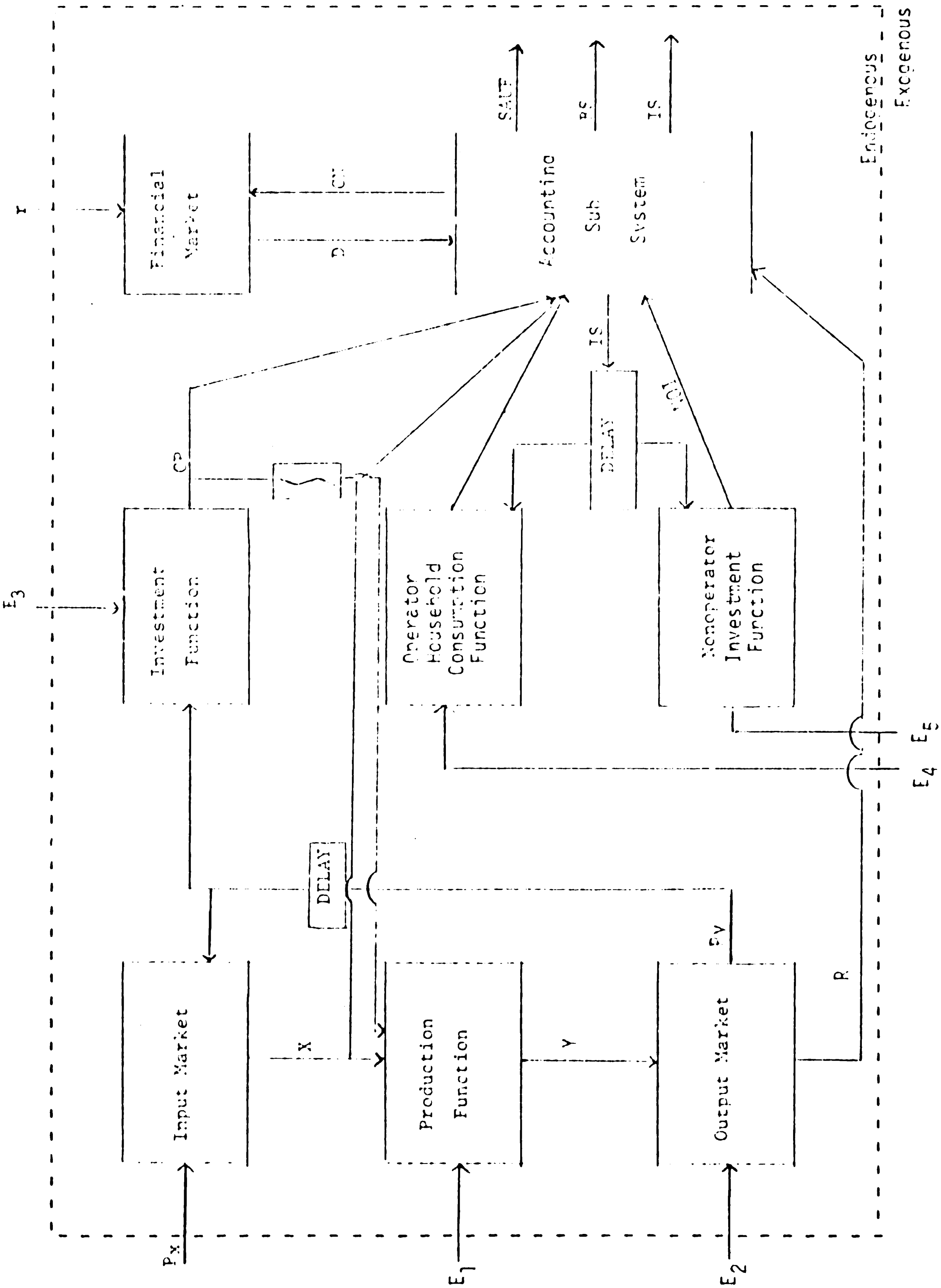

Figure 4.2. General Block Diagram of the Farming Sector

Table 4.1. Symbols Used in Figure 4.2

Symbol	Definition/Explanation
BS	Balance Sheet for the sector
C	Vector of consumption expenditures, current and capital
CN	Credit needs
CP	Vector of expenditures for productive captial items
D	Debt flows
E_i	In general, a vector of exogenous factors
E_1	Includes weather, technology, and a subset of government programs
E_2	Includes government programs, population, inflation rate, GNP
E_3	Includes prices of captial goods, r, current input prices
E_4	Includes prices of consumer goods and services, r, nonfarm income
E_5	Includes rates of return on alternative investments
IS	Income Statement for the sector
NOI	Nonoperator landlord net investment
P_x	Vector of current input prices
P_y	Vector of output prices
R	Cash receipts from farm marketings
r	Interest rate
X	Vector of current input levels
Y	Vector of output levels

In terms of the procedures outlined earlier, the block diagram is one of the outputs of premodeling analysis. There is an indication of the breakdown of variables into endogenous and exogenous categories. Specification in greater detail will be given later in this section.

The choice of processes indicated in Figure 4.2 was based upon economic theory and considerations discussed in earlier sections. Each block will yield a set of one or more equations relating inputs and outputs. Sequencing of blocks does not necessarily imply recursiveness. Simultaneity is broken by delay blocks. In the situations used here, delays may be interpreted as distributed lags.

A block diagram places emphasis on structure. This causes some problems here because the structure for an individual firm differs from the structure in a market. An example would be the shift from a fixed output price for a firm to a demand function for output when firm cost curves are aggregated to specify industry price and output relationships. The actual equations used to describe the system and to be empirically estimated will focus on structure where possible. Reduced form equations are often estimated for forecasting models but will not be estimated directly for this model because of the emphasis on long-run projections. Structural equation estimation will involve simultaneous equation estimators.

The farm production process is described in traditional economic terms of input level determination, production, and price determination. As we will see later, this is more complicated than expressed in the block diagram because of the use of crop output in the production of livestock.

The inclusion of farm operator households brings about considerations of consumption activities. These include expenditures for household capital items as well as currently consumed goods and services.

The investment block determines cash flows for purchases of productive capital items. The level of the capital stock feeds back into the production block.

Nonoperator landlords are treated as making investment into the farming sector based upon returns in farming (information from the Income Statement) and a set of exogenous factors. The lack of and poor quality of data on the current flows to and from nonoperator landlords will prevent estimation of this component. The author is not sure of the direction of bias that this may create.

The financial market is treated as a residual supplier of funds based upon credit needs. The rate of interest is taken as exogenous to the sector.

The block entitled "accounting subsystem" is included to avoid numerous and cumbersome summations. It is a set of identities producing the Income Statement, Balance Sheet, Sources and Uses of Funds Statement, and miscellaneous summaries for the sector.

The following paragraphs will derive explicit equations to describe the system. The derivation will first be the general theory without specific names given to the variables. Later, specific variables will be identified as the theory is applied to the farm sector.

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Firm Level Structure

For simplicity, we will consider a single enterprise firm producing output Q with variable nondurable inputs X_1 and X_2 and fixed level of service inputs V from a durable good according to the following production function:

$$(4.1) \quad \pi = P_Q Q - P_{x_1} X_1 - P_{x_2} X_2$$

P_Q, P_1, P_2 = output price, price of X_1, and price of X_2, respectively.

All prices are exogenous to the firm. That is, firms are perfect competitors in both input and output markets. Equation (4.2) is maximized by setting the partial derivatives with respect to the variables X_1 and X_2 equal to zero.

$$(4.3) \quad \frac{\partial \pi}{\partial X_1} = P_Q MPP_{x_1} - P_{x_1} = 0 \Rightarrow VMP_{x_1} = P_{x_1}$$

$$(4.4) \quad \frac{\partial \pi}{\partial X_2} = P_Q MPP_{x_2} - P_{x_2} = 0 \Rightarrow VMP_{x_2} = P_{x_2}$$

Second order conditions require that the principal minors of the relevant Hessian determinant alternate in sign:

$$(4.5) \quad \frac{\partial^2 \pi}{\partial x_1^2} = P_Q \frac{\partial^2 f(x_1, x_2)}{\partial x_1^2} < 0$$

and $$\frac{\partial^2 \pi}{\partial x_2^2} = P_Q \frac{\partial^2 f(x_1, x_2)}{\partial x_2^2} < 0$$

$$(4.6)\quad \begin{vmatrix} \frac{\partial^2\pi}{\partial x_1^2} & \frac{\partial^2\pi}{\partial x_1 \partial x_2} \\ \frac{\partial^2\pi}{\partial x_2 \partial x_1} & \frac{\partial^2\pi}{\partial x_2^2} \end{vmatrix} = P_Q^2 \begin{vmatrix} f_{11} & f_{12} \\ f_{21} & f_{22} \end{vmatrix} > 0$$

Conditions expressed in (4.5) imply that marginal products of both inputs are decreasing. They also imply that profit decreases with additional units of X_1 or X_2.

Conditions (4.5) and (4.6) require the production function to be strictly concave in the neighborhood of the point at which first-order conditions are satisfied.

The total cost equation is total cost in terms of input prices, input quantities, and fixed costs (FC).

$$(4.7)\quad C = P_{x_1} X_1 + P_{x_2} X_2 + FC$$

The total cost function expresses cost as an explicit function of the level of output plus fixed costs.

$$(4.8)\quad C = C(Q) + FC$$

The cost function is obtained by solving the cost equation, production function, and expansion path simultaneously to reduce the system of equations to a single equation in the form of (4.8). The cost function gives the minimum cost of producing each level of output. It has input prices as fixed parameters.

Marginal cost (MC) is the cost of producing an additional unit of output. Thus, marginal cost is the derivative of the cost function.

(4.9) $$MC = \frac{d[C(Q) + FC]}{dQ} = C_Q$$

Looking at the profit maximization problem from the revenue and output viewpoint, we can consider the determination of the optimal output level. The profit equation is

(4.10) $$\pi = P_Q Q - C(Q) - FC.$$

Setting the derivative of profit with respect to output level (Q) equal to zero will give the profit maximizing output level.

(4.11) $$\frac{d\pi}{dQ} = P_Q - C_Q = 0 \quad \text{or}$$

(4.12) $$P_Q = C_Q = MC$$

The second order conditions for a maximum require a negative second derivative.

(4.13) $$\frac{d^2\pi}{dQ^2} = \frac{-d^2C}{dQ^2} < 0 \quad \text{or}$$

(4.14) $$\frac{d^2C}{dQ^2} > 0$$

Equation (4.14) says that marginal cost must be increasing at the profit-maximizing output level.

The supply function for an individual firm is given by the profit-maximizing rule (4.12) with output (Q) solved for in terms of output price. Equation (4.15) gives the supply function for the jth firm. The fixed arguments, input prices, are also denoted.

(4.15) $$Q_j = S_j(\overline{P}_Q, \overline{P}_{x_1}, \overline{P}_{x_2})$$

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Input demand functions for an individual firm are obtained by solving the firm's first order conditions (4.3) and (4.4) for input levels as functions of product and input prices. Equation (4.16) gives the demand function for the kth input by the jth firm.

$$(4.16) \quad x_{jk} = D_{jk}(\overline{P}_{x_1}, \overline{P}_Q), \; i = 1, \ldots, k$$

Industry Structural Equations

The supply function for an industry is determined by summation of firm supply functions over all firms in the industry. Thus, the supply function for an industry with m firms is given by equation (4.17).

$$(4.17) \quad Q = \sum_{j=1}^{m} Q_j = \sum_{j=1}^{m} S_j(\overline{P}_Q, \overline{P}_{x_1}, \overline{P}_{x_2}) = S(\overline{P}_Q, \overline{P}_{x_1}, \overline{P}_{x_2})$$

At the industry level, output price (P_Q) is no longer exogenous. A demand function for output demand is shown as equation (4.18). Quantity demanded is a function of own price (P_Q), prices of substitutes (P_s), income (Y), and population (POP).

$$(4.18) \quad Q = D(P_Q, P_s, Y, POP)$$

The input demand for an industry is obtained via summation of firm input demand functions. Thus, using (4.16), the industry demand for input X_1 is given by (4.19).

$$(4.19) \quad X_1 = \sum_{j=1}^{m} x_{j1} = \sum_{j=1}^{m} D_{j1}(P_{x_1}, P_{x_2}, P_Q) = D_1(P_{x_1}, P_{x_2}, P_Q)$$

Assuming that the industry is a perfect competitor with other industries for inputs, the input prices would be exogenous (horizontal supply curves). Under this assumption, the structural equations for an industry composed of firms producing one output with two inputs are given by the following system of equations:

(4.20) Output Supply: $Q = S(P_Q, \overline{P}_{x_1}, \overline{P}_{x_2})$

Output Demand: $Q = D(P_Q, \overline{P}_s, \overline{Y}, \overline{POP})$

Input Demand: $X_1 = D_1 \ (P_Q, \overline{P}_{x_1}, \overline{P}_{x_2})$

Input Demand: $X_2 = D_2 \ (P_Q, \overline{P}_{x_1}, \overline{P}_{x_2})$

Exogenous variables are denoted by a "bar." There are four equations in four unknowns. These equations can be solved to get reduced-form equations. Reduced-form equations express endogenous variables only in terms of exogenous variables.

Extensions of the theoretical model presented above will be made in the following section as the theory is applied to the farm production sector. The modification will deal with demand for durables. In the empirical applicaiton, the view of decision making will be that levels of nondurable inputs are determined assuming fixed levels of services from durables. Thus, the level of durable services is a fixed argument of demand for inputs and supply of output equations. Then, when deriving the demand for durables, it will be assumed that the decision is being made for future periods when the durable and nondurable inputs may vary.

Demand for Durable Assets

The purpose of this section is to formulate a theoretical basis for specification of investment demand equations. This goal will be a quide and will lead to assumptions that may be less desirable if the goal were to examine the economics per se of investing in and using productive durable assets.

Investment, as used here, refers to the quantity of a durable asset purchased in a period (sometimes referred to as gross investment). It will be assumed that it is possible to measure the quantities of durable assets and that each unit of a category of durable productive assets is similar in the respect that it has identical length of life when new, produces identical services, and requires similar inputs to produce services.

The investment demand function can be viewed as consisting of two components: adjustment of the stock to a desired level, often referred to as net investment, and replacement investment.

Many of the empricial studies of investment have concentrated on estimating net investment (gross investment less replacement investment) or an optimal stock, assuming that replacement investment is a constant portion of the durable stock. These include studies by Hall and Jorgenson (1967), Griliches (1960), and Melichar (1973).

Investment demand is surely a derived demand, for there is no economic reason for a firm to desire a stream of investment per se. Investment is desired because it is economic to acquire the productive inputs of durable assets. This intuitive reasoning leads one to a formulation of the problem as one of acquiring optimal stocks of durable assets. Combined with Jorgenson's (1969) justification of replacement investment as a constant proportion of capital stock, one is led to investigating net investment.

Feldstein and Rothschild argue convincingly that a technologically determined constant rate of replacement is incorrect, even as an asymptotic limit. Some of the terminology defined in the following is derived from Feldstein and Rothschild.

Deterioration is the increase in real resource cost per unit of service output as a durable ages. It is composed of input and output decay.

Output decay is the decline in the level of service output as a machine becomes older.

Input decay is the increasing requirement of inputs used by a durable (maintenance and repairs) to produce services as it becomes older.

Scrapping is the withdrawal of a durable from the capital stock.

Depreciation is the fall in the value of a durable as it ages. Depreciation reflects deterioration, obsolescence, and riskiness of older durables.

Replacement investment is the actual purchase of durables to maintain the service capacity lost through deterioration (input and output decay) and scrappage. Replacement investment is not identical to deterioration, depreciation, or scrapping.

On an intuitive level, one can see that both scrappage and determination of the level of service output from a durable are economic decisions. The level of service output depends upon the levels of inputs used in the production of durable services; this would depend upon prices of inputs and outputs as well as technological factors. Scrappage of a durable would occur when the present value of future quasi-rent is equal to the present salvage value of the machine and thus depends upon prices of inputs and outputs.

With the consideration that scrappage is an economic decision, that the level of service output is an economic decision, and that replacement investment cannot be distinguished from net investment, the following will attempt to derive gross investment and maintenance (inputs into production of durable services) demand functions.

First, an attempt will be made to define symbols and make assumptions explicit.

In a manner similar to the earlier model, f (4.21) is a function relating input levels to the level of output.

(4.21) $Q = f(X_1, X_2, V)$

Q = level of output.

X_1 = a nondurable input.

X_2 = a nondurable input.

V = level of services from a type of durable.

The level of durable services, V, is given by the function (4.22). Variables to the right of the vertical bar are fixed.

(4.22) $V = V(X_3, I \mid St, Sc)$

X_3 = a nondurable input.

I = gross investment in the current year.

St = stock of the durable at the beginning of the year.

Sc = scrappage of the durable in the current year.

The variable cost function, here referring to variable nondurable inputs X_1 and X_2, is given by equation (4.23). It gives the least cost combination of nondurable inputs for any level of Q and V. It is solved from the expansion path, cost equation, and production function.

(4.23) $C = C(Q, V)$

C = total cost of variable nondurable used directly in production of Q.

A concept similar to that for the traditional cost function can be applied to find a cost function giving the least cost combination of nondurable inputs to produce durable services (4.24). It is a function of the level of services and level of investment.

(4.24) $M = M(V, I)$

M = cost of maintenance and repairs or the total cost of variable nondurable inputs used in the production of durable services.

The objective function (4.25) defines the net present value of the firm, assuming a zero terminal value. It gives the present value of quasi-rent over the life of the firm.

$$(4.25)\quad NPV = \int_0^T [P_Q Q - C(Q, V) - M(V, I)]\, e^{-rt}\, dt - P_d I$$

$$= r^{-1}(1-e^{-rT})[P_Q Q - C(Q, V) - M(V, I)] - P_d I$$

NPV = net present value.

T = ending time.

P_Q = price of output.

r = discount rate.

P_d = price of durable.

e^{-rt} = continuous discounting factor.[1/]

The assumptions made thus far and that will be made are: input and output markets are perfectly competitive; the functions f, V, M, and C are time invariant--that is, the partial derivatives with respect to time are all zero; Sc is known in advance or given; and the ending period T is given. Assuming that scrappage, Sc, is given is contrary to the earlier arguments. This assumption is made to derive results to use when estimating investment demand for the aggregate agricultural sector for which actual scrappage data are not available.

The time invariant assumption for the cost and production functions causes no real problems. It only assumes that production is continuous and that inputs are converted to output instantaneously. The implications for V are that investment occurs instantaneously, and that there is no output decay. The assumption implies for M that there is no input or output decay.

[1/] The present value of a dollar received at time t (t a continuous variable) with rate of discount r, compounded n times per year, is $\frac{1}{(1 + r/n)^{nt}}$ or the inverse of the compounding factor.

Taking the $\lim_{n \to \infty} (1 + r/n)^{-nt}$ will give the continuous discounting factor. It is convenient to take the limit of the natural logarithm $\ln (1 + r/n)^{-nt} = -nt \ln (1 + r/n) = \frac{\ln(1 + r/n)}{-1/nt}$.

Taking the limit and applying l'Hopital's rule gives:

$$\lim_{n \to \infty} \frac{\ln(1 + r/n)}{-1/nt} = \lim_{n \to \infty} - \frac{(r/n^2)/1 + r/n)}{1/n^2 t} = \lim_{n \to \infty} - \frac{rt}{1 + r/n} = -rt.$$

Taking the antilogarithm of -rt gives e^{-rt}.

If durable assets are of the "one-hoss-shay" variety with no input decay, they would fulfill the above assumptions.

The objective function, equation (4.25), has as variables I, X_1, X_2, and X_3. To find the first order conditions, the four partial derivatives will be taken and set equal to zero.

$$(4.26)\quad \frac{\partial NPV}{\partial X_1} = r^{-1}\ (1-e^{-rT})\ [P\ \frac{\partial Q}{Q\partial X_1} - \frac{\partial C}{\partial Q}\frac{\partial Q}{\partial X_1}]$$

$$(4.27)\quad \frac{\partial NPV}{\partial X_2} = r^{-1}\ (1-e^{-rT})\ [P\ \frac{\partial Q}{Q\partial X_2} - \frac{\partial C}{\partial Q}\frac{\partial Q}{\partial X_2}]$$

$$(4.28)\quad \frac{\partial NPV}{\partial X_3} = r^{-1}\ (1-e^{-rT})\ [P_Q\ \frac{\partial Q}{\partial V}\frac{\partial V}{\partial X_3} - \frac{\partial C}{\partial Q}\frac{\partial Q}{\partial V}\frac{\partial V}{\partial X_3} - \frac{\partial C}{\partial V}\frac{\partial V}{\partial X_3} - \frac{\partial M}{\partial V}\frac{\partial V}{\partial X_3}]$$

$$(4.29)\quad \frac{\partial NPV}{\partial I} = r^{-1}\ (1-e^{-rT})\ [P_Q\ \frac{\partial Q}{\partial V}\frac{\partial V}{\partial I} - \frac{\partial C}{\partial Q}\frac{\partial Q}{\partial V}\frac{\partial V}{\partial I} - \frac{\partial C}{\partial V}\frac{\partial V}{\partial I} - \frac{\partial M}{\partial V}\frac{\partial V}{\partial I}$$

$$- \frac{\partial M}{\partial V}\frac{\partial V}{\partial I} - \frac{\partial M}{\partial I}] - P_d$$

Setting the above four equations equal to zero gives:

$$(4.30)\quad P_Q\ \frac{\partial Q}{\partial X_1} = \frac{\partial C}{\partial Q}\ \frac{\partial Q}{\partial X_1} \qquad \text{or} \qquad VMP_{X_1} = P_{X_1}$$

$$(4.31)\quad P_Q\ \frac{\partial Q}{\partial X_2} = \frac{\partial C}{\partial Q}\ \frac{\partial Q}{\partial X_2} \qquad \text{or} \qquad VMP_{X_2} = P_{X_2}$$

$$(4.32)\quad P_Q\ \frac{\partial Q}{\partial V}\ \frac{\partial V}{\partial X_3} = \frac{\partial C}{\partial Q}\frac{\partial Q}{\partial V}\frac{\partial V}{\partial X_3} + \frac{\partial C}{\partial V}\frac{\partial V}{\partial X_3} + \frac{\partial M}{\partial V}\frac{\partial V}{\partial X_3}$$

$$(4.33)\quad P_Q\ \frac{\partial Q}{\partial V}\ \frac{\partial V}{\partial I} - \frac{\partial C}{\partial Q}\frac{\partial Q}{\partial V}\frac{\partial V}{\partial I} - \frac{\partial C}{\partial V}\frac{\partial V}{\partial I} - \frac{\partial M}{\partial V}\frac{\partial V}{\partial I} - \frac{\partial M}{\partial I} = r(1-e^{-rT})^{-1}P_d$$

Equations (4.30) and (4.31) give the standard profit-maximizing condition for variable nondurable inputs used in production: that is, they equate the value of marginal product (VMP) to the price of the input.

Equation (4.32) gives the profit-maximizing conditions for a variable nondurable input used in producing durable services that are used in the production of an output Q. The term to the left of the equality in (4.32) is the value of marginal product for X_3. It is "instumental" in that it is the VMP of durable services used in production of Q times the durable services produced with a change in X_3. The instrumental VMP of X_3 is equated to the "net" marginal factor cost of X_3. The first term to the right of the equality gives the change in variable cost as output is increased (positive). The next term is the change in variable cost as durable services are increased (negative). The third term is the change in M as more X_3 is purchased or P_{X_3} when the input supply and demand markets are competitive.

Equation (4.33) gives the rule for determining the optimal amount to invest in new durables. It says to equate the change in quasi-rent (as more of the durables are purchased) to the amortized price of the durable. The continuous amortization factor is $r(1-e^{-rT})^{-1}$. Alternatively, one could leave the discounting factor on the other side of the equation and have the rule: equate the present value of the change in quasi-rent to the price of the durable.

If one were to view the firm as making these decisions simulaneously, then the firm derived demand for input equations would be a reduced form of the four first order conditions. The quantities demanded of X_1, X_2, X_3, and I would be functions of the fixed variables, output price, price of all the inputs (including P_d), the interest rate (r), and the beginning stock of durables.

Traditionally, it is not assumed that the quantities of durables purchased can be put into service instantaneously. Thus, P_d and r would not enter the demand for nondurable inputs equations, although the beginning stock of the durable would.

If one assumes a two-step decision process where the nondurable input levels are determined, assuming the durable input level fixed and then durable purchases (investment) determined assuming the levels of nondurables fixed, then the prices of the nondurable inputs do not enter the investment equation. This leads to the acceleration principle where investment demand depends, among other things, upon the rate of change of output (Eisner, 1969).

A somewhat modified view will be used in the empirical portion of this research. It will view the decision of nondurable input level determination to be made assuming the stocks of durables fixed. The level of durables (investment) will be determined as a plan for the future when nondurables will be variable; thus the prices of nondurables (as opposed to changes in outputs) will be included in investment demand equations.

Further comment at this point is required relative to the investment equation being specified in terms of gross or net investment. The earlier portion of this section argues for scrappage of durables to be an economic decision. However, the theory is presented assuming scrappage predetermined because of the absence of good data on scrappage. (The purpose of the theory presented here is not to advance theory, but to derive a basis for the equations required in the model.) It is planned to estimate gross investment equations with estimated scrappage as an independent variable. There are several reasons for this. First, the measure of scrappage that will be used is not based on empirical data (Baker, 1978) and thus may not be an unbiased estimate of actual scrappage (i.e., expected Sc = population mean). If the measure is biased, including the scrappage variable as an independent variable would allow the regression coefficient to correct for some of the bias. Second, assuming a reasonable estimate of scrappage, inclusion of scrappage as an independent variable would allow implied replacement investment as an economic decision. The coefficient of scrappage could be interpreted as the quantity of scrappage automatically replaced, with the balance of replacement depending on the levels of other variables (e.g., output prices, price of the durable, and the prices of variable inputs).

Theory Applied to the Farming Sector

In this section, the structural equations to be estimated for the model will be specified in a general manner. The final selection of variables in each equation, along with the empirically estimated coefficients, will be presented in Chapter V.

Output

Output of the farm production sector will be aggregated to the aggregate crop and livestock levels for this study. This breakdown is based upon several considerations, including the following: (1) the demand for crops and livestock is distinctly different--livestock demand is largely derived directly from U.S. consumer demand for livestock and livestock products, while crop demand is derived from livestock (feed) demand, export demand, stock demand, and direct consumer demand for crop products; (2) input categories can be divided into inputs for livestock only, inputs for crops only, and inputs used by livestock and crops; and (3) linkages between exogenous and endogenous variables are more direct and have greater meaning when output is divided into more than one componenet. A more detailed breakdown of output could probably be justified based upon the above considerations. Such a breakdown might concentrate on disaggregation of crop output into the categories of feed grains, food grains, fiber, and other. Such a breakdown would add more detail than is necessary for this study. Aggregate data used in this study are presented in Appendix A.

For purposes of the analysis of this research, variables of interest are cash receipts, change in inventory value of livestock and livestock products, and crops. This requires knowledge of production, consumption, and price level. In the following paragraphs, equations for th

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for these variables will be specified. The glossary published in Baker (1978) should be referred to for variable name, definitions, units of measurement, data source, and source in the simulation model for specific variables used in the model.

Livestock Supply

A livestock supply equation expresses quantity supplied as a function of own and input prices and quantities of fixed inputs.

The general specification of the supply equation for the model is expressed in equation (4.34).

$$(4.34)\quad Q_t = f(P_{t-i}, \overline{R}_{t-i}, K)$$

Q_t = quantity supplied in year t.

P_{t-i} = price of livestock in year t-i.

$\overline{R}_{t-i}$ = vector of current and lagged input prices.

K = fixed factors.

It is anticipated that livestock supplied would be responsive to the current year's price, thus causing simultaneity with demand for livestock. In addition, it is hypothesized that there are effects of past prices on current output. All own price coefficients would be expected to have positive signs.

The major input into livestock production is probably feed. The current year's price of feed, as well as past prices of feed, will be considered in the estimation of the equation. Other inputs that may be important are labor and miscellaneous supplies. Coefficients of input prices would be expected to be of negative sign.

The lagged effects are expected, in part because of the physical limitations involved in expanding livestock production.

Crop Supply

When considering the crop supply equation, one must consider the empirical data to be used in estimating the equation. The data series for crops is constructed on a crop year basis that begins with harvest for major crops (see Appendix A). Thus, by definition (based on the physical or technical factors), the supply variable cannot be influenced greatly by prices in the crop year.

A supply equation gives quantity supplied as a function of own price, prices of variable inputs, and quantities of fixed inputs.

The general form of the supply of crops equation is given by equation (4.35).

$$(4.35) \quad Q_t = f(P_{t-i}, \overline{R}_{t-i}, K_{t-i})$$

Q_t = quantity supplied.

$\overline{R}_{t-i}$ = a vector of prices of variable inputs.

K_{t-i} = fixed factors.

Prices in the equation and quantities of fixed factors will be for the year leading to harvest or lagged longer periods. Major variable inputs involved in crop production would include fertilizer, hired labor, and supplies. Fixed factors would include operator labor, machinery and motor vehicle services, and acres of land.

It is anticipated that weather and technology will be important factors in determining crop supply. These variables might be refected by an index of productivity.

Livestock Demand

Livestock demand will consist of three components: export demand, domestic consumer demand, and demand for inventory. Exports, as well as the supply factor imports, are relatively unimportant and will not be estimated from structural equations but will be handled exogenous to the system via scenario projections.

The demand for livestock inventories is somewhat difficult to conceptualize, partially because of the data available. The data do not distinguish between the "capital" portion of the inventory and the reserve production or "goods-in-process" portion. Because of these factors, it was decided to handle livestock inventories exogenously.

Consumer demand for livestock and livestock products will be treated as a standard demand function with quantity demanded a function of own price, price of subsitute goods, income, and factors such as population. The general form of the equation is given by equation (4.36).

(4.36) $Q_t \quad f(P_t, \overline{R}_t, Y, POP)$

Q_t = quantity demanded.

P_t = own price.

$\overline{R}_t$ = a vector of prices of important substitute.

Y = disposable income.

POP = population.

A lag structure on prices in the demand equation is not deemed necessary, as one would expect consumers to be able to adjust quickly (within one year) to price changes.

The selection of a substitute in consumption for aggregate livestock is not easy. Two possibilities would be crops or "all other goods." Crops would be an alternative food item while "all other goods" would represent alternatives to food purchases. Problems are anticipated with the inclusion of these variables. It seems unlikely that, in the United States, consumption of crops directly is a major substitute for livestock. In addition, the selection of a price indicator for all other goods is a problem. It is anticipated that all prices and incomes in the equations will be deflated. (this will be discussed in more detail later.) A deflator would represent the overall price level of all goods and services--approximately the same concept as the desired price of all other goods.

Disposable income will be included to represent the consumer budget constraint. Population could be included in the equation directly, or the equation could be estimated on a per capita basis (with disposable income also on a per capita basis).

Crop Demand

The demand for crops is composed of five parts: feed demand, seed demand, export demand, food-industrial demand, and inventory demand. As with livestock, exports and inventory demand (also imports) will be handled exogenously.

Feed Demand. Feed demand is a derived demand from the production of livestock. Derived input demand equations express the quantity demanded of the input as a function of own price, prices of other inputs, price of output(s), and levels of fixed inputs. This general form is expressed by equation (4.37).

(4.37) $Q_t = f(P_t, \bar{R}_t, \bar{K})$

Q_t = quantity of input demanded

P_t = own price

$\bar{R}_t$ = prices of other variable inputs and output(s)

$\bar{K}$ = quantities of fixed factors

The own price variable for the feed demand equation will be an index of feed price. The price will be an endogenous variable (see later section on feed supply). The output being considered is clearly livestock. It is anticipated that current livestock price will affect current feed demand. In addition, lagged livestock prices may affect current feed demand. This relationship would hold if there are lagged own price effects in the livestock supply equation.

Other inputs that might be important are labor and supplies. One would not expect a strong substitute or complementary relationship between these variable inputs.

Seed Demand. The seed demand relationship is similar to feed demand in that seed demand is derived from crop production. A price index for seed will be the own price variable for seed with a seed supply equation (see later section) completing the seed component of the model.

The output price in the equation will be current crop price. This is basically saying that the demand for inputs into next year's crop production is affected by the price of the output at the time the input is being used.

Problems are anticipated with this approach because of the relationship between crop price and seed price. It is anticipated that crop price will be a major factor (with positive coefficient) in the seed supply equation. Thus, the differing effects as a "price of output" and "price of variable input" influences of crop price on seed supply and demand may be difficult to estimate.

Other variable inputs that may be important substitutes or complements are fertilizer, supplies, and labor. A fixed factor anticipated as having an important complementary relationship is acres of cropland harvested.

Industrial-Food Demand. In addition to feed, seed, and export uses, crops are used in industry (e.g., oils) and processed into foods for more direct consumption. These categories are combined, partially because of the availability of data in constructing the commodity aggregates. However, it seems reasonable to the author to view this demand as a derived consumer demand. That is, quantity demanded is a function of own price, prices of substitutes in consumption, income, and other factors such as population. The general form of the equation was given earlier for livestock (4.36).

As with livestock demand, it is not anticipated that lagged prices be required in the equation. In addition, the same comments

made earlier relative to finding the price of an important substitute in consumption apply. Finally, this equation may also be specified on a per capita basis.

Feed Supply

The feed supply equation is necessary to complete the system of equations. Theoretically derived supply equations give quantity supplied as a function of own price, prices of inputs, and quantities of fixed inputs. The view here of feed supply is that the quantity is largely determined in the demand equation and that the supply equation should have price as the normalized variable.[1/] That is, the equation gives "supply price" as a function of quantity supplied, input prices, and fixed inputs.

Seed Supply

The view of seed supply is similar to that of feed supply. The "supply price" of seed is given as a function of quantity supplied, the price of crops as an input in seed production, and the prices of other inputs variable in seed production. These might include labor and supplies.

1/ The terminology "dependent variable" does not really apply here as the system of equations is simultaneous. Thus, as a portion of the identifying restrictions, one normalizes one variable in each equation (gives it coefficient one). This is essentially choosing the "dependent" variable for the individual equation, although all of the endogenous variables are jointly dependent.

Demand for Hired Labor

In general, the demand for a variable input is a derived demand. It is derived from the profit-maximizing behavior of firms. The quantity of an input is a function of its own price, the price of output(s), the prices of other inputs, and the quantities of fixed inputs.

In the case of hired farm labor, it is anticipated that the quantity demanded of hired farm labor will be a function of its own price, the prices of crops and livestock, and the quantities of fixed inputs--operator labor and machine services. It would be anticipated that the fixed inputs are substitutes for hired labor. Prices of other variable inputs such as fertilizer, supplies, feed, or seed could be included in some specifications of the equation but are unlikely to be important as substitutes or complements.

Fertilizer Demand

It is anticipated that the quantity of fertilizer demanded will be a function of current fertilizer price, current and past crop prices, cropland acres, and possibly the prices of other variable inputs. It is not expected that the price of hired labor or quantity of operator labor would be significant complements or substitutes for fertilizer.

The demand for fertilizer in the current calendar year is anticipated to be a function of the price of crops in the current crop year (applying fertilizer for the next harvest), as well as a function of crop price lagged one year.

Demand for Other Nondurable Inputs

This residual category of nondurable inputs is anticipated to be a function of its own price, the prices of livestock and crops, the prices of inputs such as fertilizer and labor, and the quantities of machinery and cropland.

Demand for Durables

The model will include structural equations for investment demand for two categories of productive durable assets. These are: 1) machinery and motor vehicles and 2) service buildings, other structures, and improvements to land. In addition, a structural equation for the demand for machinery repairs and maintenance is included. Structural equations for investment or maintenance of other categories of durables are not estimated, primarily because of the lack of or low quality of data. Chapter V gives further explanation.

Investment Demand for Machinery and Motor Vehicles. Following the derived demand for the gross investment equation derived earlier, the demand for gross investment (quantity) is a function of the price of the durable, interest rate (either as a separate variable or combined with the price of durable via amortization of the price), prices of crops and livestock, prices of nondurable variable inputs, and quantities of fixed factors.

It is anticipated that the price of machinery and motor vehicles will be adjusted for investment credit. The prices of livestock and crops (output prices) may also need to be weighted and combined into one price. An additional alternative for output prices would be to use net cash flow as a variable to represent output prices and the availability or cost of internal funds.

The major variable input price anticipated to be included in the equation is the price of hired labor. Alternatively, the quantity of operator labor could be used in the equation. A substitute relationship is expected with either labor variable. Fixed inputs, such as acres harvested, might be important factors.

An indicator of the level of technology may be required, as it seems reasonable that the demand for machinery would expand as new technology is availabe. It is possible that this factor is taken into account in the measurement of machinery prices.

Estimates of the "quantity" measure stock of machinery and scrappage have been made and are explained in Baker (1978).

Machinery and Motor Vehicle Maintenance and Repair-Derived Demand. The view of demand for maintenance and repair of machinery and motor vehicles is that it is a demand derived from the use of nondurable inputs in the production of durable services. As such, the quantity demanded is a function of own price, the price of the durable input, the interest rate (or amortized durable price), the price of output, prices of other inputs, and fixed factors.

Investment Demand for Service Buildings, Other Structures and Land Improvements. Gross investment for this category of durable assets is specified in a manner similar to that of machinery and motor vehicles. The quantity demanded is a function of own price, the interest rate (or amortized price), the price of output, prices of other inputs, and fixed factors.

Deflation of Prices and Money Flows

The first order conditions for a firm's profit maximization (or for a consumer-maximizing utility) are homogenous to degree zero in prices.[1/] That is, a proportional change in all prices has no effect on the solution to the equations (quantities supplied, demanded, etc.). The existence of money illusion would be contrary to the homogenous to degree zero condition. In this study, nearly all prices and money flows included in structural equations are deflated. The hypothesis of money illusion is, in general, not tested.

One should distinguish between the type of deflating discussed here and the deflation of current dollar flows to get quantity flows. The two concepts are completely unrelated.

The choice of a deflator for the general level of prices is the consumer price index for all items. One could construct arguments to use the CPI to deflate consumer-oriented prices and the implicit GNP deflator to deflate producer-oriented prices. This is not done for the model, since to do so would involve adding another exogenous variable. It was felt that one price level indicator would suffice.

Alternative Approaches

The amount of "structure" to include is always somewhat arbitrary, for one could specify a nearly infinite amount of detail. The approach

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outlined in this chapter has presented the traditional approach of market supply and demand functions.

Some might argue for modeling of more structure. This might include estimation of production functions to get the direct relationships between inputs and outputs. In addition, one could directly derive input demand equations from the production function, assuming profit maximization.

The production function approach has not been attempted for this model for numerous reasons, including the following. Estimation of production functions for crops and livestock would require a breakdown of data on inputs into those inputs used in livestock and those used in crops. Aggregate data in this form are, in general, not available. In addition, it seems to the author, highly unlikely that input demand functions derived from an aggregate production function and first order conditions would fit the historical data series.

A modification of the approach used here would be to incorporate risk into the model. While this is an appealing idea, the author has not attempted it, based on the following factors. First, the theoretical basis for aggregate risk models is not well developed. Static economic theoretical frameworks, such as those alluded to for "portfolio balance theory," basically do not exist. At a minimum, an aggregate risk model would involve variance and covariance estimates for the basic structural variables. Placing these demands on the meager data available seems outlandish.

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Summary

The first portion of this chapter outlined the system to be modeled. The major performance variables of interest were determined to be those appearing on financial statements for the sector. These variables are the results of economic activities of the sector. Economic activities can be expressed mathematically in the form of a set of equations. The solution of this set of equations gives values for the economic variables of interest. Economic theory relevant to derivation of these equations was presented. Application of the theory to the farming sector was made to derive general expressions for the equations to be empirically estimated.

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CHAPTER V

The Empirical Model

Introduction

The chapters to this point have identified the system to be modeled and have developed a theoretical framework. The performance variables of interest were determined to be those appearing on financial statements for the farming sector. This chapter presents equations estimated for the model. Where the data and theoretical framework were deemed adequate, structural equations have been estimated. This does not, however, provide all of the variables required to prepare a complete and consistent set of financial statements. A significant number of equations have been estimated that are not intended to represent system structure. These equations are based upon many factors, but reflect only the author's judgment that they are the best equations considering the constraints.

Additional relationships are specified in the model based upon assumptions or single observations of relationships. These relationships are largely in the intersector transfers component, where both data and theory are absent.

Again it should be indicated that the "guiding light" for which variables are necessary is the set of financial statements for the sector. The financial statements are presented in Chapter VII. The research process began with a set of financial statements and desired economic relationships to model. These were modified as data were discovered to be adequate or inadequate and as the author gained insight into accounting at the sector level.

Additional considerations in specifying the model were related to its use in policy analysis. Specification of the structural detail to model and variables in equations was influenced by the need for explicit introduction of policy-related variables whenever possible.

In the process of empirical estimation, some ad hoc procedures were employed in selecting variables for the equations. The total number of variables theoretically appropriate for each equation involved a greater number than expected to be included in the final form selected. Signs unambiguously specified by theory were considered a minimum requirement for all coefficients. Some equations include time trends, productivity indexes, or other noneconomic variables which were required to get the proper economic relationships.

Time Index

One of the major sources of confusion when trying to interpret the equations estimated for the model is the use of the time label. The confusion may arise because the crop and calendar years differ. The crop year variables were constructed from data that began with harvest of the crops. In general, this is toward the end of the calendar year. Thus, the crop year is labeled with the second calandar year of the two it overlaps. For example, the 1974-75 crop year is labeled 1975.

Data Period

The data period used to estimate most of the equations is 1951 to 1974. There are exceptions which will be noted when necessary. If there is no reference to a data period, it may be assumed that the 24 observations from 1951 through 1974 were used.

Statistical Considerations

Appendix B gives a description of statistical considerations relevant to this model. However, the following items will be useful when interpreting statistical results: 1) simultaneous equations are estimated via two-stage least squares (2SLS); 2) all nonsimultaneous equations are estimated via ordinary least squares (OLS); 3) all critical values are for one-tailed tests; 4) all equations are linear in the variables unless otherwise stated; and 5) unless other stated, t statistics, not coefficient standard errors, are given.

Crop Supply

Equation (5.1) shows the supply equation for aggregate crop output (CRPROD). Appendix A gives a description of crop aggregation. The time index for this variable is the calendar year in which harvest occurs. CRPROD is CROPS(2) lagged forward one period. Thus CRPROD is crop production in calendar year t. It enters the crop supply utilization identity for crop year t+1 and is recursive to a set of simultaneous equations determining crop price and utilization.[1/]

The supply of crops equation includes as independent variables (1) output price, the real crop price for the year leading to harvest (RPCROP), and the previous year's real crop price (RPCRM1); (2) the price of an important input, the real price of fertilizer (RPFERT); (3) quantities of fixed inputs, harvested acres (HARACR), and beginning-of-year stock of machinery and motor vehicles per acre (SM4/A); and (4) the productivity index (XPROD) to "capture" changes in technology and weather variations. Expected signs are shown under the variable names in equation (5.1).

The empirical results from estimating equation (5.1) via OLS are shown below in Table 5.1. The short- and long-run price elasticities of supply are less than unity (see Table 5.1). This holds when the price and quantity used are mean values over the entire historical series or for the three most recent years of the data set. At the average price and quantity for recent years, the long- and short-run elasticities are less inelastic than for the mean price and quantity over the entire data period. Adding an additional lagged crop price resulted in a statistically insignificant coefficient of negative sign. Thus, the lag structure is cut off after using two prices.

$$\text{(5.1)}\quad CRPROD = f(\underset{+}{RPCROP}, \underset{+}{RPCRM1}, \underset{-}{RPFERT}, \underset{+}{HARACR}, \underset{+}{SM4/A}, \underset{+}{XPROD})$$

1/ It can also be viewed as CROPS(2), predetermined for the following year's set of equations.

CRPROD = crop production in calendar year t, for use in the following crop year (t+1) supply-utilization identity

RPCROP = real crop price for crop year t

RPCRM1 = real crop price for crop year t-1

RPFERT = real fertilizer price for calendar year t

SM4/A = beginning of calendar year stock of machinery and motor vehicles per harvested acre

XPROD = index of farm productivity, United States

Table 5.1. Empirical Results for Equation (5.1), Crop Supply, CRPROD

Explanatory Variable	Regression Coefficient	t Statistic	Selected Elasticities 1951-74	1972-74
Constant	-5507.498	---	---	---
RPCROP	36.57623	4.1	.205	.285
RPCRM1	19.34327	1.4	.314[a]	.435[a]
RPFERT	-65.93648	-5.4	---	---
HARACR	14.97038	1.7	.23	---
SM4/A	1.4963	.1	.013	---
XPROD	232.00885	11.7	---	---

R^2 = .993, D.W. = 1.6, $t_{.01}$ = 2.898, $t_{.05}$ = 2.110, $t_{.10}$ = 1.740

[a] Long run elasticity

An "elasticity" calculated with respect to harvested acres is shown in Table 5.1. This elasticity gives an indication of the responsiveness of the sector to changes in acreage. As one might expect, a 1 percent change in harvested acres will result in a less than 1 percent change in crop output. This result has implications for the effectiveness of acreage control policies in controlling crop output.

The beginning-of-year stock of machinery and motor vehicles is included in the equation, in spite of its statistically insignificant coefficent, in order to maintain a linkage between the decisions of farmers to purchase machinery and output capacity. This linkage is weak, as indicated by the very low elasticity. One reason suggested for the low statistical significance and elasticity is that the existence of excess machinery capacity has had little direct effect on output resulting from changes in the machinery stock.

Alternative specifications of the model included deletion of the productivity index and inclusion of the real wage rate and real price of supplies. The exclusion of the productivity index, while not having a great effect on the R^2, caused problems with significance levels and signs of coefficients for other variables. Inclusion of additional input prices did not improve the equation.

Demand for Crops

The demand for crops is the sum of several components. These include feed demand, seed demand, export demand, food-industrial demand, and inventory demand. In the model here, inventories and exports are exogenous. Thus, crop demand estimation consisted of estimating seed, feed, and food-industrial demand functions.

Food-Industrial Crop Demand

Equation (5.2) shows domestic per capita food and industrial demand for crops to be a function of the real price of crops (RPCROP), real gross national product per capita (RGNP/POP), and the logarithm of time.

$$(5.2)\quad CROPS(7)/POP = f(\underset{-}{RPCROP}, \underset{+}{RGNP/POP}, Log_{10}T)$$

CROPS(7) = food and industrial crop usage in crop year t.

POP = U.S. population.

RPCROP = real price of crops in crop year t.

RGNP = real gross national product for calendar year t.

T = time (1950=1).

This demand equation proved difficult to specify empirically in a satisfactory manner. The final equation, estimated via 2SLS shown in Table (5.2), includes a time variable. In addition, the coefficient of price is not significant at the normally acceptable level. From a theoretical viewpoint, the demand equation lacks a "price of substitute" variable. At the level of aggregation for this model, the only price that seemed appropriate, the real price of livestock, was not statistically significant. Less desirable results were obtained when the equation was estimated on a "total" rather than per capita basis with population as an independent variable.

Table 5.2. Empirical Results for Equation (5.2), Per Capita Food-Industrial Demand for Crops, CROPS(7)/POP

Explanatory Variable	Regression Coefficient	t Statistic	Selected Elasticities 1951-74	1972-74
Constant	46.43573	---	---	---
RPCROP	-.00976	.98	-.026	-.0453
RGNP/POP	.001949	4.75	.16	.205
$Log_{10}(T)$	-9.02276	-8.85	---	---

R^2 = .91, D.W. = 1.96, $t_{.01}$ = 2.845, $t_{.05}$ = 2.086, $t_{.10}$ = 1.725

The variable $\log_{10}T$, the base ten logarithm of time, represents a set of factors causing a reduction in per capita consumption of crops over time not explained by price, income, or population.

The price elasticity of demand for crops for food and industrial consumption is very low, -.026 using mean values for the 1951 to 1974 period and -.0453 for the recent 1972 to 1974 period. The income elasticities are .16 and .205 with variables at their 1951 to 1974 and 1972 to 1974 mean values, respectively.

The low elasticities seem reasonable in light of the fact that the equation is a "farm level" demand. That is, it is the response in terms of "raw" commodity demanded to changes in farm price. One would hypothesize that demand is much less price and income inelastic for services that may be added to the commodity.

Feed Demand

Equation (5.3) shows feed demand for crops to be a function of the real price of feed (RPFEED), current and lagged real livestock prices, and the base 10 logarithm of time.

$$(5.3) \quad CROPS(6) = f(\underset{-}{RPFEED}, \underset{+}{RPLIV}, \underset{+}{RPLVM1}, \underset{+}{RPLVM2}, \log_{10}T)$$

CROPS(6) = feed usage of crops in crop year t.

RPFEED = real price of feed for calendar year t.

RPLIV = real price of livestock for calendar year t.

RPLVM1 = real price of livestock lagged one year.

RPLVM2 = real price of livestock lagged two years.

T = time (1950=1).

The empirical results from estimating this equation via 2SLS are shown in Table 5.3. Earlier specifications of the equation included additional input prices. In addition, attempts were made to estimate the equation using the real price of crops rather than the real price of feed, thus eliminating the need for a feed supply equation. These alternatives were considered less desirable than the specification (5.3).

Table 5.3. Empirical Results for Equation (5.3), Feed Demand for Crops, CROPS(6)

Explanatory Variable	Regression Coefficient	t Statistic	Selected Elasticities 1951-74	1972-74
Constant	-3628.84548	---	---	---
RPFEED	-18.07679	-2.28	-.22	-.19
RPLIV	42.5208	5.95	---	---
RPLVM1	20.74522	2.03	---	---
RPLVM2	11.50612	1.22	---	---
$Log_{10}T$	6079.80507	13.04	---	---

R^2 = .97, D.W. = 1.64, $t_{.01}$ = 2.878, $t_{.05}$ = 2.101, $t_{.10}$ = 1.734

The price elasticity of demand for feed[1/] with the variables at their 1951-74 and 1972-74 means is -.22 and -.19, respectively.

The base ten logarithm of time has a positive coefficient and might be interpreted as representing the longer term trend toward greater feed usage not induced by real livestock or feed prices.

[1/] This elasticity is with respect to feed price. Later, the supply function for feed will be substituted into the demand for feed equation to derive the elasticity with respect to crop price. This is useful when looking at feed demand as a component of aggregate crop demand.

Feed Supply

Equation (5.4) shows the supply of feed equation (price dependent) as a function of the quantity of feed, the price of crops, and the base ten logarithm of time. The price of feed was chosen as the normalized variable in the equation as a result of viewing the system as having feed quantity somewhat more predetermined than feed price on the supply side. That is, on the demand side, feed price allocates the quantity of feed, while on the supply side, the price of crops and quantity of feed used determine the "supply price" of feed.

$$(5.4) \quad RPFEED = f(\underset{+}{CROPS(6)}, \underset{+}{RPCROP}, Log_{10}T)$$

RPFEED = real price of feed in calendar year t.

CROPS(6) = feed use of crops in crop year t.

T = time, 1950 = 1, etc.

Table 5.4 gives the 2SLS results from estimating equation (5.4).

Table 5.4. Empirical Results for Equation (5.4), Feed Supply, RPFEED

Explanatory Variable	Regression Coefficient	t Statistic	Selected Elasticities 1951-74	1972-74
Constant	4.92227	---	---	---
CROPS(6)	.003283	2.47	.27[a]	.32[a]
RPCROP	.86112	11.76	---	---
$Log_{10}T$	-20.74726	-2.68	---	---

R^2 = .96, D.W. = 2.15, $t_{.01}$ = 2.845, $t_{.05}$ = 2.086, $t_{.10}$ = 1.725

[a] In this case, these are supply flexibilities.

Solved Feed Demand

The feed supply and demand functions can be solved to eliminate feed price. This provides an alternative form of the structural equation for crop demand which allows direct examination of the elasticity of feed demand with respect to crop price.

Table 5.5 shows the solved demand for feed equation. This equation may be viewed as a partial reduced form in that an endogenous variable (RPFEED) has been eliminated from the system of equations but other endogenous variables (RPCROP, PRLIV) still remain.

Table 5.5. Empirical Results for Equation (5.5), Solved Feed Demand for Crops, CROPS(6)

Variable	Coefficient	Selected Elasticities 1951-74	1972-74
Constant	-3509.5467	---	---
RPCROP	-14.6942	-.186	-.26
PRLIV	40.1387	---	---
PRLVM1	19.583	---	---
RPLIV2	10.4367	---	---
$\text{Log}_{10}T$	5385.1728	---	---

The price elasticity of feed demand for crops is -.186 and -.26 with the variables evaluated at their 1951-74 and 1972-74 mean values. While still inelastic, the feed demand component is considerably more elastic than food-industrial demand for crops (see Table 5.2).

Seed Demand

Equation (5.6) shows the demand for seed as a function of: own price, real seed price; the price of output, real price of crops; prices of other variable inputs, the real prices of labor and supplies;

and quantities of fixed inputs, harvested acres.

$$(5.6)\quad \text{CROPS}(5) = f(\underset{-}{\text{RPSEED}}, \underset{+}{\text{RPCROPS}}, \text{RPSUP}, \text{RPLABOR}, \underset{+}{\text{HARACR}})$$

CROPS(5) = seed use of crops.

RPSEED = real price of seed.

RPCROPS = real price of crops.

RPSUP = real price of supplies.

RPLABOR = real price of hired farm labor.

HARACR = harvested acres.

The seed demand equation proved to be a difficult equation to estimate. Harvested acres did not prove to be a dominant variable as expected, although the coefficient is positive and has a t value of 3.03. A major problem is related to the signs and statistical significance of seed and crop prices. The problem probably relates to the following factors: farmers may not be very price responsive to the price of seed; the price of seed and price of crops are positively correlated (see equation (5.7) the seed supply equation) thus making it difficult to distinguish between the "price of output" effects of crop price in the seed demand equation and the relationship of crop price as an input price in the seed supply equation; and there is heterogeneity in seed demand for individual crops, making the aggregate seed quantity a poor measure of seed use.

The use of simultaneous equation estimators did not improve the statistical significance of the seed and crop price coefficients. In fact, three stage least squares (3SLS) estimation of the equation with the same variables as shown in Table 5.6 results in a "switching of the signs" of both prices and thus is theoretically unacceptable.

The equation shown in Table 5.6, estimated via 2SLS, is used in the model as it was the best of the several specifications estimated.

Table 5.6. Empirical Results for Equation (5.6), Seed Demand for Crops, CROPS(5)

Explanatory Variable	Regression Coefficient	t Statistic	Selected Elasticities 1951-74	1972-74
Constant	-256.35372	---	---	---
RPSEED	-.365018	-.68	-.11	-.12
RPCROP	.344871	.83	---	---
RPSUP	1.63481	1.60	---	---
RPLABOR	2.5682	3.81	---	---
HARACR	.65568	3.03	---	---

R^2 = .87, D.W. = 1.85, $t_{.01}$ = 2.878, $t_{.05}$ = 2.101, $t_{.10}$ = 1.734

The price elasticity of demand for seed with the variables at their 1951-74 and 1972-74 means are -.11 and -.12, respectively.

Seed Supply

Equation (5.7) gives the supply of seed equation. In a manner similar to the feed supply equation, the real price of seed is the normalized variable. The equation shows the supply price of seed as a function of the quantity supplied and the price of the major input, the price of crops.

The 2SLS estimated results of equation (5.7) are presented in Table 5.7.

(5.7) RPSEED = f(CROPS(5), RPCROP)
$\qquad\qquad\qquad\qquad +\qquad\quad +$

RPSEED = real price of seed for calendar year t.

CROPS(5) = seed use in crop year t.

RPCROP = real price of crops in crop year t.

Table 5.7. Empirical Results for Equation (5.7), Seed Supply, RPSEED

Explanatory Variable	Regression Coefficient	t Statistic	Selected Flexibilities 1951-74	1972-74
Constant	-58.29288	---	---	---
CROPS(5)	.29978	5.61	.97	.93
RPCROP	.546898	8.21	---	---

R^2 = .85, D.W. = 1.83, $t_{.01}$ = 2.831, $t_{.05}$ = 2.080, $t_{.10}$ = 1.721

The seed supply flexibility as shown in Table 5.7 is nearly unitary with the variables evaluated at both their 1951-74 and 1972-74 mean values.

Solved Seed Demand

The partial reduced form equation (5.8) for seed demand is shown in Table 5.8. It is obtained via substitution of the seed supply equation into the seed demand equation to eliminate the real price of the seed variable. It is interesting to note that the coefficient of real crop price is positive. This indicates that the positive influence on the demand for seed (as the price of output variable) outweighs the negative influence of crop price (entering via the positive relation between crop price and seed price in the supply of seed equation).

Table 5.8. Empirical Results for Equation (5.8), Solved Seed Demand for Crops, CROPS(5)

Variable	Coefficient	Selected Elasticities 1951-74	1972-74
Constant	-211.8945	---	---
RPCROP	.10932	.041	.035
RPSUP	1.4736	---	---
RPLABOR	2.3149	---	---
HARACR	.59102	---	---

Livestock Demand

Equation (5.9) shows the per capita demand for livestock as a function of the real price of livestock, real per capita disposable income, and the base ten logarithm of time.

(5.9) $LIV(5)/POP = f(\underset{-}{RPLIV}, \underset{+}{RDI/POP}, Log_{10}T)$

LIV(5) = U.S. livestock consumption in calendar year t.

POP = total U.S. population on July 1, year t.

RDI = real disposable income.

T = time (year - 1949).

As was the case in the industrial-food demand for crops, a "price of substitute" variable was not included in the demand for livestock equation. While the equation estimated via 2SLS (see Table 5.9) has proper signs and reasonable statistical significance for own price and disposable income, it was necessary to include a time trend variable to achieve these results. The time variable indicates a reduction in per capita demand for livestock caused by factors other than livestock price and income.

Table 5.9. Empirical Results for Equation (5.9), Demand for Livestock, LIV(5)/POP

Explanatory Variable	Regression Coefficient	t Statistic	Selected Elasticities 1951-74	1972-74
Constant	110.19175	---	---	---
RPLIV	-.089916	-2.25	-.10	-.15
RDI/POP	.006682	2.82	.17	.21
$Log_{10}T$	-19.1997	-4.64	---	---

R^2 = .80, D.W. = 1.69, $t_{.01}$ = 2.845, $t_{.05}$ = 2.086, $t_{.10}$ = 1.725

The livestock demand equation used in the model (Table 5.9) has fairly low price elasticity with variables evaluated at recent and entire sample period mean values, although both income and price elasticities are higher for the recent period.

Livestock Supply

Equation (5.10) shows the quantity of livestock supplied as a function of current and lagged real livestock prices, the real price of feed (an important input), and a time trend.

$$\text{(5.10) LIV(2)} = f(\underset{+}{\text{RPLIV}}, \underset{+}{\text{RPLVM1}}, \underset{-}{\text{RPFEED}}, \text{Log}_{10}\text{T})$$

LIV(2) = quantity of livestock supplied in calendar year t.

PRLIV = real price of livestock in the current calendar year.

RPLVM1 = RPLIV for the previous calendar year.

RPFEED = real price of feed in the current calendar year.

T = time (year - 1949).

The empirical results from 2SLS estimation of equation (5.10) are shown in Table 5.10. The inclusion of the time trend variable was necessary to get the desired signs and reasonable statistical significance of the other variables. It is hypothesized that the time trend represents improved technology in the livestock industry over time. The productivity index did not work as well in the equation as did $\log_{10}T$. This is probably because most of the variables reflected in the productivity index are the result of weather and technology associated with crop production.

Table 5.10. Empirical Results for Equation (5.10), Livestock Supply, LIV(2)

Explanatory Variable	Regression Coefficient	t Statistic	Selected Elasticities 1951-74	1972-74
Constant	7857.864	---	---	---
RPLIV	40.3453	3.09	.24	.31
LVM1	28.10999	1.84	.41[a]	.53[a]
RPFEED	-23.4773	-1.56	---	---
$\log_{10}T$	5196.8917	8.16	---	---

R^2 = .86, D.W. = 1.44, $t_{.01}$ = 2.861, $t_{.05}$ = 2.093, $t_{.10}$ = 1.729

[a] Long run elasticity

The short run elasticity of supply (.31 for the recent years' data) indicates a reasonable capacity to change output of livestock and livestock products in a short period of time. This elasticity is based on a coefficient with high statistical significance. The real price of livestock lagged two periods was dropped from the equation because of low statistical significance.

Demand for Other Non-Durable Inputs

Equation (5.11) shows the formulation of derived demand for other nondurable inputs. This category of inputs includes items such as pesticides, utilities, and ginning. The own price variable used is the index of prices paid for farm supplies. The equation shows quantity demanded as a function of own real price, the price of output, the fixed stock of a substitute durable input, and a time trend.

$$(5.11) \quad OTHER = f\,(\underset{-}{RPSUP},\ \underset{+}{RPTOUT},\ \underset{+}{SMMV4},\ Log_{10}T)$$

OTHER = quantity of other nondurable inputs.

RPSUP = real price of supplies.

RPTOUT = real price of total output.

SMMV4 = stock (quantity measure) of machinery and motor vehicles.

T = time (year-1949).

The empirical results for equation (5.11) are shown below in Table 5.11. Other specifications of the equation included real fertilizer price and the real price of hired labor. The fertilizer price coefficient was not significantly different from zero. The price of labor is highly correlated with time and had a highly significant positive coefficient (in the absence of the time variable) when included in the equation. The author did not feel that labor and other nondurable inputs were substitutes to the extent indicated by the equation. Instead, it seems more reasonable to include the time trend to represent the increased use of intermediate inputs such as pesticides and herbicides over time as new technologies have evolved.

Table 5.11. Empirical Results for Equation (5.11), Derived Demand for Other Nondurable Inputs, OTHER

Explanatory Variable	Regression Coefficient	t Statistic	Selected Elasticities 1951-74	1972-74
Constant	10530.4645	---	---	---
RPSUP	-74.9380	-7.36	-2.29	-1.34
RPTOUT	22.5522	6.48	---	---
SMMV4	-.0841	-3.27	---	---
$Log_{10}T$	2831.3732	5.05	---	---

R^2 = .98, D.W. = 1.62, $t_{.01}$ = 2.861, $t_{.05}$ = 2.093, $t_{.10}$ = 1.729

Table 5.11 gives price elasticities of the derived demand with variables at their mean values for the whole data period and the recent three year period. Both elasticities are greater than one, but with variables at recent levels, the elasticity is much lower. The negative coefficient on the stock of machinery and motor vehicles (SMMV4) indicates a substitute relationship between other nondurable inputs and services from durables.

When entered as separate variables, the prices of livestock and crops had different signs and low statistical significance. This prompted the usage of RPTOUT which is a weighted average of RPCROP and RPLIV.

Demand for Hired Farm Labor

Equation (5.12) shows the formulation of the derived demand for hired farm labor. The quantity demanded is shown to be a function of own real price, the real price of output, and the quantities of fixed inputs (family labor and the stock of machinery and motor vehicles).

(5.12) LABOR = f(RPLABOR, RPTOUT, FAMILY, SMMV4)
$\quad\quad\quad\quad\quad\quad\quad\quad -\quad\quad\quad +\quad\quad\quad -\quad\quad\quad -$

LABOR = quantity of hired farm labor.

RPTOUT = real price of total output.

FAMILY = number of operator and family workers.

SMMV4 = stock (quantity measure) of machinery and motor vehicles.

The empirical results for the labor demand equation are shown in Table 5.12. Alternative specifications of the equation include using the prices of crops and livestock as separate variables and inclusion of acres harvested. When the prices of livestock and crops are entered as separate variables rather than combined in RPTOUT, they both have significant positive coefficients. Other coefficients and "t" values remain about the same. The equation including RPTOUT was chosen because of slightly larger t values and a slightly smaller standard error of estimate (98.8 vs. 104.6).

Cropland acres harvested had a very significant negative coefficient when included in the equation. This would imply a substitute relationship between hired labor and land which is contrary to the author's expectations. Thus, the variable is excluded from the equation.

Table 5.12. Empirical Results for Equation (5.12), Demand for Hired Farm Labor, LABOR

Explanatory Variable	Regression Coefficient	t Statistic	Selected Elasticities 1951-74	1972-74
Constant	10049.2	---	---	---
RPLABOR	-44.0789	-7.60	-1.11	-1.66
RPTOUT	15.4469	5.71	---	---
FAMILY	-412.466	-4.94	---	---
SMMV4	-.039701	-3.73	---	---

R^2 = .95, D.W. = .95, $t_{.01}$ = 2.861, $t_{.05}$ = 2.093, $t_{.10}$ = 1.729

Table 5.12 shows the price elasticity of demand for hired labor to be -1.11 with variables at their 1951 to 1974 mean values and -1.66 with variables at the 1972-74 mean values. The Durbin-Watson statistic is at the lower end of the inconclusive region (d_L at the 1 percent level is .80). This would indicate a problem with first order auto-correlation. Using the Cochran and Orcutt procedure for correcting first order auto-correlation results in a substantially different coefficient for the stock of machinery and motor vehicles and somewhat different coefficients for output prices and family workers. The sign of the coefficient of machinery stock changes and is not statistically significant (t = .14). The size of the coefficient of output price is reduced from 15.45 to 8.93 (t value from 5.7 to 3.4), and the family workers coefficient is changed from -412.45 to -287.87 (t value from 4.9 to 3.4). The equation without the correction for auto-correlation was chosen for use in the model largely because of the author's belief in a substitute relationship between machinery and labor over the relevant range.

Demand for Fertilizer

Equation (5.13) shows the formulation of the derived demand for fertilizer. The equation shows the quantity of fertilizer demanded as a function of real fertilizer price, current and lagged real price of crops, and the real price of supplies.

$$\text{(5.13)}\quad FERT = f(\underset{-}{RPFERT}, \underset{+}{RPCROP}, \underset{+}{RPCRM1}, RPSUP)$$

FERT = quantity of fertilizer used in calendar year t.

RPFERT = real price of fertilizer for calendar year t.

RPCROP = real price of crops in crop year t.

RPCRM1 = real price of crops in crop year t-1.

RPSUP = real price of supplies in calendar year t.

The empirical results of equation (5.13) are shown in Table 5.13. It is interesting to note that lagged price of crops has a coefficient about twice as large as current crop prices. It might be reiterated here that crop price in year t is the price for the crop year beginning the previous fall and extending until harvest. The results indicate that there is some positive response of fertilizer demand to crop price changes within the year but that a larger determinant of fertilizer demand is the crop price for the previous year.

Table 5.13. Empirical Results for Equation (5.13), Demand for Fertilizer, FERT

Explanatory Variable	Regression Coefficient	t Statistic	Selected Elasticities 1951-74	1972-74
Constant	9451.26	---	---	---
RPFERT	-21.7701	-3.45	-1.28	-.63
RPCROP	21.2711	5.21	---	---
RPCRM1	40.0646	3.88	---	---
RPSUP	-113.6409	-6.37	---	---

R^2 = .95, D.W. = 1.89, $t_{.01}$ = 2.861, $t_{.05}$ = 2.093, $t_{.10}$ = 1.729

The empirical results show other nondurable inputs (OTHER) and fertilizer to be highly complementary inputs (indicated by the negative coefficient for real price of supplies). The coefficient probably overstates the "economic" relationship and partially reflects the correlation between a technologically related decline in RPSUP and increased fertilizer usage. The results indicate a large difference between the price elasticity of demand for fertilizer with the variables at their means for recent years and over the whole data period. In recent years, there has been a movement into the inelastic portion of the linear fertilizer demand function.

One of the variables hypothesized to be an important input, harvested acres, did not have a statistically significant coefficient and thus was excluded from the equation.

Petroleum, Fuel, and Oil Expense

The cash expenditures for petroleum,fuel, and oil are estimated using the price of motor supplies and the "quantity measure" stock of machinery. The equation is not intended to be a structural equation giving the demand for petroleum, fuel, and oil. The data are not adequate to support that effort. The specification chosen is based on information in Agricultural Handbook 365, Volume 3. The handbook suggests that numbers of motor vehicles, average fuel consumption, and the price of petroleum products are used in data calculations. The model does not contain data on the numbers of machines; thus the stock measure of machinery and motor vehicles was used in the equation.

Table 5.14. Empirical Results for Equation (5.14), Expenditure for Petroleum, Fuel, and Oil, PETRO

Explanatory Variable	Regression Coefficient	t Statistic
Constant	-403.6385	---
PMOTSUP	16.9919	18.70
SM4	.0051055	1.51

$R^2 = .947$, $t_{.01} = 2.831$, $t_{.05} = 2.080$, $t_{.10} = 1.721$

PMOTSUP = price index of motor supplies.

SM4 = stock "quantity" measure of machinery and motor vehicles.

The coefficient of SM4 is not statistically significant but is of the expected sign and therefore is left in the equation.

Investment Demand for Machinery and Motor Vehicles

Equation (5.15) shows the gross investment demand equation for machinery and motor vehicles. Gross investment is shown to be a function of real amortized price (the own price variable), the beginning of year stock of machinery and motor vehicles, the estimated scrappage of machinery and motor vehicles, the real net cash flow (represents price of output and internal availability of funds) and the acres per farm (represent the technology being used and changes in operator labor).

(5.15) EXPMMV = f(RAMORTM, SM4, DM4, RNCF, ACRFRM)
$\qquad\qquad\qquad\qquad\qquad$ - $\quad$ - $\quad$ + $\quad$ + $\quad$ +

EXPMMV = gross investment (quantity) in machinery and motor vehicles.

RAMORTM = real amortized price of machinery and motor vehicles.

SM4 = stock (quantity) of machinery and motor vehicles.

DM4 = approximated scrappage and output decay of machinery and motor vehicles.

RNCF = real net cash flow.

ACRFRM = harvested acres per farm.

Table 5.15 presents the empirical results for equation (5.15). Several other specifications of the investment demand equation were estimated. Among these were separate usage of the machinery price and interest rate. Separate usage resulted in positive coefficients for both variables, a result contrary to the theoretical expectation. When combined into the single variable RAMORTM (via amortization of the machinery and motor vehicles price index adjusted for investment credit and deflated by the CPI), the coefficient becomes negative but not statistically significant at normally acceptable levels (t value is -1.04).

The real price of farm output was substituted in the equation for real net cash flow in an alternative formulation. The variable had a positive significant coefficient, but the equation with real net cash flow was chosen because of a higher R^2.

The stock and scrappage measures and harvested acres per farm have significant coefficients of expected sign. The scrappage (DM4) variable has a coefficient substantially less than one (.219), giving some indication that replacement investment is not automatically equal to scrappage (assuming DM4 is a reasonably good estimate of scrappage).

Table 5.15. Empirical Results for Equation (5.15), Investment Demand for Machinery and Motor Vehicles, EXPMMV

Explanatory Variable	Regression Coefficient	t Statistic	Selected Elasticities 1951-74	1972-74
Constant	7679.71	---	---	---
RAMORTM	-266.187	-1.04	-.5558[a]	-.5545[a]
			-.5545[b]	-.5541[b]
			-.2476[c]	-.2821[c]
SM4	-.118741	-4.41	---	---
DM4	.218561	2.11	---	---
RNCF	.0600804	2.43	---	---
ACRFRM	38.8175	2.25	---	---

R^2 = .78, D.W. = 1.93, $t_{.01}$ = 2.878, $t_{.05}$ = 2.101, $t_{.10}$ = 1.734

[a] is elasticity with respect to RAMORTM.

[b] is elasticity with respect to RAPMMV.

[c] is elasticity with respect to RBK.

Elasticities have been calculated with respect to real amortized price, real price of machinery and motor vehicles adjusted for investment credit, and the interest rate. With variables at their mean values for the 1951-74 period, the elasticities are -.5558, -.5545, and -.2476 with respect to RAMORTM, RAPMMV, and RBK, respectively.

Demand for Machinery and Motor Vehicle Maintenance and Repair

Equation (5.16) shows the demand equation for repairs and maintenance of machinery and motor vehicles. The quantity demanded is a function of the amortized price of new machines, the beginning of year stock, scrappage during the year, and the real price of hired farm labor.

(5.16) RREPM = f(RAMORTM, SM4, DM4, RPLABOR)
+ + - -

RREPM = quantity of repairs and maintenance of machinery and motor vehicles.

RAMORTM = real amortized price of machinery and motor vehicles.

SM4 = beginning of year stock (quantity measure) of machinery and motor vehicles.

DM4 = estimated scrappage and output decay of machinery and motor vehicles.

RPLABOR = real price of hired farm labor.

Empirical results for equation (5.16) are shown in Table 5.16.

Table 5.16. Empirical Results for Equation (5.16), Machinery and Motor Vehicle Maintenance and Repair Derived Demand, RREPM

Explanatory Variable	Regression Coefficient	t Statistic
Constant	1962.75	---
RAMORTM	137.283	2.16
SM4	.0130701	1.98
DM4	-.0743533	-2.74
RPLABOR	-21.0810	-5.03

R^2 = .90, D.W. = 1.54, $t_{.01}$ = 2.861, $t_{.05}$ = 2.093, $t_{.10}$ = 1.729

The equation does not contain an "own price" variable per se in that the cost of maintenance and repair usually involves a combination of parts, resources (such as oil), and labor. RAMORTM represents the price of a substitute; that is, new machines substitute for repairing old machines. The stock of machines was expected to have a positive coefficient, as one would expect more repairs with a greater number of machines. Scrappage (DM4) was expected to have a negative coefficient as repairs should go down as more old machines are scrapped. The real price of labor is included to represent a major cost of repairs and maintenance. In addition, RPLABOR probably picks up the effects of increasing prices of parts. In an alternative specification, the real price of machinery and motor vehicles (used to deflate maintenance expenses) was included in the equation as a separate variable (it also enters in an altered form via RAMORTM) to reflect the price of parts, but the coefficient was not statistically significant. In the absence of RPLABOR, inclusion of RPMMV has a significant negative coefficient, appropriate for an own price variable, but the coefficient of RAMORTM became negative and was not significant. The real price of total output was also included in an alternative specification. The coefficient of RPTOUT had the wrong sign (negative), was not statistically significant, and thus is not included in the equation.

Investment Demand for and Repairs of Farm Buildings

An extensive set of data on capital expenditures and repairs of farm buildings is published by the USDA.[1/] The building categories include 1) farm operator dwellings and 2) other and land improvements. Category two includes service buildings, other structures, fences, windmills, wells, dams and ponds, terraces, drainage ditches and tile lines, other soil conservation facilities, and dwellings not

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1/ Currently in Farm Income Statistics, formerly called Farm Income Situation.

occupied by the farm operators. Data are published for both categories for expenditures, repairs and maintenance, and depreciation.

Scott and Heady (1967) used the data on building expenditures (or transformations of the data) to estimate regional demand for farm buildings. This prompted a series of comments, replies, and rejoinders, by Grove (1969, 1970), O'Dell (1969), and Scott and Heady (1969, 1971) over the inappropriate use of the data. The basic point was the use of farm income to explain expenditures when the data for expenditures were estimated from changes in income. This method of estimating the data is apparently no longer used.[1/] For a reasonably detailed, but possibly out of date, review of the building data series, see Bhatia (1971). The frequently referenced Agricultural Handbook 365, Volume 3, published by the USDA appears to be of little value in determining the procedures used to estimate these USDA data series.

The July, 1974 Farm Income Situation has significant revisions of the expenditures on buildings and land improvements back to 1959. This revision reverses a downward trend in expenditures and leaves a seemingly large jump in the data between 1958 and 1959. To the extent of the author's knowledge, there is no published explanation of this large data revision.

It is the author's understanding that the expenditures for farm operator dwellings data series is moved from year to year according to changes in total building expenditures. In addition,

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1/ Personal discussion with David L. Kincannon, USDA, ERS.

repairs and maintenance are estimated as a percentage of capital expenditures for both farm operator dwellings and other buildings and improvements to land.

One final point is that expenditures for service buildings, other structures, and land improvements are published as a total. Presumably there is more faith in the sum of the two components than the individual components (see Bhatia, 1971, p. 493).

Thus, although the data are fairly complete, the "real" information is not as extensive as a casual look at the data would suggest. The following sections give the equations used in the model to project the above data series. In some instances, the procedures are ad hoc but seem, to the author, appropriate for the data

Investment Demand for Service Buildings, Other Structures, and Land Improvements

Equation (5.17) shows the formulation of the investment demand equation for service buildings, other structures, and land improvements. The equation includes variables representing own price, beginning stock, scrappage, and the price of output. In addition, harvested acres per farm represents several factors. The quantity of operator labor (a substitute variable) is reflected in the denominator. If there are fewer farms, the ratio increases. The ratio also is an indicator of changing technology over time. As farm size has increased, so has the availability of new types of buildings and other structures.

(5.17) EXPBLD = f(RAMORTB, SB4, DB4, RPTOUT, ACRFRM)
                  -       -   +   +   +

EXPBLD = gross investment (quantity) in service buildings, other structures, and land improvements.

RAMORTB = real amortized price of buildings.

SB4 = stock (quantity) of buildings.

DB4 = approximated scrappage and output decay of buildings.

RPTOUT = real price of total output.

ACRFRM = harvested acres per farm.

Table 5.17 gives the empirical results from estimating equation (5.17).

Table 5.17. Empirical Results for Equation (5.17), Investment Demand for Service Buildings, Other Structures, and Improvements to Land, EXPBLD

Explanatory Variable	Regression Coefficient	t Statistic	Selected Elasticities 1951-74	1972-74
Constant	1651.32	---	---	---
RAMORTB	-198.859	-3.14	-1.31[a] -1.31[b] -.558[c]	-1.41[a] -1.40[b] -.737[c]
SB4	-.0639205	-1.83	---	---
DB4	.0819004	1.59	---	---
RPTOUT	5.07174	2.52	---	---
ACRFRM	14.5637	2.18	---	---

$R^2 = .89$, D.W. = 1.36, $t_{.01} = 2.878$, $t_{.05} = 2.101$, $t_{.10} = 1.734$

[a] is elasticity with respect to RAMORTB.
[b] is elasticity with respect to RAPBLD.
[c] is elasticity with respect to RFLB.

As indicated earlier, the nature of the data used as a basis for this equation is in question. Although the author felt there was enough information in the data to estimate a structural equation, one should view the results cautiously.

The data period 1951 to 1974 was used to estimate the equation. The low Durbin Watson[1/] statistic may result in part from the previously mentioned jump in the data between 1958 and 1959.

The stock and scrappage variables are not significant at high levels but have been included in the equation because of their theoretical importance, correct sign, and the lack of other variables to measure the concepts they represent.

The elasticities with respect to own price factors of RAMORTB, RAPBLD, and RFBL with variables at their 1972-74 mean values are -1.41, -1.40, and -.737, respectively.

Repairs and Maintenance of Service Buildings, Other Structures, and Land Improvements

As indicated earlier, it is the author's understanding that the historical data series on repairs and maintenance are estimated from the expenditure series. Thus, no attempt is made here to present structural equations.

Equation (5.18), giving current dollar expenditures for repairs and maintenance as a function of current expenditures for service buildings, other structures, and land improvements, and a dummy variable, is shown in Table 5.18.

The equation was estimated using 1955 to 1974 data. Several of the equations intended to reproduce USDA procedures for estimating

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[1/] The Durbin Watson statistic is in the indeterminate range (d_u = 1.01, d_L = 1.79) at the .05 level.

Table 5.18. Empirical Results for Equation (5.18), Repairs and Maintenance of Service Buildings, Other Structures, and Land Improvements, REPBLD

Explanatory Variable	Regression Coefficient	t Statistic
Constant	272.836	---
CE(2)	.206476	20.37
DUM2	17.2526	4.67

R^2 = .9856, D.W. = 2.22, $t_{.01}$ = 2.878, $t_{.05}$ = 2.101, $t_{.10}$ = 1.734

CE(2) = current dollar expenditures for service buildings, other structures and land improvements.

DUM2 = a binary variable, 0 for years before 1973, 1 for 1973 and later years.

data fit much better for data after 1955, possibly indicating consistency in procedures after that time.

Equation (5.18) includes a dummy variable for recent years under the hypothesis that there may have been a shift in the data series, possibly based on new benchmarks. The use of the dummy variable was prompted by a pattern of residuals, clearly indicating that something had changed (the dummy variable is quite significant as the t ratio is 4.67).

Expenditures for Farm Operator Dwellings

Although it was indicated to the author that expenditures for farm operator dwellings are estimated as a proportion of total expenditures for all building, a clear identity equation was not to be found from the published data. The equation used in the model, equation

(5.19), includes a time trend and a dummy variable for 1974. Table 5.19 shows this equation.

Table 5.19. Empirical Results for Equation (5.19), Expenditures for Farm Operator Dwellings, CE(3)

Explanatory Variables	Regression Coefficient	t Statistic
Constant	425.952	---
CE(2) + CE(3)	.145323	2.82
DUM	182.727	2.68
T	-10.2616	-3.12

$R^2 = .7346$, D.W. = 2.22, $t_{.01} = 2.845$, $t_{.05} = 2.086$, $t_{.10} = 1.725$

CE(3) = current dollar expenditures for farm operator dwellings.

CE(2) = current dollar expenditures for service buildings, other structures, and land improvements.

DUM = a binary variable, 1974 and later years equal to one, zero otherwise.

T = time (year - 1949).

The data period used for this equation is 1955 to 1974. Residuals of an equation including 1950 to 1954 data indicated that a different method of estimating the historical data was used for the earlier period.

The time trend was clearly indicated by the pattern of residuals from an equation excluding time. This may be the result of moving to a different coefficient for total expenditures over time. In addition, there was a large jump in dwelling expenditures in 1974. It is assumed that this is a result of shifting to a new benchmark.

In the model, the coefficient for DUM is simply added to the constant for projections.

An additional source of error in the equation is the inclusion of land improvements in expenditures (explanatory variable) which, to the extent of the author's knowledge, are not included in the actual identity that produces this USDA data series.

Repairs and Maintenance of Farm Operator Dwellings

The equation for repairs and maintenance of farm operator dwellings is shown in Table 5.20. It is estimated on data for the 1955 to 1974 period. The equation chosen for use includes a time trend variable which is statistically quite significant. With an R^2 of .9951, the equation is nearly an identity. The residuals for recent years did not differ substantially from other years, indicating that while different procedures may be being used for estimating expenditures, the procedures for estimating repairs are probably still the same.

Table 5.20. Empirical Results for Equation (5.20), Repairs and Maintenance of Farm Operator Dwellings, REPDWL

Explanatory Variable	Regression Coefficient	t Statistic
Constant	2.68799	---
CE(3)	.565384	56.70
T	-1.77588	-13.08

R^2 =.9951, D.W. = 1.84, $t_{.01}$ = 2.898, $t_{.05}$ = 2.110, $t_{.10}$ = 1.74

REPDWL = current dollar repairs and maintenance of farm operator dwellings.

CE(3) = current dollar expenditures for farm operator dwellings.

T = time (year - 1949).

Real Estate Price and Transfers

There have been a large number of studies of the farm real estate market. Among these are Tweeten and Martin, Herdt and Cochrane, Reinsel, Melichar (1973), and Nelson. While a fair amount of theorizing is done in the above studies and others, empirically a large number of sets of variables will produce reasonable equations with high R^2's (at least equations with some rationalization). The author has made no attempt in this study to further the theory as it relates to farm real estate prices, although it is the author's opinion that previous authors have not properly specified and/or examined quantity supplied and quantity demanded variables.

Real Estate Price

The equations estimated here for real estate price (probably a demand equation) include variables standard in the above studies, except in the study by Reinsel, and some ad hoc experimenting.

Table 5.21 presents the results of estimating three real estate price equations, one with nominal price as the dependent variable and two with real (deflated) real estate price as the dependent variable. The basic independent variables considered are net cash flow (real net cash flow), the consumer price index (used as a deflator and as an independent variable), and the number of farms. The index of farm real estate value per acre is the value reported as of March 1st. All independent variables are values for the previous year.

The author has some faith in the coefficients of the income variable and general price level indicator (CPI). The meaning of the number of farms, however, is not clear. The negative coefficient might indicate that as there are fewer farmers, there is less competition for land and thus price is lower. It might mean that there is a simultaneous relationship and that as real estate price goes up, people sell out, resulting in fewer farms. Alternatively, the relationship might be purely spurious, only indicating that land price has gone up over time while the number of farms has gone down.

The coefficients for net and real cash flow were statistically significant in all equations. New cash flow rather than net farm income was used in the equations because it would represent, in addition to profitability, the availability of internal funds (there is no other cost of funds variable in the equation).

There is frequently ad hoc theorizing that land is purchased as a hedge against inflation; there is also popular opinion that land prices increase faster than the rate of inflation. This later hypothesis is tested in two ways. In equation (5.21a), the real estate price is not deflated, and the CPI is included as a separate variable. The test that the coefficient is 1 versus the alternative that it is not 1, yields a t statistic of 1.41, which gives about a .10 level

Table 5.21. Real Estate Price Equations[a]

Dependent Variable \ Coefficient of	Constant	NCF	RNCF	CPI	FARMS	R^2	D.W.
5.21a PREAL	-23.0348	.00208267 (7.47)		1.22097 (7.79)	-10.4242 (-4.97)	.9944	1.41
5.21b RPREAL	128.539		.00279968 (12.32)		-22.8324 (-23.5)	.9767	1.92
5.21c RPREAL	89.8703		.00200437 (6.57)	.326726 (3.3)	-17.3241 (-9.36)	.9849	1.37

$t_{.01} = 2.845$, $t_{.05} = 2.086$, $t_{.10} = 1.725$

[a] all equations linear in the variables, "t" statistics in parenthesis

NCF = net cash flow

RNCF = real net cash flow

CPI = consumer price index

FARMS = number of farms

of significance. This equation does not truly test the CPI as a deflator versus a deflator plus something else, however, since division by the CPI (as one would with a true deflator) will not give equation (5.21b) because one would have FARMS/CPI. Thus equation (5.21c) was estimated. In this equation the coefficient of CPI is significantly different from zero (see the t statistic of CPI in equation 5.21c) and thus gives statistical evidence of an effect in addition to a deflator. Equation (5.21c), Table 5.21, was chosen to use in the model on this basis.

Real Estate Transfers

The real estate supply variable used in this study is acres of real estate sold in the form of voluntary and estate sales of 10 acres or more. Equation (5.22) shows the formulation of acres transferred as a function of the real price of real estate, the real price of crops, and the number of farms. The equation is recursive to the demand for real estate equation. Acres sold rather than number of transfers was chosen as the supply variable in spite of the availability of only ten observations. This decision is based in large part upon the use intended for the variable. Namely, it is intended to use acres transferred multiplied by the price index of real estate to get the value of real estate transferred for use in the purchases of real estate from discontinuing proprietors equation.

(5.22) ASLD = f(RPREAL, RPCROP, FARMS)

$$ASLD = f(\underset{+}{RPREAL},\ \underset{-}{RPCROP},\ FARMS)$$

ASLD = acres of farm real estate sales, voluntary and estate sales of 10 or more acres.

RPREAL = real price of real estate as reported March 1, of the following year.

RPCROP = real price of crops.

FARMS = number of farms

Table 5.22. Empirical Results for Equation (5.22), Acres of Real Estate Sold, Voluntary and Estate Sales of 10 Acres or More, ASLD

Explanatory Variable	Regression Coefficient	t Statistic
Constant	-223.577	---
RPREAL	1.26544	4.99
RPCROP	-.667691	-4.15
FARMS	57.3143	3.68

R^2 = .8450, D.W. = 1.85, $t_{.01}$ = 3.707, $t_{.05}$ = 2.447, $t_{.10}$ = 2.015

The estimates of all coefficients are reasonably significant and the signs of RPREAL and RPCROP are of the hypothesized sign. The meaning of the number of farms coefficient is not totally clear to the author. One might have hypothesized a negative coefficient, reasoning that drops in the number of farms would surely create sales of land. However, one might rationalize the positive sign. When there are more farmers, there is a greater likelihood of estate sales; historically there have been larger drops in the number of farms when there were more farmers.

The equation tracks the historical data quite well considering the large jumps in the data in recent years. The actual data for 1972, 1973, and 1974 are 36.31, 41.76, and 26.98. The fitted values were 34.49, 41.84, and 27.58 for the same years. However, a small sample, lack of theoretical basis, and absence of other studies (using acres sold) with which to compare the results leave the findings tenous.

Value of Real Estate Transferred

A near identity equation is estimated for the value of land transfers and is shown below:

$$(5.23)\quad VLUTRS = 1059.50 + \underset{(29.87)}{1.73876}*PREAL*ASLD, \quad R^2 = .9911$$

VLUTRS = value of real estate transfers.

PREAL = index of real estate value per acre.

ASLD = acres of real estate transferred.

The variable VLUTRS is used in the equation that estimates real estate purchases from discontinuing proprietors (see section on intersector flows).

The System of Equations

This section is written with the benefit of having completed estimation of the equations. Thus, the exact subset of variables included in each equation is known. The nature of a system of equations (i.e., simultaneous, recursive, or block recursive) depends, of course, upon which endogenous variables are included in each equation as well as which variables are endogenous. That is, addition of an endogenous variable to an equation may tie together equations (or sets of equations) that would otherwise be recursive.

The purpose of this section is to present the matrix of coefficients of the endogenous variables so that the simultaneous or recursive nature of the system can be examined. It will be seen that the equations giving the supply and utilization of crops and livestock are simultaneous, while the input demand equations (including investment) are recursive to the simultaneous equations.

Table 5.23 presents $\underline{A}\bar{Y}$ of the matrix formulation of the set of equations $\underline{A}\bar{Y} = \underline{B}\bar{X}$, where $\underline{A}$ is the matrix of coefficients for endogenous variables, $\bar{Y}$ is a vector of endogenous variables, $\underline{B}$ is a matrix of coefficients for predetermined variables, and $\bar{X}$ the vector of predetermined variables.

Strictly speaking, the system of equations is not linear as presented in Table 5.23. The nonlinearities occur where RPTOUT or RNCF is used (see equations 5.11 and 5.12). The matrix presented indicates the prices of livestock and crops as being in the equations as these are what RNCF and RPTOUT represent. However, equations, 1 through 10 are linear for any given value of population.

From the matrix presented in Table 5.23, the following observations can be made: 1) equation 1 is pretetermined; 2) equations 2 through 10 are simultaneous, but recursive to equation 1; 3) if current livestock price were not in the feed demand equation, there would be two separate simultaneous equation blocks (equations 2 through 7 and 8 through 10); 4) the input demand equations are all recursive to the simultaneous equations; 5) the real estate equations are recursive to each other and to the rest of the

Table 5.23. Matrix Showing Placement of Endogenous Coefficients for Structural Equations[a]

Equation Description	A																			$\bar{Y}$	
1. Crop Supply	1																			CROPS(2)	
2. Food-Industrial Crop Demand		$\frac{1}{pop}$					x													CROPS(7)	
3. Feed Demand			1	x						x										CROPS(6)	
4. Feed Supply			x	1			x													RPFEED	
5. Seed Demand					1	x	x													CROPS(5)	
6. Seed Supply					x	1	x													RPSEED	
7. Crops Identity	1	-1	-1		-1															RPCROP	
8. Livestock Supply				x				1		x										LIV(2)	
9. Livestock Demand									$\frac{1}{pop}$	x									*	LIV(5)	$= \underline{B}\,\bar{X}$
10. Livestock Identity								-1	1											RPLIV	
11. Fertilizer Demand							x				1									FERT	
12. Labor Demand							x			x		1								LABOR	
13. Other Demand							x			x			1							OTHER	
14. Machinery Investment							x			x				1						EXPMCN	
15. Machinery Repairs															1					REPMCN	
16. Building Investment							x			x						1				EXPBLD	
17. Real Estate Demand							x			x							1			RPREAL	
18. Real Estate Supply							x										x	1			

[a]See glossary for description of variable names

system; and 6) demand for categories of durables and demand for repairs and maintenance of the same are not simultaneous.

Equation one, the crop supply equation, would become part of the simultaneous system if current crop price were included in the equation.

If the prices of variable inputs (e.g., PFERT, PLABOR, PSUP) were endogenized, the demand for inputs (plus the added supply functions) would be simultaneous with the supply-utilization equations.

The real estate equations would be simultaneous if acres sold were to be included in the demand equation.

Britros (1976) presented a "statistical theory" and estimated equations for capital expenditures and repairs. He argues that repairs and expenditures are simultaneous. However, the theory outlined in Chapter IV does not derive quantities of repairs as a function of the quantity of expenditures and vice versa, as Britros includes in his equations. The theory indicates that quantities are functions of prices, and thus the demand equations are not simultaneous <u>unless</u> input supply equations are included in the model.

Reduced Form Equations

Equations 2 through 10 in Table 5.24 can be solved for a given level of population. That is, the sub-matrix can be inverted. From this and an appropriately reduced matrix $\underline{B}$, one can get reduced form equations. Here the system will be described as, $\underline{A}\bar{Y} = \underline{B}\bar{X}$, where only the simultaneous equations (2 through 10) are included. Table 5.24 presents $\underline{A}^{-1}\underline{B}$ for population at the 1975 level.

Table 5.24, Reduced Form Matrix Representation of the Simultaneous Equations

CROPS(7)	-7230.5	.1354	-268.5	-.4647	-7.7392	-.9952	-1.563	-.3991	-.6661	.6753	.6753	.6753	-.6753	-.6753	-.4798	-.4798	.4798	.4798
RPCROP	5586.8	.1349	-795.9	.2225	3.7054	.4765	.748	.1911	.3285	-.3233	-.3233	-.3233	.3233	.3233	.2297	.2297	-.2297	-.2297
CROPS(6)	1212.1	-.1531	372.6	.4356	7.2548	-.5408	-.849	-.2169	.6432	.3670	.3670	.3670	-.3670	-.3670	.4498	.4498	-.4498	-.4498
RPFEED	-4819.8	.2156	-704.9	.1930	3.2146	.4085	.642	.1638	.2850	-.2772	-.2772	-.2772	.2772	.2772	.1993	.1993	-.1993	-.1993
RPLIV	2162.9	.0456	-433.9	-.3957	1.2666	.1610	.253	.0646	.1363	-.1092	-.1092	-.1092	.1092	.1092	.0953	.0953	.0953	.0953
CROPS(5)	515.5	.0176	-104.1	.0291	.4844	1.5360	2.413	.6160	.0429	-.0423	-.0423	-.0423	.0423	.0423	.0300	.0300	.0300	.0300
RPSEED	3152.5	.0790	-466.5	.1304	2.1717	.7211	1.133	.2692	.1925	-.1595	-.1595	-.1595	.1595	.1595	.1346	.1346	.1346	.1346
LIV(5)	-18035.3	-.5766	4240.4	7.6141	-24.3710	-3.0937	-4.864	-1.2422	-2.1904	2.1017	2.1017	2.1017	-2.1017	-2.1017	-1.8339	-1.8339	1.8339	1.8339
LIV(2)	-19035.3	-.8766	4240.4	7.6141	-24.3710	-3.0937	-4.864	-1.2422	-2.1904	2.1017	2.1017	2.1017	-2.1017	-2.1017	-1.8339	-1.8339	1.8339	1.8339

Multiplied (·) by the vector:

RGNPCAP
ALOG10(T)
RPLVM1
RPLVM2
RPSUP
RPLABOR
HARACR
RDICAP
CROPS(1)
CROPS(2)
CROPS(3)
CROPS(4)
CROPS(8)
LIV(4)
LIV(6)
LIV(1)
LIV(3)

The reduced forms for the recursive equations can be found by substituting the reduced forms of the endogenous variables into the recursive structural equations and then by collecting coefficients for the exogenous variables. This would be tedious and has not been done here.

The reduced form coefficients in each equation are the impact multipliers. Interim and dynamic multipliers exist. However, they have not been calculated.

Other Equations and Relationships

The following sections present the balance of equations and relationships required to complete the internal workings of the model. Many of the equations transform price and quantity data into cash flows. Others include: intersector flows, accounting relationships, household activities, financial assets, and other relationships required for completeness.

"Near" Identity Equations

At numerous points in the model, one is confronted with conversion of quantity measures and price indexes into cash flows (revenues or expenses). If the relationship between a price index, P, multiplied by a quantity, Q, to get a revenue, R, were an actual identity (a nonstochastic equation), the relationship would be

$$R = k\ (PxQ).$$

One could simply solve for the conversion factor, k, as follows:

$k = (PxQ)/R$

In the data used for the model, there are numerous factors causing k to be different for each observation. These factors include: independent measurement of prices, quantities, and cash flows; different time periods covered; measurement error; and aggregation. Thus, there are numerous "near" identity equations in the model estimated via OLS.

Perquisites to Hired Labor. Noncash perquisites to hired farm workers are treated as a simple function of the quantity of hired labor and a time trend. The current dollar value is estimated by multiplying "real" perquisite by the current wage rate paid to hired farm workers. Equation (5.28) gives the empirical results.

$$(5.28) \quad RPERQ = 15.0946 + \underset{(9.22)}{.161194}\,(LABOR) - \underset{(-7.62)}{76.0920}(Log_e T), \quad R^2 = .9817$$

RPERQ = real perquisites.

LABOR = hired farm labor.

T = time (year - 1949).

The negative time trend indicates the reduction over time in the use of noncash wages as payment to hired farm workers. In the simulation model, the time trend should not cause RPERQ to go negative, as difference in the impact of the time trend between 1974 and 2000 is approximately -54 (RPERQ in 1974 is 231.4). However, an IF statement will be included in the program to keep RPERQ non-negative.

Cash Receipts from Farm Marketings of Livestock. The cash receipts from livestock sales are derived in the model from a "near" identity equation relating cash receipts to the quantity of livestock use multiplied by the price index for livestock. Livestock use is production minus the change in inventory where the change in inventory is ending inventory less beginning inventory.

The following equation estimated via OLS gives the relationship between cash receipts from livestock (CSHLIV) and livestock use times the price of livestock (LIVUSE*PLIV) and the base 10 logarithm of time:

$$(5.25)\quad CSHLIV = -6466.6671 + \underset{(49.5)}{1.2496}\,(LIVEUSE*PLIV) + \underset{(12.6)}{5857.2753}\,(\mathrm{Log}_{10}\ TIME),\ R^2 = .9955$$

The inclusion of Log_{10} TIME in the equation reduces the size of the coefficient of LIVUSE*P from 1.4239 to 1.2496. The ratio of CSHLIV/LIVUSE*PLIV in the base year, 1967, is 1.29. The equation with Log_{10}TIME was chosen because of the higher R^2, .9955 versus .9616, with the coefficient of LIVUSE*PLIV still being reasonable.

Cash Receipts from Farm Marketing of Crops. A variable needed for the Income and Sources and Use of Funds Statements is calendar year cash receipts from farm marketings of crops. A problem mentioned earlier arises because the crop quantity and price variables in the model are on a crop year basis. Additional complications evolve from "on farm" seed and feed use, since the data constructed for the model do not provide a breakdown of purchased (sold) feed and seed quantities. Finally, the inventory data do not give a breakdown between farm and nonfarm-owned quantities. This has implications for cash receipts in that farmer owned quantities, whether on farms or in commercial storage, do not create cash flows,[1/] while quantities purchased from farmers and held as inventories do create cash flows for farmers.

To overcome the potentially large source of error from using crop year data, an additional identity can be utilized. This identity is that farmer calendar year sales of crops (quantity) are equal to production in the calendar year minus the change in inventory.[2/] Production in the calendar year is known. It is the production variable CROPS(2). A confusing factor here relates to the use of the time index. The crop year begins with harvest. Crop years overlap two calendar years and are labeled with the second of the two calendar years. Therefore, production for the 1950-51 crop year is labeled 1951, even though the harvest occurred in 1950. Thus, production in a calendar year is the production that enters the following year's crop supply-utilization identity.

Farm Income Statistics includes a data series for change in crop and livestock inventories which is intended to be the change in farmer held quantities times the average price during the year.[3/] Thus, if P is average price during the year, Q_S is quantity sold, Q_P is

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1/ With the exception of CCC loans, CCC loans are included in cash receipts when the loans are made and subtracted from cash receipts when repaid.

2/ Throughout the dissertation, a change in inventory is ending inventory minus beginning. Thus, a positive change in inventory is an increase in inventory.

3/ Data were provided to the author by Dave Kincannon from the ERS, USDA, which separate the inventory change into the livestock and crop components.

quantity produced, R is cash receipts, and ΔI is the change in inventory, then the following equation holds:

$$R = P^*Q_s$$

$$Q_s = Q_p - \Delta I$$

Substituting Q_s into the revenue equation gives

$$R = P^*Q_p - P^*\Delta I.$$

The production data used in the model do not include 100 percent of actual production. The assumption throughout has been that the portion excluded remains a fairly constant percentage of the total. Even if this holds, P^*Q_p would need a scale factor for the identity hold. This factor can be estimated by moving $P^*\Delta I$ to the other side of the equation. Making use of $P^*\Delta I$ based on Farm Income Statistics data, the following equation was estimated:

$$R + P^*\Delta I = f(P^*Q_p)$$

Rewriting the equation in the notation used in the simulation model:

(5.26) CSHCRP + CHCRV = f(PCROP*CRPROD)

CSHCRP = cash receipts from crops in the calendar year.

CHCRV = change in calendar year inventory of crops held by farmers valued at average price for the year.

PCROP = crop year price of crops.

CRPROD = crop production in the calendar year.

In the simulation model, CHCRV will be calculated based on exogenous inventory quantities, and the price will be calculated endogenously. The results for equation (5.26) are shown in Table 5.26.

Table 5.26. Empirical Results for Equation (5.26), Cash Receipts from Crops Near Identity, CSHCRP + CHCRV

Explanatory Variable	Regression Coefficient	t Statistic
Constant	-4702.523	-12.58
PCROP*CRPROD	.99103	47.07
T	97.095	3.48

$R^2 = .9956$, S.E. = 737.15, $t_{.01} = 2.819$, $t_{.05} = 2.074$, $t_{.10} = 1.717$

Feed Expense. Feed expenses (FEEDEXP) are given by an equation relating feed use multiplied by the feed price index to feed expenses. Time is also used in the equation to pick up the trend in increased off-farm purchase of feed. Inclusion of time raises the R^2 from .9629 to .9949 and reduces the coefficient on feed use times feed price (CROP(6)*PFEED) by a small amount. The equation used in the model is given here.

$$(5.27)\quad FEEDEXP = -1370.4733 + \underset{(35.93)}{.6397}\ (CROPS(6)*PFEED) + \underset{(11.51)}{102.7391}(TIME)$$

$R^2 = .9949$

Feeder Livestock Expenses. Data were not available to incorporate the quantity of feeder livestock into the livestock identity. Thus, feeder livestock expense is treated as a constant portion of livestock sales. Part of the error in this equation will result from feeder prices relative to the change of livestock prices from year to year. This will depend largely on the demand for feeder factors, including the prices of feed and fed livestock. The equation used in the model for feeder livestock expense is:

(5.29) FEEDERS = -1371.5704 - .1970(CSHLIV), R^2 = .9130
(15.19)

CSHLIV = cash receipts from livestock.

FEEDERS = feeder livestock expense.

Interest Paid on Mortgage Debt. The interest paid on farm mortgage debt is computed in the model using an equation relating the Federal Land Bank interest rate times the beginning of the year mortgage debt to mortgage interest paid. The equation estimated via OLS is as follows:

(5.30) MORINT = 68.0078 + .9991*RFLB*DEBTM, R^2 = .9981
(107.43)

MORINT = interest paid on mortgage debt.

RFLB*DEBTM = FLB interest rate times beginning of year mortgage debt.

Interest Paid on Nonreal Estate Debt. The interest paid on nonreal estate debt is estimated in a manner similar to mortgage interest. The equation used is as follows:

(5.31) INTNR = -167.1775 + 1.1948*RBK*DEBTNR, R^2 = .9892
(44.91)

INTNR = interest paid on nonreal estate debt.

RBK*DEBTNR = bank rate of interest times the beginning of year level of nonreal estate debt.

Household Purchases of Nondurable Goods and Services

Purchases of nondurable goods and services by continuing farm operator families are based on a 1973 survey of farm operator families (USDA 1975). The method of estimation is similar in concept to the method used by Penson (1977). Expenditures for the specific items of interest are summed from data in the survey. The ratio of expenditures to a three year average of disposable income for farm operators is calculated. It is then assumed that expenditures for these items remain a constant proportion of the three year moving average. Penson used the average of the three previous years arguing that expenditures were based on an "expected" income. Here it is assumed that the current year's income influences current consumption expenditures (as well as income in the two previous years). Thus the constant calculated is based on disposable income for the years 1971, 1972, and 1973. The three year average include the current year.

Disposable income is defined as net farm income plus off-farm income minus personal taxes. Definitions and data as used in the model apply to net farm income (see the Income Statement), off-farm income, and personal taxes.

The items included in nondurable goods and services (using terminology from the survey publication) are: all food; insurance premiums of owner-occupied dewllings; rented living quarters, cash rent; other housing expenses; service contracts; household operations; all clothing; renting and leasing of vehicles; vehicle operating expense; vehicle maintenance and repair expense; transportation used on trips; public transportion cost; transportation to and from school for someone attending school away from home; all medical expenditures; all personal care; all tobacco and alcoholic beverages; reading, memberships, and other recreations; all education; all miscellaneous; all personal insurance; and all cash gifts and contributions.

Items excluded are related to purchases of such durable assets as household equipment and furnishings and automobiles and trucks. Included were purchases of durable services and operating expenses of household durables other than dwellings.

The purchases of nondurable goods and services totaled $19996 million for 1973. The average disposable income for the three years 1971, 1972, and 1973 is $43190 million. Thus, the model uses 46.298 percent of the recent three year average disposable income as purchases of nondurable goods and services.

Personal Tax and Non-Tax Payments

The historical data used for personal taxes are from Farm Income Statistics, Table 5H. The data include all personal tax and nontax payments by the farm population to federal, state, and local governments. Although these data are not the conceptually appropriate data, they are the only available data. One might hypothesize that personal taxes of the farm population would exceed that of farm operators. However, personal income of the farm population from nonfarm sources[1/] is less than off-farm income of farm operators.[2/] Thus, the relationship is unknown, and the data are used as a proxy for the data desired.

In the model, personal taxes are given as a function of net farm income plus off-farm income. This equation is shown as follows:

$$(5.32) \quad U(5) = 522.767 + \underset{(14.94)}{.0898225}*NETY, \; R^2 = .9103$$

U(5) = personal tax and nontax payments.

NETY = net income from all sources = NET(2) + S(2).

NET(2) = net farm income (see Income Statement).

S(2) = off-farm income of farm operators.

Financial Assets

The model includes three categories of financial assets. These are: 1) deposits and currency, 2) U.S. savings bonds, and 3) investment in cooperatives. These categories are based on the available data. Clearly, farmers have and make investments in other financial assets such as stocks and bonds, in addition to U.S. savings bonds. Data are not available for these investments nor for investments in nonfarm businesses. Net investment/disinvestment in unaccounted for items is included in the residual on the Sources and Uses of Funds Statement.

1/ Farm Income Statistics, Table 5H.

2/ Off-farm income per operator family (Farm Income Statistics, Table 5D) times the number of farms.

The three categories of financial assets are all projected on a per farm basis using time trends. It was the opinion of the author that there was not sufficient merit to justify specifying and estimating structural equations for financial assets. This was based on the following factors: 1) the data are incomplete and thus a full system of equations would be impossible to specify; 2) specifying structural equations would expand the number of exogenous variables, including rates of return in alternative investments; 3) annual net investment in financial assets for which data are available is small relative to other flows; and 4) the per farm current dollar stocks of financial assets fit time trends well.

Equations (5.33), (5.34), and (5.35) shown in Table 5.27 give the equations used to project the per farm current dollar stocks of financial assets.

Table 5.27. Per Farm Stocks of Financial Assets

Equation / Coefficient of:	Constant	T+1	$(T+1)^2$	$Log_e(T+1)$	R^2
5.33 PFCOOP	400.482	17.5011	3.86578		.9989
		(4.25)	(26.00)		
5.34 PFDEP	2611.33	-138.177	9.76201		.9949
		(-7.57)	(16.80)		
5.35 Log_e(PFUSB)	6.64812			.174851	.8823
				(12.84)	

PFCOOP = per farm investment in cooperatives, end of year.

PFDEP = per farm deposits and currency, end of year.

PFUSB = per farm U.S. savings bonds, end of year.

T = time (year - 1949).

Quadratic equations were used for per farm investment in farm cooperatives and per farm deposits and currency. Per farm U.S. savings bond investment was estimated in log-log form.

The simulation model must be examined carefully to avoid unreasonable expansion in financial assets caused by using the functional forms chosen.

Intersector flows of financial assets resulting from proprietors entering and leaving the sector are assumed to be equal to the beginning-of-year stock of financial assets per farm times the change in the number of farms. Rather than enter a use of funds called "purchases of financial assets from discontinuing proprietors," as in the case of real estate, the calculated withdrawals from the sector are added to capital expenditures for financial assets. This gives the net additions to financial assets of continuing proprietors. Net additions by the sector would not include the withdrawal of discontinuing proprietors. However, it is necessary to account for the use of funds. In the case of real estate it is reasonably clear that a majority of the real estate sold by discontinuing proprietors would stay in the sector. However, in the case of financial assets, it is probably more reasonable to assume that the assets are removed. Thus, to arrive at the ending levels of financial assets, continuing proprietors would have to invest in the net change for the sector plus the amount withdrawn by discontinuing proprietors.

Number of Family Workers

The number of family workers (FAMILY) is given by an equation in the model for projection purposes. However, this should not be considered a structural equation. FAMILY is included as an independent variable in the demand for hired labor equation. One could argue for an integrated set of supply and demand equations for hired labor, unpaid family labor, operator labor, and possibly the number of farms. It was the author's opinion that for the purpose of this study, the optimal procedure is to consider only hired labor demand, assuming a perfectly elastic supply and no simultaneity with other labor components. This decision is based on the relative unimportance of the labor equations to the study, lack of quality data on operator and unpaid family labor, and the definitional and conceptual problems with the number of farms.

The equation used for family labor is as follows:

$$(5.36)\quad FAMILY = 1.07181 + \underset{(6.88)}{1.17978}*FARMS - \underset{(-3.02)}{.0575823}*(T-1), \quad R^2 = .9928$$

FAMILY = number of family workers.

FARMS = number of farms.

T = time (year - 1949).

The negative time coefficient is probably a reflection of the reduction in farm family size over time and a general reduction of family participation in farming. The coefficient of time is large enough to have a heavy influence relative to the number of farms in long-run projections. The model will not allow the number of family workers to fall below the number of farms.

Household Expenditures for Automobiles and Trucks

Data for farm business capital expenditures in Farm Income Statistics are based on the assumption that 78 percent of truck and 40 percent of automobile expenditures are for the farm business. The implicitly assumed expenditures for personal or household use were calculated based on this factor.

The model uses 11.2 percent of machinery and motor vehicle expenditures as the estimate of purchases of automobiles and trucks by farm household families (FMLMMV). This coefficient is the average of the 1970 to 1975 ratios of expenditures for automobiles and trucks for personal use to farm business expenditures for machinery and motor vehicles.

Depreciation of Household Durables

Depreciation of household durable items in the model consists of depreciation of automobiles and trucks and depreciation of household furnishings and equipment.

Uses and potential uses for these data are: 1) inclusion in ending stock identities, 2) inclusion in calculation of capital formation, and 3) calculation of household consumption of durables.

Depreciation of household furnishings and equipment is calculated simply as constant dollar depreciation (DEPH) inflated by PHEF.

Depreciation of automobiles and trucks for household use is calculated in a manner similar to that for nonbusiness expenditures for automobiles and trucks. It is assumed that household depreciation is 11.2 percent of business depreciation.

Depreciation of household items is not included in the capital consumption listed for the Income Statement. However, it is used to calculate ending stocks and net capital formation for farm households.

Stocks of Household Durables

Data on stocks of household durables are included in the model for household furnishings and equipment and farm operator dwellings. Stocks of financial assets and machinery and motor vehicles are combined business and household quantities.

The capital formation account includes separation of business and household motor vehicles based on previously described assumed ratios of expenditures and depreciation.

In the capital formation, account financial assets are attributed totally to the household.

Non-Money Income Equations

Sources of nonmoney income to the farming sector include: the value of farm products consumed directly in farm households, the gross rental value of farm dwellings, and the net change in farm inventories. USDA estimates (Farm Income Statistics, Table 10H) are used as the historical data series for home consumed products and rental value of dwellings.

Farm Products Consumed. The value of farm products consumed directly in farm households is estimated in the model by projecting the quantities of crops and livestock (plus livestock products) consumed as functions of time and then multiplying by the price indices of crops and livestock. The historical "quantity" data were obtained via division of the value of products consumed data by the respective price indexes. The equations estimated via OLS for the aggregate U.S. farming sector quantities of home consumed livestock, products, and crops are given in Table 5.28 (equations 5.37 and 5.38).

Gross Rental Value of Farm Dwellings. The gross rental value of farm operator dwellings is estimated in the model by projecting real per farm rental value as a time trend. The CPI is used as the deflator. The equation, estimated via OLS, is given in Table 5.28, equation (5.39).

Table 5.28. Equations for Quantity of Home Consumed Livestock, Crops, and Rental Value of Farm Operator Dwellings

Dependent Variable	Constant	Time	R^2
(5.37) QLIVCON	1467.3527	-47.9002 (-14.615)	.9068
(5.38) QCRPCON	659.0785	-21.2649 (-17.495)	.9329
(5.39) RDWL/FARMS	279.6263	31.2143 (27.633)	.9720

T = time (year - 1949).

QLIVCON = quantity of livestock and livestock products consumed.

QCRPCON = quantity of crops consumed.

RDWL = deflated rental value of farm operator dwellings.

FARMS = number of farms.

Other Farm Income

Other farm income includes income from custom work, recreation facilities, and other farm related income. USDA estimates are used as the historical data base (Farm Income Statistics, Table 10H).

Other farm income is projected in the model via the use of an equation projecting a time trend for deflated per farm other farm income. The deflator used is the CPI. The equation used is the following:

(5.40) ROTHY/FARMS = -23.1424 + 9.160*T, R^2 = .9752

ROTHY = real other farm income.

FARMS = number of farms.

T = time (year - 1949).

Off-Farm Income

Off-farm income of farm operator families as herein defined includes wages and salaries from nonfarm employment, nonfarm business and professional income, rents from nonfarm real estate, dividends, interest, royalties, unemployment compensation, and Social Security payments. The historical data for the 1960 to 1974 period were the USDA estimates (Farm Income Statistics, Table 5D) multiplied by the number of farms. Data for the 1950 to 1959 period were estimated by using an equation relating off-farm income to personal income of the farm population from nonfarm sources (Farm Income Statistics, Table 5H). The equation was estimated via OLS and is shown here:

(5.41) $OFFY = -254.8324 + 1.2452*FRMPOPY, \; R^2 = .9964$
$$(60.15)$$

OFFY = total off-farm income.

FRMPOPY = personal income of the farm population from nonfarm sources.

The source of off-farm income in the model is an equation projecting a time trend for deflated per farm off-farm income. The CPI is used as the deflator. This equation is as follows:

(5.42) $ROFFY/FARMS = 731.0804 + 207.8911*T, \; R^2 = .9462$
$$(19.67)$$

ROFFY = real off-farm income.

FARMS = number of farms.

T = time (year - 1949).

Demand for Loan Funds

The model projects the demand for loan funds (net of repayments) as a residual source of funds. A critical weakness of this approach is that the sum of errors in other components, as well as errors of omission, directly affects the estimated net flow of loan funds.

This approach to estimating debt financing requirements is the basic reason for emphasizing cash flows in the Sources and Uses of Funds Statement. If the purpose of the SAUF statement is to estimate the net flow of loan funds, then it is not necessary to include flows that do not require financing or are self-financing.

The Sources and Uses of Funds Statement does not indicate that the net flow of loan funds is derived from real estate or nonreal estate lenders. However, the Balance Sheet does include a breakdown of debt by real estate and nonreal estate. The breakdown used in the model is made on no real information. The procedure in the model is to maintain a constant ratio of real estate to nonreal estate debt, beginning with January 1, 1975.

Handling of Intersector Flows

Generally, intersector flows are not measured, and thus the historical data are based on assumption or, in the case of real estate purchases, from discontinuing proprietors, based on a one-time survey. Estimating equations from such data has been avoided to the extent possible.

In the following paragraphs, the assumptions made and method of handling each item with respect to intersector flows are described.

Real estate is the most important individual item. Purchases from discontinuing proprietors are estimated as the value of voluntary real estate transfers less debt owed on the transfers (11.1%) times the proportion of sellers who do not remain active in farming (1-.095). The information on percentage of debt (11.1%) and proportion of sellers who remain active in farming (.095) is based on a one-time survey. It should be noted that this is the only place where debt of discontinuing proprietors is taken into account. Implicitly, it is assumed that discontinuing proprietors have no other debt.

One might note the implications of handling debt of discontinuing proprietors in this manner. The net flow of loan funds given as a source of funds understates the net flow of continuing proprietors by the amount of debt attributed to discontinuing proprietors. One might include the entire value of real estate purchases from discontinuing proprietors as a use of funds and add debt of discontinuing proprietors to the net flow of loan funds. The implied debt of discontinuing proprietors in 1975 was approximately 1.2 billion dollars. The net flow of real estate loan funds was 4.6 billion in 1975. Thus, the net increase in real estate debt of continuing proprietors is 26 percent greater than the change for the sector.

The above explanation is included largely to clarify the meaning of the accounts. The accounts herein are largely sector accounts, not accounts for continuing proprietors. As one can see by the implications of the above, these might differ in presentation of data.

The other flow related to real estate is net purchases of real estate from the farming sector. This flow is estimated by assuming that the change in acres in the farming sector (SRS land in farms data, see Agricultural Statistics) is sold to nonfarm sectors at the average value per acre for the year.

Discontinuing proprietors' inventories of crops and livestock, as well as their holdings of machinery and motor vehicles, are not taken into account.

Financial assets and household equipment and furnishings owned by discontinuing proprietors are assumed to be equal to the per farm stock at the beginning of the year. It is assumed that these assets leave the sector with discontinuing proprietors, and this withdrawal is estimated by multiplying the per farm stock by the change in number of farms. This assumption implies that investment by continuing proprietors in financial assets is the change in nominal value plus the amount removed from the sector by discontinuing proprietors.

Purchases of household equipment and furnishings have been adjusted to reflect assets removed by discontinuing proprietors (see Baker, 1973).

Adjustments in cash receipts, off-farm income, personal taxes, and so forth are not made for discontinuing proprietors. The adjustments are not made because a proprietor in the sector for part of the year is counted as being in the sector for the entire year. It may be more accurate with this view to make adjustments described above based on year end stock of assets, or the average of beginning and ending. The view taken here is that the adjustments being made are based on little real knowledge and should not be given the legitimization implied by more complicated calculations. All of the intersector flows are token adjustments, not based on real observations. Any correspondence to the actual flows is a result either of making realistic assumptions or luck (more probably the latter).

Calculating Stocks of Durable Assets and Depreciation

There are four categories of depreciable durable assets in the model. These are: machinery and motor vehicles, service buildings and other structures, farm operator dwellings, and household equipment and furnishings. The following will describe the methods used to calculate stock levels and depreciation for each category.

Machinery and Motor Vehicles. There are two basic stock variables for machinery and motor vehicles in the model. One is based on a value concept and is used to calculate the Balance Sheet value of machinery and motor vehicles and depreciation for use on the Income Statement. The other stock variable is based on a productive capacity concept and is used in the investment demand, crop supply, and machinery repair equations. The productive capacity concept and construction of the variables are explained in greater detail in Baker (1978).

With respect to the Balance Sheet value of machinery and motor vehicles (and related depreciation), the model is not totally consistent with the published USDA series. The inconsistencies arise in several areas. The USDA data are based on calculations using investment series for individual components (e.g. tractors, trucks, and autos). The model has investment as the sum of the components and therefore is not broken down by item. Thus, only one rate of depreciation is used for the aggregate. In addition, the lack of component data for investment in machinery and motor vehicles requires making adjustments for household use of automobiles and trucks as a constant portion of total machinery and motor vehicles rather than of the components.[1/]

1/ According to USDA, Agricultural Handbook 365, Volume 3, p. 10, the farm business portion is 40 percent of automobile and 78 percent of truck expenditures.

The stock data in the model are maintained internally on a constant dollar basis. Depreciation and the stock are converted to a current dollar basis via multiplication by a price index. This is similar to the USDA procedure. A difference arises with respect to the constant dollar Balance Sheet value. To initialize the model for simulation runs, the current dollar value of the machinery stock is deflated by a price index for machinery and motor vehicles based on prices paid by farmers indices for machinery and motor vehicles. This gives a different constant dollar value than that published in the Balance Sheet of the Farming Sector.

The depreciation rate is applied in a declining balance manner to the beginning-of-year stock. The mean value of the ratio of motor vehicle depreciation plus other machinery and equipment depreciation to the beginning of the year stock for the 1970 to 1975 period (.147) is used in the model as the depreciation rate.

Service Buildings and Other Structures. In a manner similar to that of machinery and motor vehicles, there are two stock and depreciation series for service buildings and other structures. The stock based on a productive capacity concept is explained in Baker (1978). The other stock, used on the Balance Sheet and to calculate depreciation, is calculated using a declining balance rate of 7.2 percent applied to the constant dollar stock. The constant dollar data are converted to current dollars via multiplication by a price index. The constant dollar stock is also adjusted by accidental damage deflated by the price index for buildings. A later section on real estate will give more detail.

Farm Operator Dwellings. Only one measure of depreciation of farm operator dwellings is included in the model. This is a "value" concept used with a declining balance rate of 4.5 percent. As in the case of the other series, the basic internal data are in constant dollars with conversion to current dollars using a price index for dwellings. Depreciation and stocks calculated in this manner are included in the Income Statement and Balance Sheet respectively. A later section on real estate will give more detail.

Household Equipment and Furnishings. A stock measure for household furnishings and equipment is required for the Balance Sheet. In addition, an estimate of replacement investment is required for use in conjunction with historical data on the stock of household equipment and furnishings to estimate expenditures.

Baker (1978) gives the explanation of how the expenditure series for household equipment and furnishings is constructed. A corresponding method is used in the model to calculate purchases for the Sources and Uses of Funds Statement and depreciation for use in calculating net capital formation.

The ending current dollar stock of household equipment and furnishings is projected using a time trend for per farm household equipment and furnishings. This equation is the following:

$$(5.43)\quad PFHEF = 3330.65 - \underset{(-5.85)}{213.829*T} + \underset{(9.05)}{10.5298*T^2}, \qquad R^2 = .96$$

PFHEF = per farm stock of household equipment and furnishings.

T = time (year - 1949).

The end of year total value of household equipment and furnishings is PFHEF multiplied by the number of farms. The total ending value of household equipment and furnishings, deflated by the price index for household equipment and furnishings, is used in conjunction with depreciation (replacement expenditure) and discontinuing proprietor withdrawals to calculate implicit constant dollar purchases. Conversion to current dollars is made via multiplication by the price index.

Investment Credit

The handling of investment credit in the model is not ideal, but the ideal was not possible. Over the historical data period, investment credit was observed at 0 and 7 percent. Sometimes the credit was available for only a portion of the year Over the period to be simulated, the investment credit will be at levels other than 0 or 7 percent. Investment credit cannot be treated as a continuous variable in regression equations because of the lack of observation at various levels. Treatment as a binary (0, 1) variable will not accommodate projection under alternative investment credit levels.

With the preferred methods lacking feasibility, the following method of handling investment credit was chosen. It was assumed that farmers view investment credit as a reduction in the price of the asset being purchased. The prices of machinery and motor vehicles and buildings were reduced in years when investment credit applied by the following method. The investment credit (e.g., 7 percent of the price) is received in the form of a tax reduction on the current year's income. The reduction is effectively received in the following year. Thus, the prices in the current year were reduced by the present value of the tax benefits. The discount rate used was the bank rate of interest and the period discounted was one half of a year. Machinery and building prices in years for which the investment credit was available for only part of the year were reduced by a fractional amount of the discounted tax benefits.

The model determines personal taxes via a rather crude method which does not allow for linkages between investment credit and reduced taxes.

The level of credit and fraction applied to the historical data is shown in the following table.

Table 5.29. Investment Credit Data

Year	Level	Fraction
1962	.07	1
1963	.07	1
1964	.07	1
1965	.07	1
1966	.07	0.5
1967	.07	0.5
1968	0.0	0
1969	.07	0.25
1970	0.0	0
1971	.07	0.5
1972	.07	1
1973	.07	1
1974	.07	1

Price and Quantity of Total Output

The prices and quantities of total output are indexes constructed in the following manner.

Price of total output is the sum of crop and livestock prices using quantities utilized in the crop year and calendar year, respectively, as weights.

$$P = (P_1(Q_1)/(Q_1 + Q_2)) + (P_2(Q_2)/(Q_1 + Q_2))/B1967$$

where:

P = price index for total output.

P_1 = crop price index.

Q_1 = quantity of crops utilized = feed + seed + exports - imports + food and industrial use.

P_2 = livestock price index.

Q_2 = livestock use = consumption + exports - imports.

B1967 = value of P in 1967, converts to 1967 = 100 index.

The quantity of output index is simply livestock and crop output occurring in the calendar year summed and divided by the base year.

$$Q = (Q_1 + Q_2)/Q1967$$

where:

Q = index of total output.

Q_1 = crop output (e.g. crop output for crop year 1951-52 is entered into the 1951 output index).

Q_2 = livestock output.

Q1967 = $Q_1 + Q_2$ in 1967.

Property Taxes

Property taxes (nominal dollars) are projected in the model as a function of time and the beginning of year real estate value. The equation used is given as follows:

$$\text{(5.44) PROPTAX} = 413.1961 + \underset{(3.67)}{3.5363(\text{REAL})} + \underset{(7.59)}{62.5678(\text{TIME})}, \quad R^2 = .9815$$

PROPTAX = nominal property tax.

REAL = aggregate farm real estate value (nominal dollars).

TIME = time (year - 1949).

Disposable Income

Aggregate disposable income is calculated from gross national product (GNP) in the model. The hypothesis that time would be a factor, because of rising income and the increasing marginal tax rates, was rejected.

Deflated per capita disposable income is used in the demand for livestock equation. It was reasoned that disposable income would be a more accurate measure of a consumer's budget constraint than using GNP. The equation used in the model is as follows:

$$\text{(5.45) DI} = -2.5384 + \underset{(162.9)}{.6987\ (\text{GNP})}, \quad R^2 = .9992$$

DI = nominal disposable income.

GNP = nominal gross national product.

Real Estate Value

The model divides real estate into three components: value of farm operator dwellings, value of service buildings and other structures, and value of land and improvements to the land. The inclusion of the breakdown of real estate value into its component parts for the Balance Sheet in the model is not consistent with the Balance Sheet published in The Balance Sheet of the Farming Sector. It is included in the model to maintain consistency between the Balance Sheet and the rest of the model. Also, the values printed in the Balance Sheet are required internally. Thus, the author felt that while the data may not be highly reliable, the implied values for these items should not be hidden in the model but printed for inspection.

Farm Operator Dwellings

The model contains an internal constant dollar stock of farm operator dwellings (SDCON). Depreciation in constant dollars is 4.5 percent of the sum of the beginning constant dollar stock and one half of the current year's purchases of dwellings in constant dollars. The constant dollar dwelling purchases are the current dollar purchases less accidental damage to dwelling (DMAGD) deflated by PDWL. The ending constant dollar value is beginning value plus purchases less depreciation. The ending constant dollar value is inflated by PDWL to use in the Balance Sheet.

Historical Data Series. The model is initialized for constant and current dollar values of dwellings by using the value implied in the USDA depreciation series. The depreciation of dwellings, as calculated by USDA, is 4.5 percent of a constant dollar stock times an inflator. Thus, the implied current dollar stocks can be derived by dividing published depreciation data by .045. Division by the price index for dwellings yields the constant dollar value. To get the beginning of year implied values, one must subtract one half of the current year's expenditures.

This procedure was applied to the data for the period 1964 to 1974. The procedure is not error free as, during some years in which the implied constant dollar stock increased, there was implied net disinvestment (purchases minus depreciation). The current dollar stock of dwellings data constructed were used in deriving the historical series for land.

Capital Gains. Nominal capital gains for farm operator dwellings are calculated as ending Balance Sheet nominal value minus beginning Balance Sheet nominal value minus purchases plus capital consumption.

Service Buildings and Other Structures

As with dwellings, the model contains a constant dollar stock of service buildings and other structures (SBCON). Depreciation is 7.2 percent of the sum of beginning value and one half of the current year's constant dollar purchases. The current dollar purchases are the estimated expenditures (in constant dollars) for service buildings, other structures, and land improvements less 21.4 percent of the same less deflated accidental damage. The 21.4 percent is the average ratio of expenditures for land improvements to expenditures for service buildings, other structures, and land improvements for the

1967 to 1975 data period.[1/] The ending constant dollar value is the beginning value plus purchases minus depreciation. All current values are constant dollar values inflated by PBLD.

Historical Data Series. The historical series is constructed in a manner similar to that for dwellings. Depreciation[2/] is divided by .072 to derive the implied current value stock. One half of current purchases (service buildings and other structures), less accidental damage to service buildings (DMAGB), is subtracted from the implied stock to get the beginning of year stock in current dollars. The historical series is used in deriving the value of land data.

Capital Gains. Nominal capital gains on service buildings and other structures are calculated from current dollar values as follows: ending Balance Sheet value less beginning Balance Sheet value minus purchases during the year plus capital consumption.

Value of Land and Improvements

The value of land in the model is given as a function of real estate price times the acres of land in farms. This near identity equation is given as follows:

$$(5.46)\ LAND = 5021.9 + \underset{(29.87)}{1.32347}*PREAL*LDFRMS, \quad R^2 = .9982$$

LAND = end-of-year land value (beginning of following year value).

PREAL = index of real estate value for March 1st of the following year.

1/ From unpublished USDA data.

2/ Farm Income Statistics, Table 18H.

LDFRMS = land in farms, current year

Historical Data Series. The historical data used to estimate Equation (5.46) was constructed by subtracting from total real estate value the value of service buildings and other structures (BLDVLU) and the value of dwelling (DWLVLU). Derivations of BLDVLU and DWLVLU havebeen explained above.

Capital Gains. Nominal capital gains of land are calculated as follows: ending Balance Sheet value less beginning Balance Sheet Value minus land improvements during the year 1/ plus value of real estate sold to nonfarm sectors, S(4).

Accidental Damage to Farm Buildings

A component of capital consumption is accidental damage to farm buildings (DAMG). The model contains an equation giving DAMG as a time projection. This equation is shown below:

$$(5.47)\ DMAG = 145.274 + \underset{(4.17)}{4.31609}*T, \quad R^2 = .4414$$

The equation was estimated from data covering 1951 to 1974. Alternative specifications including the value of farm buildings (covering the data period 1965 to 1974) did not improve the equation.

Accidental damage is subtracted from 1) the stocks of farm operator dwellings and 2) service buildings and other structures. DMAG is divided between the two categories according to their proportions

1/ Estimated in the model as 21.4 percent of expenditures for service buildings, other structures, and land improvements the average for the 1965 to 1976 data period.

of capital expenditures. Thus the following equations are used:

DMAGB = .786*CE(2)*DMAG/.786*CE(2) + CE(3)

DMAGD = CE(3)*DMAG/(.786*CE(2) + CE(3))

DMAGB = accidental damage to service buildings and other structures.

DMAGD = accidental damage to farm operator dwellings.

DMAG = total accidental damage.

CE(2) = capital expenditure for service buildings, other structures, and land improvements.

CE(3) = capital expenditures for farm operator dwellings.

.786 = 1965-1975 average proportion of service building and other structures expenditures to expenditures for the same plus land improvements.

Other Uses of Funds

This category is the residual use of funds on the SAUF statement. It is the summation of many items. A few of these are (a + indicates the item adds to the use; a - indicates it is actually a source of funds): net cash gifts and inheritances from farming sector participants to nonfarming sectors (+); purchases of machinery and motor vehicles from discontinuing proprietors (+); net investment in off-farm capital, financial assets such as stock and bonds (+); equity flows from nonfarm sector participants such as limited partnerships and farm corporations (-); net error in measurement of all other sources and uses (+ or -); and all other unmeasured cash flows (+ or -).

Table 5.30 shows the data for other uses of funds as defined in the model. It is hypothesized that a large portion of this residual use of funds is in the category including investment in nonfarm capital.

Table 5.30 Historical Data for Other Uses of Funds and Alternative Income Measures

Year	Other Uses	Net Farm Income	Off-Farm Income	Disposable Farm Income[a]
		Billion Dollars		
1961	5.0	13.3	9.3	21.1
1962	5.5	13.5	10.3	22.9
1963	5.5	13.4	10.9	22.6
1964	6.1	12.1	11.7	22.1
1965	8.0	14.8	12.7	25.8
1966	9.8	16.0	13.9	28.0
1967	6.2	14.2	14.5	26.7
1968	7.1	14.3	15.5	27.6
1969	10.1	16.3	16.6	30.1
1970	9.7	16.2	17.4	30.6
1971	8.2	16.9	18.7	32.4
1972	12.1	22.2	20.4	30.1
1973	23.1	39.0	23.5	58.1
1974	19.0	31.6	26.1	52.6
1975	12.3	29.1	28.5	53.3
1976	15.9	24.2	31.1	50.6

[a]Net farm income plus off-farm income minus personal taxes.

Penson (1977) has estimated a similar category for 1970 to 1975 referred to as: net additions to equity in life insurance reserves, individual retirement accounts, stocks and bonds, and other nonfarm capital. While the details of the procedures used by Penson to construct the data differ in some respects from those used in this study, the data act as one basis for comparison. The data for other uses of funds shown in Table 5.30 peak in 1973 at 23.1 billion. Penson's data also peak in 1973 (at 19.6 billion). However, for a direct comparison, the data used in this study need to be adjusted for net rent to nonoperator landlords (subtract 5.7 billion). Making this adjustment (23.1 - 5.7 = 17.4) leaves the other uses of funds calculated here at a level less than Penson's figure. Penson has used net additions to household furnishings ignoring replacement purchases. Additionally, Penson adjusted for withdrawals of current income by discontinuing proprietors, internal sales of breeding livestock, capital purchases by nonoperator landlords, and debt acquired by nonoperator landlords. Consistent adjustment for household furnishings and equipment replacement purchases and internal sales of breeding livestock would bring the data in this study and Penson's closer together. The other two items would increase the divergence. Penson's study does not adjust for the items in the residual such as gifts, inheritances, or purchases of machinery and motor vehicles from discontinuing proprietors. While the data calculated here correspond reasonably well with Penson's, the latter may be in error when attributing all of the residual to investment in off-farm financial assets.

If it is reasonable to assume that a substantial portion of the other uses of funds category is composed of off-farm financial assets (an assumption that has not received empirical testing), then one would expect income of farmers to be highly correlated with this use of funds. Table 5.30 also shows data for net farm income, off-farm income, and disposable farm income (net farm income plus off-farm income minus taxes). It is interesting to note that the turning points in the residual use of funds follow net farm income much more closely than the other income measures. One can see data that 1975 will have a large error because of the small decline in net farm income (the other two measures increased) and the large drop in other users of funds.

Regression equations were run using the three income measures individually and net farm income and off-farm income in combination. The data covered the 16 years from 1961 through 1976. Additionally, an equation using net farm and off-farm income was estimated omitting 1975. These equations are shown in the following table.

The equation chosen for use in the model is number 5.47e in Table 5.31. The choice was based partially on the a priori belief that both farm related income and off-farm income are factors affecting the elements making up the dependent variable.

Equations 5.47a through 5.47d have very large errors for 1975 (relative to errors in other years), as was expected. In addition equations 5.47a and 5.47d, the equations including net farm income underestimate for 1976. Equation 5.47e, estimated with the 1975 observation deleted, fits 1976 very closely (15.9 versus 15.83)

Table 5.31. Equations for Other Uses of Funds U(6)

Equation	Constant	Net Farm Income	Off-farm Income	Disposable Farm Income	R^2	Durbin Watson
5.47a	-1861.22	.6297 (11.61)			.91	2.32
5.47b	-681.92		.6202 (5.0)		.64	1.54
5.47c	-2434.83			.3789 (8.46)	.84	1.77
5.47d	-2175.56	.5801 (6.19)	.0722 (.66)		.91	2.36
5.47e	-3464.63	.5712 (10.85)	.1766 (2.73)		.97	1.74

and fits other recent years as well as the other equations. However, the higher R^2 should be largely attributed to the deletion of 1975, not to the fact that it fits the other observations better.

It is the author's opinion that these results are very encouraging in the respect that an a priori troublesome area, the need to specify an equation for a conglomerate residual use of funds, has been handled with a reasonably specified equation that has a good fit.

Summary

This chapter has presented the equations and relationships required for the endogenous portion of the model. These include structural equations, time trends, near identities, and accounting relationships. Statistical results have been presented where appropriate for the individual equations. The following chapter (VI) will investigate the properties of structural equations as a set.

CHAPTER VI

Model Evaluation

Introduction

Evalutaion and validation of the model consisted largely of 1) equation by equation statistical and economic criteria and 2) ability of the model to track over the historical period.

The statistical and economic criteria for each equation have been presented in Chapter V. While the criteria used in estimating and selecting the individual equations are considered essential, they do not guarantee that the model will fit all variables well. While this is true of all multiple equation models, it is especially true when some equations are simultaneous. For example, a simultaneous equations model that has very price inelastic demand and supply equations might track quantities well but have wide fluctuations in prices. A recursive equation or block recursive set of equations with very influential explanatory variables being current endogenous variables could have a high R^2 with actual values of the endogenous variables but track poorly with predicted values. This could also be true of a single equation model with lagged endogenous variables.

The model has been developed primarily to project (under alternative conditions) the Income, Balance Sheet, and SAUF statements for the farming sector. The data on these statements are largely transformations of other variables. Thus, errors in tracking variables on financial statements would be directly traceable to errors in tracking the underlying variables. However, errors in tracking underlying variables might cancel each other. In the author's opinion, the validity of a model rests largely upon its ability to track endogenous variables. A model that tracks variables well because of offsetting errors should not be accepted without reservation. The individual equations provide the mechanism for evaluating policies (levels of controllable exogenous variables) and scenario projections of uncontrollable exogenous variables. If the individual equations do not behave well, the conclusions with respect to the impacts of alternative scenarios will be less reliable.

It is possible for a model to track individual variables reasonably well and not track a transformation of these variables. This would not seem to be a highly likely occurrence nor as invalidating as failure to track underlying variables.

The model here has a very large number of variables (counting all transformations). Clearly, presenting data relative to the tracking of all variables would be counter productive. Thus, a decision as to which variables are most important had to be made. The set chosen includes the variables in the simultaneous equation set and the input quantities resulting from the recursive demand for variable inputs equations. These variables are a large portion of endogenous prices and quantities which are transformed into cash flows and other financial variables. An additional factor considered was the amount of computer programming required to include additional variables in the evaluation. Extension of the set of variables evaluated substantially beyond those included would involve significant increments of programming.

The following pages describe the evaluation procedures and results. The first section describes adjustments made to the model. The following section presents tabular and graphical results of simulating over the historical data period.

Adjustments to the Model

Initial efforts at running the model over the historical data period indicated relatively poor performance by the system of simultaneous equations. It was determined that the poor performance resulted from very low price elasticity of demand for crops in the system of equations (Baker, 1978). Two modifications were made to the model and are presented below.

Endogenizing Crop Inventories

The model was conceptualized from a traditional static theoretical framework. This factor, combined with an intuitive feeling that an inventory demand equation would be difficult to specify theoretically as well as empirically, led to treating inventories exogenously. Further impetus was provided by complications involved with government-held crop inventories and in simulating policies related to inventories. However, it becomes obvious when evaluating the model's performance and looking at the data that a portion of the adjustments to shocks in the crop sector (e.g., high or low production, increased exports, etc.) is absorbed via changes in inventories. Thus, the problem of projecting a consistent set of exogenous variable values (e.g., export levels and inventory levels) would arise. To aid in this problem, an inventory demand equation has been estimated to use at least for base projections. The equation is estimated as a function of the change in the real price of crops and beginning crop inventories. These is herein no theoretical derivation of this formulation of inventory demand, although the formualtion is intuitively appealing. Empirical estimates for equation (6.1) shown below are presented in Table 6.1.

(6.1) $\quad CROPS(8) = f(\underset{-}{CHCRP}, \underset{+}{CROPS(1)})$

CROPS(8) = ending inventory of crops.

CROPS(1) = beginning inventory of crops.

CHCRP = RPCROP - RPCRM1.

RPCROP = real price of crops.

RPCRM1 = real price of crops lagged one period.

Table 6.1 Empirical results for Equation (6.1), Demand for Crop Inventory, CROP(8)

Explanatory Variable	Regression Coefficient	t Statistic	Selected Elasticities 1951-74	Selected Elasticities 1972-74
Constant	1318.34	---	---	---
CHCRP	-40.4695	-2.37	-.42	-.86
CROPS(1)	.86665	5.52	---	---

$R^2 = .8553$, D.W. = 2.3145, $t_{.01} = 3.055$, $t_{.05} = 2.179$, $t_{.10} = 1.782$

The equation for inventory demand was estimated using the 1960 to 1974 data period. Much of the variation in the observations over this period occurs in the later portion. It is hoped that this variance in the observations will give the equation some predictive power for handling projections. The entire data period was not included in the estimation of the equation. This decision was made as an attempt to avoid including more observations under a different "structure" than necessary. The structural change referred to is the change from a situation of stable prices with the market absorbing all it would at those prices (with the balance going into inventories) to a situation of inventories, prices, and other quantities demanded adjusting simultaneously.

Part of the basis for choosing the inventory demand equation was the own price elasticity. This was necessary for the model to track well and is a result of the crop price inelasticity of the other crop demand equations in the model. The short-run price elasticity of demand for the equation is -.86 at recent price and inventory levels. The long run price elasticity is zero.

Revised Feed Demand Equation

In addition to endogenizing inventories, examination of the model's tracking performance led to re-estimation of the feed demand equation. Upon re-examination, two changes were made in equation (5.3).

The own price elasticity of feed demand (with respect to feed price) and the price elasticity of feed demand with respect to crop price (derived from the partial reduced form equation, see Tables

5.3 and 5.5) were in the range of -.2 at current prices and quantities. This elasticity is misleading, as the price elasticity of demand for crops of the system is -.0288 at recent price and quantity levels (Baker, 1978).

This price elasticity is lower than the own price elasticity for any of the individual components. The reason for the apparent contradiction is the simultaneous relationship with the livestock sector. That is, the elasticity in the crop demand component is "wiped out" by the livestock sector. Basically, the relationship is that increases in feed price cause increased livestock price which then increases feed demand and thus offsets the crop sector adjustment. This description is technically incorrect as there is no sequential adjustment as described; it is simultaneous. Thus, it was felt that the price elasticity of feed demand was low relative to the elasticity with respect to the price of livestock.

The second problem with the earlier specified demand for feed equation is the trend variable. While feed demand includes an increasing trend over time that cannot be explained with prices, it can be explained by the overall increases in the level of livestock production as reflected in livestock inventories. Livestock beginning inventory is included as a replacement for the time trend in re-specification of the equation.

The equation now used in the model is shown below as equation (6.2). Empirical results follow in Table 6.2.

$$(6.2) \qquad CROPS(6) = f(\underset{-}{RPFEED}, \underset{+}{RPLIV}, \underset{+}{RPLVM1}, \underset{+}{LIV(1)})$$

CROPS(6) = feed use of crops.

RPFEED = real price of feed.

RPLIV = real price of livestock.

RPLVM1 = real price of livestock lagged one year.

LIV1 = beginning livestock inventories.

Table 6.2 Empirical Results for Equation (6.2), Feed Demand, CROPS(6)

Explanatory Variable	Regression Coefficient	t Statistic	Selected Elasticities 1951-74	1972-74
Constant	-6603.67	---	---	---
RPFEED	-47.9611	-6.29	-.565	-.475
RPLIV	34.7116	5.01	---	---
RPLVM1	10.8519	1.29	---	---
LIV(1)	.859385	15.72	---	---

R^2 = .9587, D.W. = 1.53, $t_{.01}$ = 2.861, $t_{.05}$ = 2.093, $t_{.10}$ = 1.729.

Elasticities in equation (6.2) differ from the earlier feed demand equation (5.3) in two major respects. First the equation has a higher own price elasticity and second, the own price elasticity has increased relative to the current livestock price elasticity.

Model Performance

The model was evaluated using a computer program written by Rodney Kite (USDA, ERS, CED, Forecast Support Group). The solution algorithm uses the method of Gauss-Siedel. While the model herein can be solved directly in a given year by matrix inversion, the program (called GASSP), written by Kite, includes numerous convenience features. These include: generation of evaluative statistics, ease of exogenizing of "turning off" selected equations, and easily changing from using actual values for lagged endogenous variables (one Period Forecasts) to using predicted values for lagged endogenous variables.

After initial difficulty in achieving convergence in the solution of the system of equations, the model solved quickly with a stringent convergence criterion. The early problem was solved by changing the order of the equations. (The problem was one of finding the solution to the equations rather than there being more than one solution or converging to unreasonable solutions). Ortega (1972) discusses the solution properties of the Gauss-Siedel solution algorithm further.

The convergence criterion was .0001. When the estimated values for all endogenous variables changed by less than .0001 between iterations, the algorithm stopped. The criterion seemed quite strict in light of the fact that the value of the smallest variable was in the range of 100 and that several of the variables had values over 10,000. The solution algorithm converged to within this criterion in about 20 iterations.

Evaluative Data

The evaluative data are presented in Tables 6.3 through 6.17 and in the accompanying Figures 6.1 through 6.15. Data are presented for each year and summary statistics are presented. The model is evaluated over the 1952 through 1974 period (the first year of data prepared for GASSP was lost due to lagged variables). The evaluation procedure required the model to use its own forecasts as values for the lagged endogenous variables. That is, the model was forced to "feed" on itself. This method of evaluation is appropriate for a model to be used for multi-period projections. A model to be used extensively for single period projections would be evaluated using actual values for lagged endogenous variables.

The data generated for each year are: 1) actual and estimated values, 2) the error (estimated minus actual, thus positive values indicate overestimation and negative values underestimation), and 3) the error as a percentage of the actual value. The summary data generated are: 1) the mean value of actual data, 2) the mean absolute value of the actual data, 3) the mean value of the estimates, 4) the mean absolute value of the estimates, 5) the mean error, 6) the mean absolute error, 7) the mean percentage error, 8) the mean absolute percentage error, 9) standard deviations of the actual and estimated data, 10) the mean and mean absolute percentage change in values from year to year, 11) the square of the mean error, and 12) the root mean squared error of the forecast.

For the purpose of evaluating the simulation model, the following summary data are considered the most informative among the group listed above: 1) mean percentage error, 2) mean absolute percentage error, and 3) root mean squared error of the forecast. The mean percentage error should be near zero. A large mean percentage error (positive or negative) indicates that bias could be a problem. The mean absolute percentage error utilizes the absolute values of the errors and thus positive and negative values do not cancel out. Thus, the mean absolute percentage error is a reasonable measure of fit. An alternative measure of fit is the root mean squared error. This latter measure has the feature of weighting large errors more heavily than small errors.

Crop Quantities

The evaluative data for crop quantities are presented in Tables 6.3 through 6.7 and Figures 6.1 through 6.5. With the exception of crop inventories, the model tracks crop quantities quite well. The mean percentage errors range from .149 to .0311 percent. The mean absolute percentage errors range from 1.73 to 3.40 percent. These would indicate a good fit and little problem with bias.

The crop inventory equation, Table 6.7 and Figure 6.5, underestimates the levels of inventory for most years. Crop inventory is a stock variable. This factor must be taken into account when evaluating the equation. If in a historical simulation the value of a stock variable is underestimated for a year, the year to year change (the flow) could be properly estimated, but an error would still occur in the level of the stock. Over a large portion of the historical period for which the equation underestimates the level of crop inventories, the structure was one of price supports with excess supply going into government supported storage. This is not the structure which the equation is intended to represent. (The crop inventory equation was estimated using only 1960 through 1974 data.)

Table 6.3. Evaluative Data for Crop Production, CROPS(2)

Year	Actual	Estimate	Error	%Error
1952	15941.074	15857.299	-83.8	-.526
1953	16692.524	16876.944	184.	1.10
1954	16563.681	16690.117	126.	.763
1955	16376.271	16000.868	-375.	-2.29
1956	16967.540	16465.110	-502.	-2.96
1957	17058.997	16931.459	-128.	-.748
1958	16870.684	16965.224	94.5	.560
1959	18808.225	18616.766	-191.	-1.02
1960	18347.779	17762.721	-585.	-3.19
1961	19819.048	18761.284	-1057.8	-5.34
1962	19466.150	18998.708	-467.	-2.40
1963	19883.691	19723.482	-160.	-.806
1964	20621.965	20805.951	184.	.892
1965	20102.505	20730.031	628.	3.12
1966	21309.446	22037.889	728.	3.42
1967	20815.419	20779.250	-36.2	-.174
1968	22061.919	22102.307	40.4	.183
1969	22545.329	22838.406	293.	1.30
1970	22595.945	22413.647	-182.	-.807
1971	21922.509	22492.752	570.	2.60
1972	24337.877	25510.602	1173.	4.82
1973	24548.632	24369.837	-179.	-.728
1974	25786.700	25786.473	-.227	-.00095
Mean	$.200*10^5$	$.200*10^5$	3.18	-.0967
Absolute	$.200*10^5$	$.200*10^5$	347.	1.73

PERFORMANCE STATISTICS 1952-1974

	MEAN	STD DEV	MEAN % CHANGE	MEAN ABSOLUTE % CHANGE	MEAN % ERROR	MEAN ABSOLUTE % ERROR
ACTUAL	$.200*10^5$	$.287*10^4$	2.34	3.65		
ESTIMATE	$.200*10^5$	$.307*10^4$	2.35	4.37	-.0967	1.73

SQUARED MEAN ERROR 10.134
ROOT SQUARED ERROR OF FORECAST 486.774

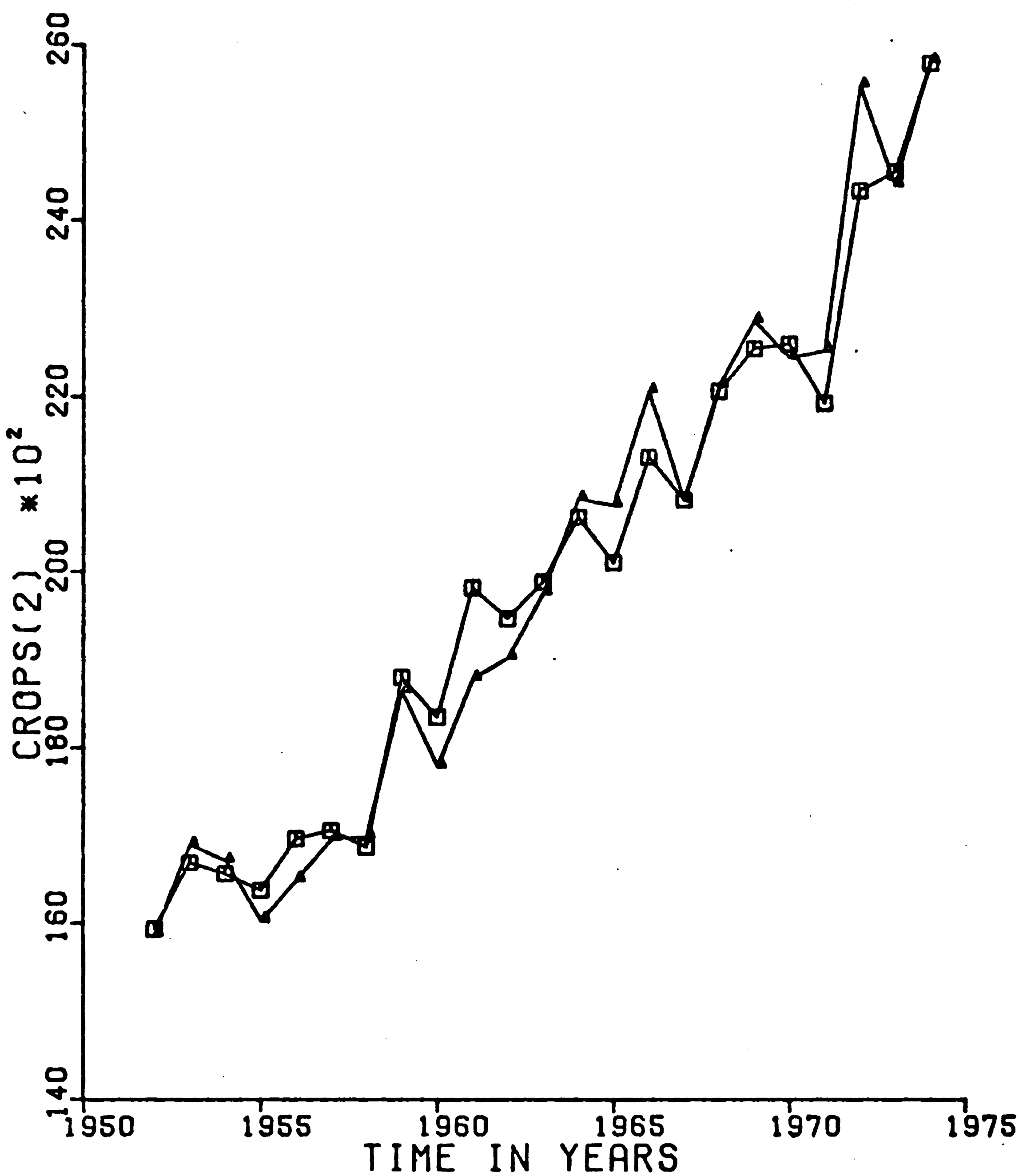

Figure 6.1

Crop Production

[] Actual
Δ Estimated

Table 6.4. Evaluative Data for Quantity of Feed Use, CROPS(6)

Year	Actual	Estimate	Error	%Error
1952	7328.040	6987.228	-341.	-4.65
1953	7095.544	7415.186	320.	4.50
1954	7041.321	7870.730	829.	11.8
1955	7046.355	7766.410	720.	10.2
1956	7509.104	7548.519	39.4	.525
1957	7501.713	7175.675	-326.	-4.35
1958	7739.019	7427.856	-311.	-4.02
1959	8391.235	8328.251	-63.0	-.751
1960	8726.246	8338.395	-388.	-4.44
1961	8725.898	8445.588	-280.	-3.21
1962	9008.591	8619.900	-389.	-4.31
1963	8920.802	9055.986	135.	1.52
1964	8919.331	9269.850	351.	3.93
1965	8921.038	9046.030	125.	1.40
1966	9526.674	9388.390	-138.	-1.45
1967	9699.773	9137.149	-563.	-5.80
1968	9655.009	9557.997	-97.0	-1.00
1969	10125.317	10315.874	191.	1.88
1970	10734.392	10567.176	-167.	-1.56
1971	10580.202	10548.210	-32.0	-.302
1972	11254.162	11666.560	412.	3.66
1973	11390.783	11282.641	-108.	-.949
1974	11333.587	11118.288	-215.	-1.90
Mean	$.901*10^4$	$.899*10^4$	-12.9	.0311
Absolute	$.901*10^4$	$.899*10^4$	284.	3.40

PERFORMANCE STATISTICS 1952-1974

	MEAN	STD DEV	MEAN % CHANGE	MEAN ABSOLUTE % CHANGE	MEAN % ERROR	MEAN ABSOLUTE % ERROR
ACTUAL	$.901*10^4$	$.143*10^4$	2.07	2.72		
ESTIMATE	$.899*10^4$	$.139*10^4$	2.23	3.97	.0311	3.40

SQUARED MEAN ERROR	165.902
ROOT SQUARED ERROR OF FORECAST	365.690

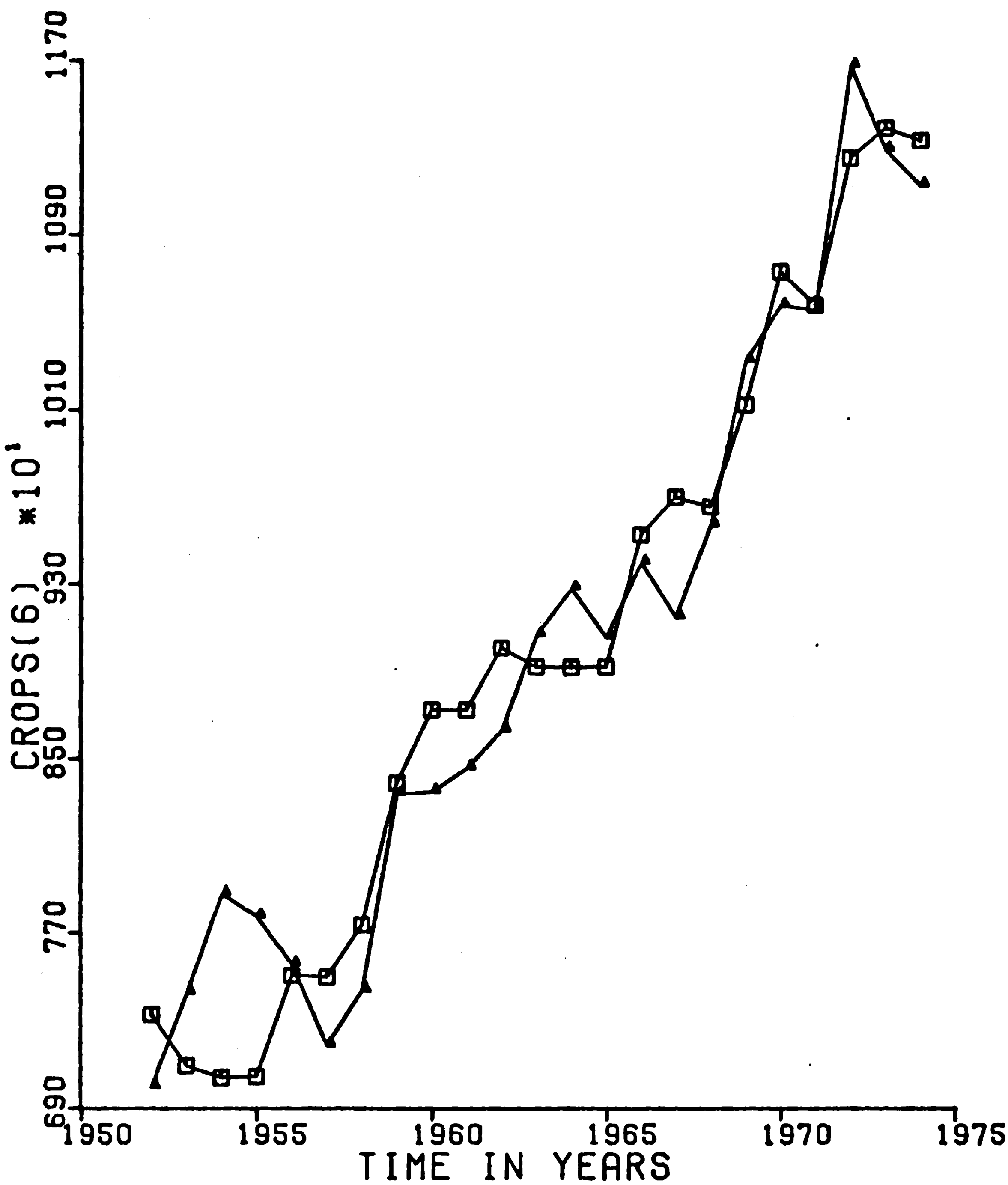

Figure 6.2

Feed Use of Crops

[] Actual

Δ Estimated

Table 6.5. Evaluative Data for Quantity of Seed Use, CROPS(5)

Year	Actual	Estimate	Error	%Error
1952	358.	371.	12.6	3.52
1953	372.	367.	-4.62	-1.24
1954	359.	352.	-6.41	-1.79
1955	351.	352.	.300	.0853
1956	353.	342.	-10.3	-2.93
1957	332.	339.	7.59	2.29
1958	340.	335.	-5.68	-1.67
1959	333.	340.	6.49	1.95
1960	328.	341.	13.5	4.13
1961	340.	332.	-7.64	-2.25
1962	322.	330.	7.43	2.31
1963	330.	333.	3.19	.968
1964	332.	336.	3.59	1.08
1965	341.	341.	-.432	-.127
1966	346.	344.	-1.42	-.410
1967	378.	360.	-18.3	-4.85
1968	376.	361.	-15.1	-4.02
1969	356.	359.	2.11	.593
1970	352.	361.	9.17	2.61
1971	365.	371.	5.18	1.42
1972	362.	366.	4.25	1.17
1973	395.	393.	-1.29	-.327
1974	422.	426.	3.93	.931
Mean	354.	354.	.348	.149
Absolute	354.	354.	6.55	1.85

PERFORMANCE STATISTICS 1952-1974

	MEAN	STD DEV	MEAN % CHANGE	MEAN ABSOLUTE % CHANGE	MEAN % ERROR	MEAN ABSOLUTE % ERROR
ACTUAL	354.	23.6	.783	3.30		
ESTIMATE	354.	22.3	.674	2.07	.149	1.85

SQUARED MEAN ERROR .121
ROOT SQUARED ERROR OF FORECAST 8.446

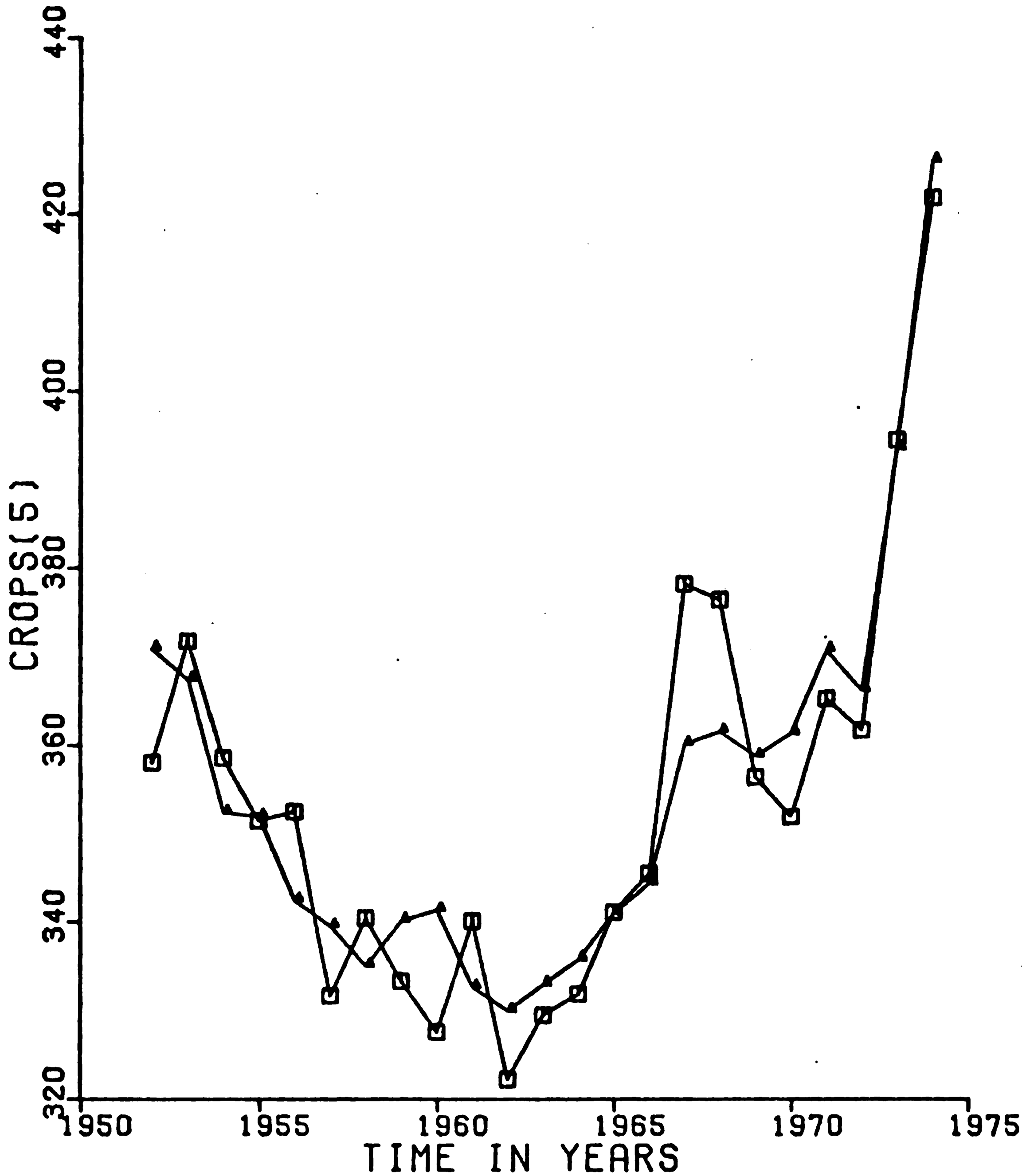

Figure 6.3

Seed Use

[] Actual

Δ Estimated

Table 6.6. Evaluative Data for Quantity of Food-Industrial Use of Crops, CROPS(7)

Year	Actual	Estimate	Error	%Error
1952	7233.715	7219.805	-13.9	-.192
1953	7248.260	7224.736	-23.5	-.325
1954	7216.452	7209.154	-7.30	-.101
1955	7122.090	7277.384	155.	2.18
1956	7296.246	7332.540	36.3	.497
1957	7463.062	7377.044	-86.0	-1.15
1958	7247.112	7397.208	150.	2.07
1959	7623.267	7548.567	-74.7	-.980
1960	7590.886	7623.048	32.2	.424
1961	7660.573	7687.147	26.6	.347
1962	7927.586	7784.907	-143.	-1.80
1963	8002.793	7876.759	-126.	-1.57
1964	8014.879	7985.563	-29.3	-.366
1965	8083.936	8106.606	22.7	.280
1966	8301.153	8249.097	-52.1	-.627
1967	8391.016	8300.865	-90.2	-1.07
1968	8478.514	8410.253	-68.3	-.805
1969	8671.612	8517.840	-154.	-1.77
1970	8428.669	8525.123	96.5	1.14
1971	8573.895	8585.939	12.0	.140
1972	8692.328	8774.887	82.6	.950
1973	8670.206	8804.705	134.	1.55
1974	8755.528	8733.794	-21.7	-.248
Mean	$.794*10^4$	$.794*10^4$	-6.12	-.0623
Absolute	$.794*10^4$	$.794*10^4$	71.2	.896

PERFORMANCE STATISTICS 1952-1974

	MEAN	STD DEV	MEAN % CHANGE	MEAN ABSOLUTE % CHANGE	MEAN % ERROR	MEAN ABSOLUTE % ERROR
ACTUAL	$.794*10^4$	572.	.713	1.69		
ESTIMATE	$.794*10^4$	563.	.872	.964	.0623	.896

SQUARED MEAN ERROR 37.479
ROOT SQUARED ERROR OF FORECAST 91.284

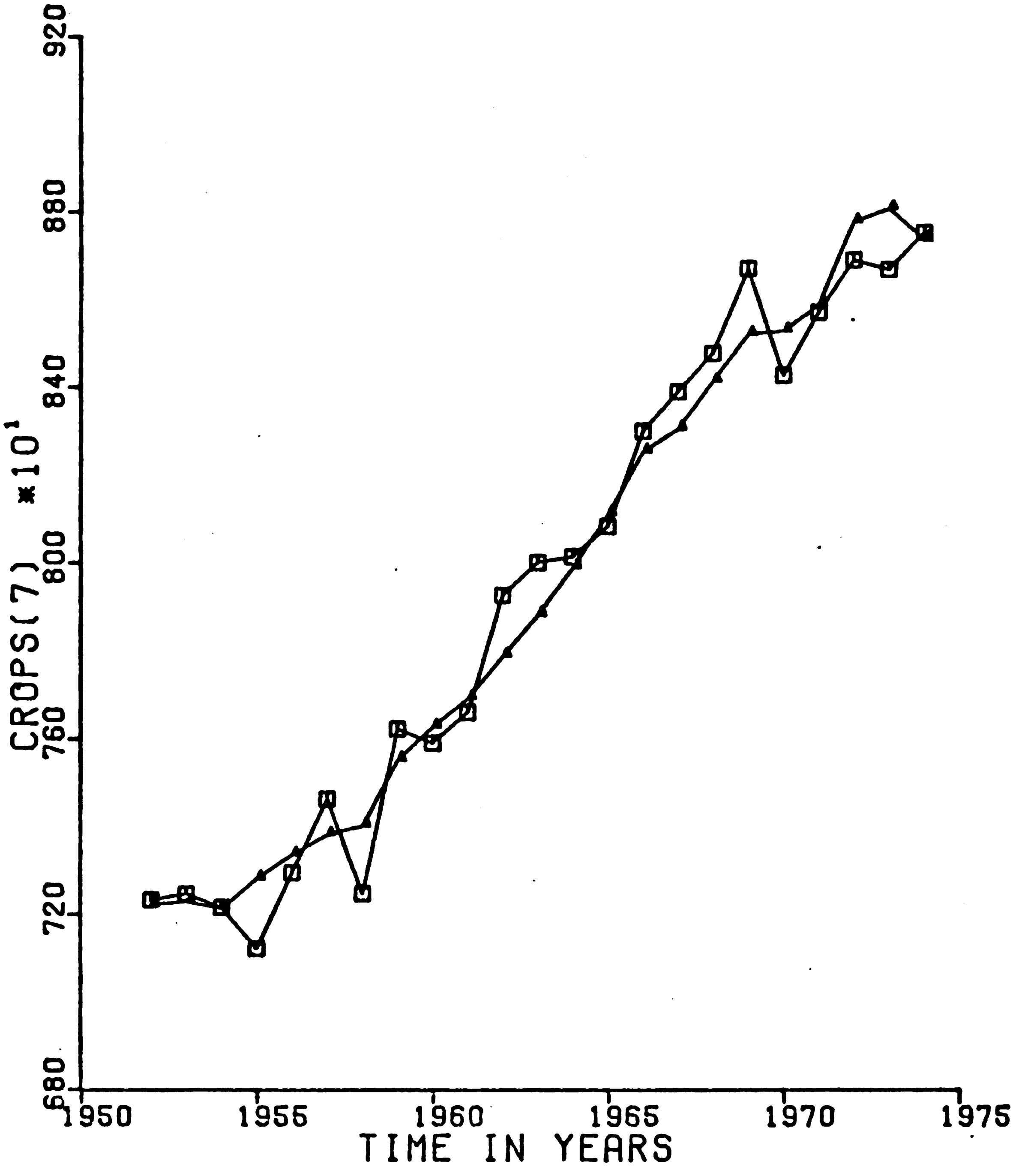

Figure 6.4

Food-Industrial Use of Crops

[] Actual

Δ Estimated

Table 6.7. Evaluative Data for Ending Inventories of Crops, CROPS(8)

Year	Actual	Estimate	Error	%Error
1952	7111.027	7394.398	283.	3.98
1953	8443.700	8628.615	185.	2.19
1954	9862.658	9365.58	-498.	-5.05
1955	10945.065	9193.634	-1751.	-16.0
1956	11826.535	9482.462	-2344.	-19.8
1957	11666.927	9615.047	-2052.	-17.6
1958	11602.228	9830.433	-1772.	-15.3
1959	12699.706	10863.894	-1836.	-14.5
1960	12334.487	10250.605	-2084.	-16.9
1961	12946.258	10051.225	-2895.	-22.4
1962	12425.091	9599.996	-2825.	-22.7
1963	12703.188	9678.090	-3025.	-23.8
1964	12765.733	9633.663	-3132.	-24.5
1965	12349.227	9679.946	-2669.	-21.6
1966	11850.858	10138.031	-1712.	-14.5
1967	10747.565	9661.208	-1086.	-10.1
1968	10863.894	10003.964	-860.	-7.92
1969	11496.014	10941.690	-554.	-4.82
1970	11192.144	10517.982	-674.	-6.02
1971	9882.090	9789.729	-92.4	-.935
1972	10400.529	10984.366	584.	5.61
1973	8827.587	9210.704	383.	4.34
1974	7992.749	8668.551	676.	8.46
Mean	$.110*10^5$	$.970*10^4$	$-.129*10^4$	-10.4
Absolute	$.100*10^5$	$.970*10^4$	$.148*10^4$	12.6

PERFORMANCE STATISTICS 1952-1974

	MEAN	STD DEV	MEAN % CHANGE	MEAN ABSOLUTE % CHANGE	MEAN % ERROR	MEAN ABSOLUTE % ERROR
ACTUAL	$.110*10^5$	$.164*10^4$	.668	6.62		
ESTIMATE	$.970*10^4$	802.	.989	5.71	-10.4	12.6

SQUARED MEAN ERROR 1673307.293

ROOT SQUARED ERROR OF FORECAST 1820.086

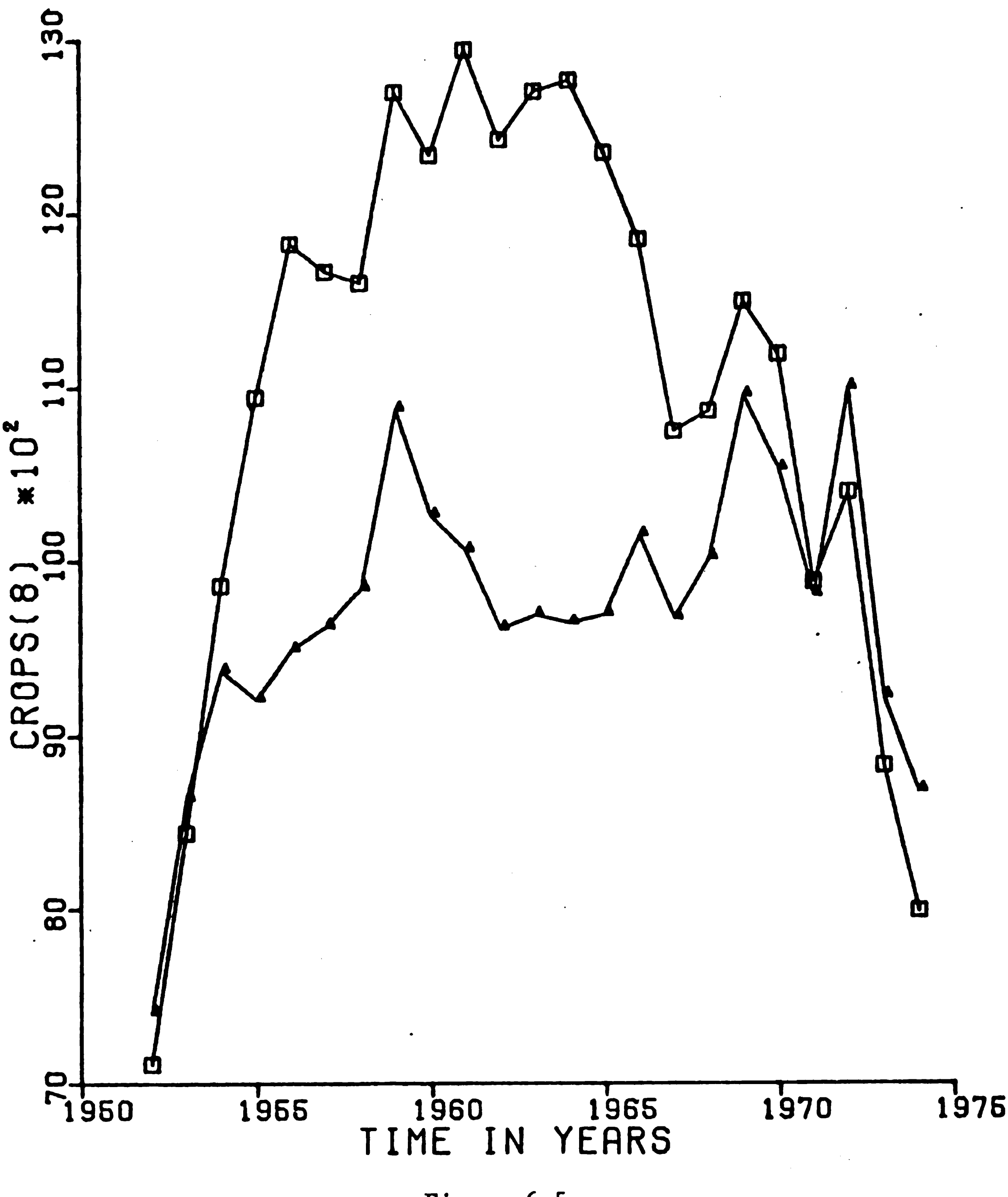

Figure 6.5

Ending Inventory of Crops

[] Actual

Δ Estimated

Real Price of Crops

Table 6.8 and Figure 6.6 present the evaluative data for the tracking of real price of crops. The model does not track crop price as well as hoped. The mean absolute percentage error is 6.98 percent. The error varies greatly from year to year, with 1959 and 1971 exceeding 20 percent. The graphical representation given in Figure 6.6 indicates that the model tracks the general level--high real price in the early fifties, declining until the early seventies, then high in 1973 and 1974. However, the model depicts much greater swings in crop price than actually occur. The mean absolute percentage year to year change of the estimated values is 11.8 percent compared with the actual 5.98 percent. The greater fluctuation in estimated prices might be expected when one considers the structure of the model. The model is simulated over the historical period without the impostiion of government policy variables. The structural equations are intended to represent unrestricted markets. The procedure intended for projections is to impose constraints on the model to simulate government policy.

For example, a price floor for crops could be established in the following manner. First, the model could be solved with no restrictions. If this would yield a crop price below the minimum, the model could be re-solved deleting an equation (RPCROP would not be endogenous) and making crop inventories a residual demand.

Errors in estimating crop price feed throughout the model, causes errors in other prices. These include feed, seed, and livestock prices.

Table 6.8. Evaluative Data for Real Price of Crops, RPCROP

Year	Actual	Estimate	Error	%Error
1952	147.	154.	7.94	5.42
1953	135.	132.	-3.14	-2.32
1954	130.	118.	-11.5	-8.90
1955	129.	124.	-5.06	-3.92
1956	124.	119.	-4.29	-3.47
1957	119.	117.	-1.22	-1.03
1958	112.	113.	1.01	.904
1959	110.	87.7	-22.7	-20.6
1960	109.	99.6	-9.27	-8.52
1961	110.	103.	-6.32	-5.76
1962	111.	114.	2.59	2.32
1963	112.	113.	.832	.740
1964	113.	115.	1.99	1.76
1965	100.	115.	14.5	14.5
1966	106.	104.	-1.72	-1.62
1967	102.	115.	12.7	12.4
1968	96.3	107.	11.1	11.6
1969	89.1	83.9	-5.20	-5.84
1970	83.5	90.9	7.39	8.85
1971	88.5	107.	18.2	20.6
1972	86.4	77.6	-8.86	-10.3
1973	114.	118.	4.16	3.67
1974	141.	133.	-8.01	-5.67
Mean	112.	111.	-.209	.212
Absolute	112.	111.	7.39	6.98

PERFORMANCE STATISTICS 1952-1974

	MEAN	STD DEV	MEAN % CHANGE	MEAN ABSOLUTE % CHANGE	MEAN % ERROR	MEAN ABSOLUTE % ERROR
ACTUAL	112.	17.1	.269	5.98		
ESTIMATE	111.	17.0	.589	11.8	.212	6.98

SQUARED MEAN ERROR .044
ROOT SQUARED ERROR OF FORECAST 9.697

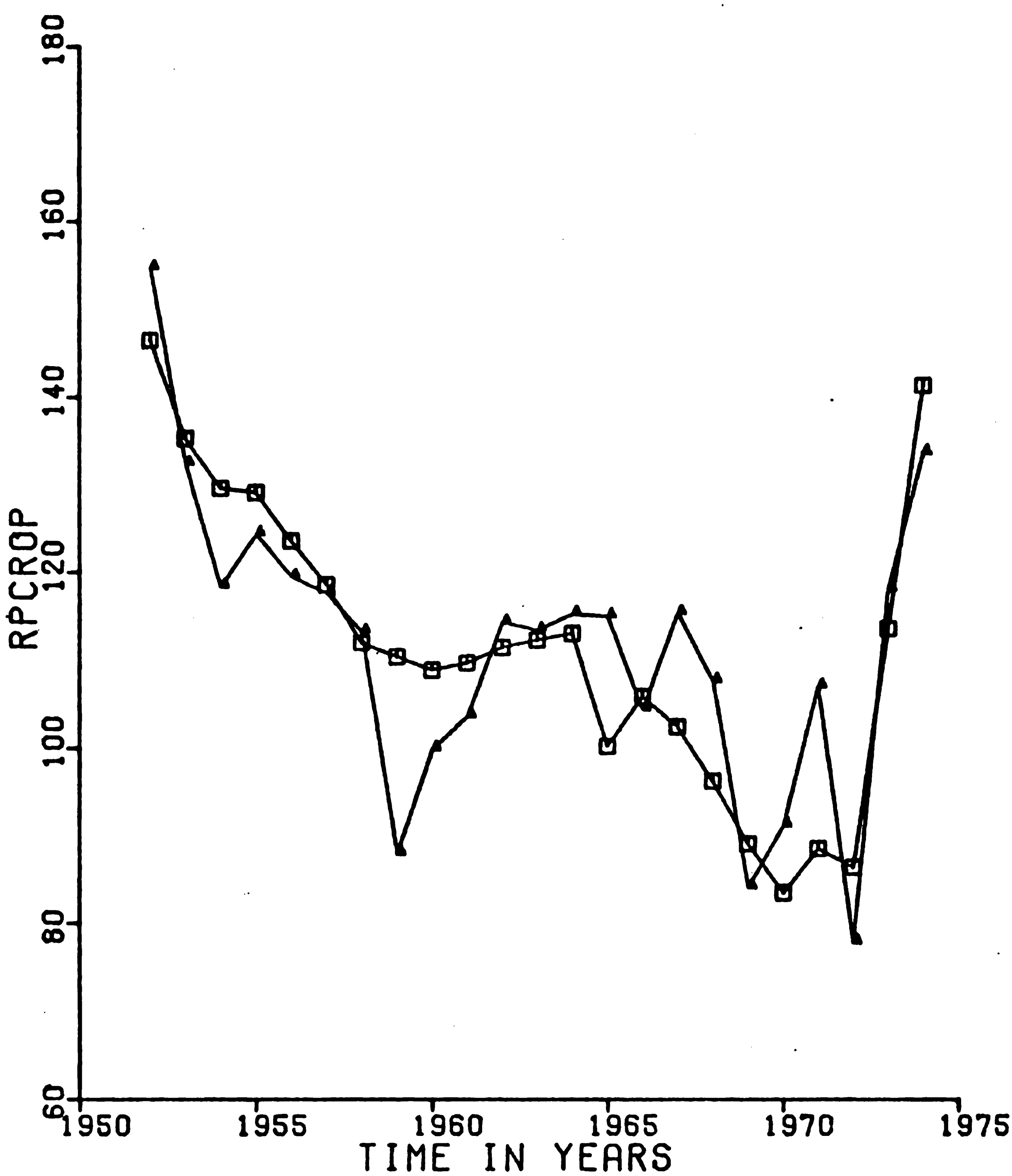

Figure 6.6

Real Price of Crops

[] Actual

Δ Estimated

Livestock Quantities

The model predicts the quantities of livestock supplied and demanded quite well. The evaluative data are presented in Tables 6.9 and 6.10 and in Figures 6.7 and 6.8. The mean percentage errors (-.0773 and -.0941) indicate little problem with bias. The mean absolute percentage errors of 1.31 and 1.32 indicate that the model tracks these variables well.

Livestock Price

In a manner similar to that for crop price, the model is somewhat erratic in tracking the real price of livestock. The evaluative data are presented in Table 6.11 and Figure 6.9.

The estimated values follow actual values with respect to the overall level but diverge from actual values in periods of more stable prices. This is most easily seen by looking at Figure 6.9.

Much of the error can be traced to the errors in predicting real price of crops. This can be found by exogenizing RPCROP (solving the model using actual values for RPCROP). When this is done, the model tracks RPLIV, as well as other variables, much better.

The mean percentage error of -.422 percent indicates that bias is not a problem. The mean absolute percentage error is 6.05 percent, with the largest errors occurring in 1959 and 1971, the same years in which RPCROP has large errors.

Real Price of Total Output

The real price of total output is derived as an identity, a summation of crop and livestock prices weighted by the quantities

Table 6.9. Evaluative Data for Livestock Production, LIV(2)

Year	Actual	Estimate	Error	%Error
1952	16585.807	16555.268	-30.5	-.184
1953	16067.145	16126.527	59.4	.370
1954	17057.814	16588.741	-469.	-2.75
1955	17079.639	16718.431	-361.	-2.11
1956	16362.104	16449.505	87.4	.534
1957	16166.284	16573.426	407.	2.52
1958	17281.119	17403.676	123.	.709
1959	17745.503	17646.777	-98.7	-.556
1960	17142.029	17507.433	365.	2.13
1961	18048.665	17882.124	-167.	-.923
1962	18372.742	18165.203	-208.	-1.13
1963	18640.356	18400.441	-240.	-1.29
1964	18683.368	18415.866	-268.	-1.43
1965	17681.789	18256.740	575.	3.25
1966	18520.020	18759.404	239.	1.29
1967	18898.767	18825.928	-72.8	-.385
1968	19040.498	19191.103	151.	.791
1969	19017.839	19493.517	476.	2.50
1970	20183.089	19763.074	-420.	-2.08
1971	20319.949	19927.925	-392.	-1.93
1972	20423.045	20228.748	-194.	-.951
1973	20490.683	20452.851	-37.8	-.185
1974	20226.232	20232.602	6.37	.0315
Mean	$.183*10^5$	$.182*10^5$	-20.4	-.0773
Absolute	$.183*10^5$	$.182*10^5$	237.	1.31

PERFORMANCE STATISTICS 1952-1974

	MEAN	STD DEV	MEAN % CHANGE	MEAN ABSOLUTE % CHANGE	MEAN % ERROR	MEAN ABSOLUTE % ERROR
ACTUAL	$.183*10^5$	$.143*10^4$	.846	2.62		
ESTIMATE	$.182*10^5$	$.137*10^4$	.929	1.56	-.0773	1.31

SQUARED MEAN ERROR 416.119

ROOT SQUARED ERROR OF FORECAST 300.509

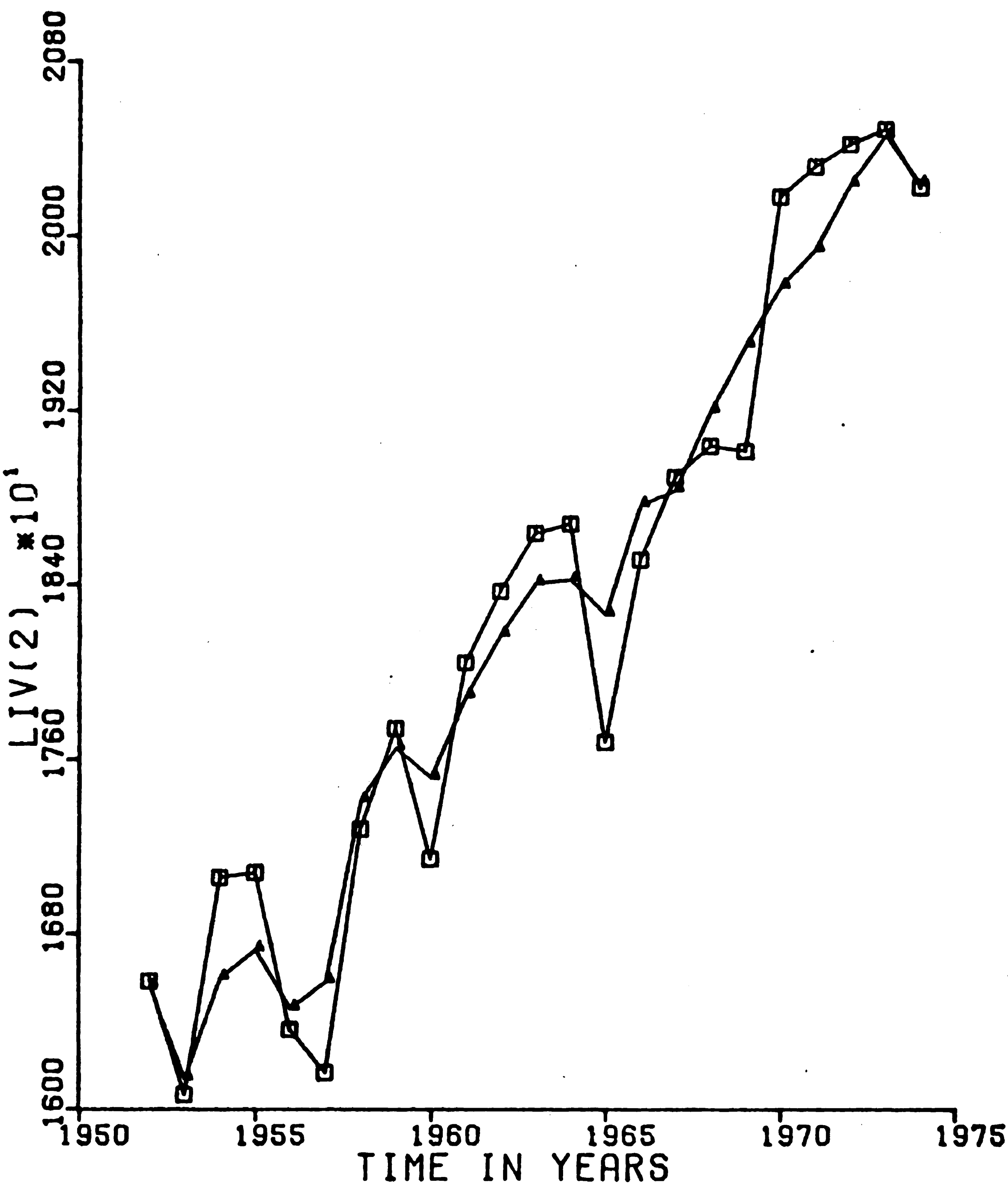

Figure 6.7

Livestock Production

[] Actual
Δ Estimated

Table 6.10. Evaluative Data for Livestock Consumption, LIV(5)

Year	Actual	Estimate	Error	%Error
1952	16001.411	15970.871	-30.5	-.191
1953	16202.073	16261.455	59.4	.367
1954	16588.629	16119.556	-469.	-2.83
1955	16789.126	16427.918	-361.	-2.15
1956	16665.190	16752.591	87.4	.524
1957	16431.980	16839.122	407.	2.48
1958	16633.647	16756.204	123.	.737
1959	17361.776	17263.050	-98.7	-.569
1960	16958.350	17323.753	365.	2.15
1961	17696.995	17530.453	-167.	-.941
1962	17826.975	17619.435	-208.	-1.16
1963	18133.813	17893.898	-240.	-1.32
1964	18456.086	18188.584	-268.	-1.45
1965	18044.941	18619.891	575.	3.19
1966	18452.085	18691.469	239.	1.30
1967	19037.559	18964.720	-72.8	-.383
1968	18918.488	19069.093	151.	.796
1969	18905.473	19381.152	476.	2.52
1970	19733.985	19313.970	-420.	-2.13
1971	19942.987	19550.964	-392.	-1.97
1972	20103.253	19908.955	-194.	-.966
1973	19729.352	19691.520	-37.8	-.192
1974	19986.427	19992.797	6.37	.0319
Mean	$.180*10^5$	$.180*10^5$	-20.4	-.0941
Absolute	$.180*10^5$	$.180*10^5$	237.	1.32

PERFORMANCE STATISTICS 1952-1974

	MEAN	STD DEV	MEAN % CHANGE	MEAN ABSOLUTE % CHANGE	MEAN % ERROR	MEAN ABSOLUTE % ERROR
ACTUAL	$.180*10^5$	$.134*10^4$	1.06	1.86		
ESTIMATE	$.180*10^5$	$.132*10^4$	1.03	1.29	-.0941	1.32

SQUARED MEAN ERROR	416.119
ROOT SQUARED ERROR OF FORECAST	300.560

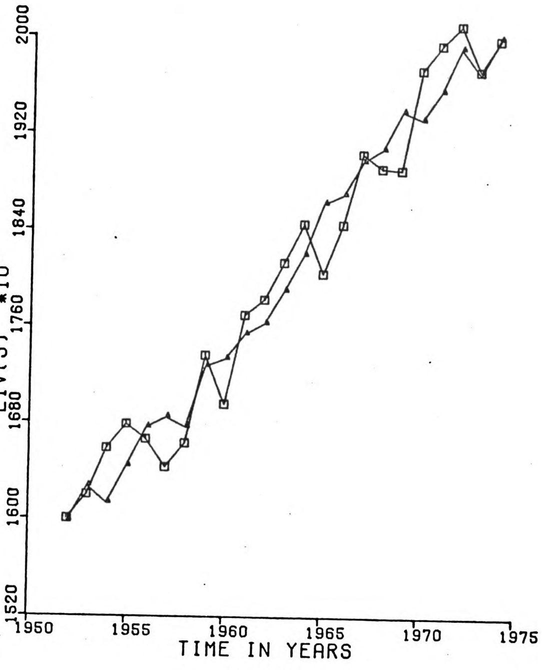

Figure 6.8

Livestock Consumption

[] Actual

Δ Estimated

Table 6.11. Evaluative Data for Real Price of Livestock, RPLIV

Year	Actual	Estimate	Error	%Error
1952	139.	133.	-5.65	-4.07
1953	121.	110.	-10.4	-8.57
1954	112.	118.	6.37	5.71
1955	105.	108.	2.27	2.16
1956	100.	96.0	-4.28	-4.27
1957	105.	97.3	-7.17	-6.86
1958	114.	108.	-5.82	-5.11
1959	106.	89.2	-16.7	-15.7
1960	103.	99.0	-3.89	-3.78
1961	101.	98.2	-2.89	-2.86
1962	102.	107.	4.93	4.85
1963	96.4	102.	6.04	6.26
1964	91.7	103.	11.1	12.1
1965	99.7	94.1	-5.57	-5.59
1966	101.	104.	3.25	3.22
1967	100.	100.	.351	.351
1968	99.8	106.	5.97	5.98
1969	106.	96.0	-10.2	-9.59
1970	101.	110.	9.29	9.18
1971	95.5	110.	14.0	14.7
1972	107.	102.	-4.41	-4.13
1973	135.	130.	-5.00	-3.71
1974	111.	110.	-.433	-.392
Mean	107.	106.	-.813	-.422
Absolute	107.	106.	6.34	6.05

PERFORMANCE STATISTICS 1952-1974

	MEAN	STD DEV	MEAN % CHANGE	MEAN ABSOLUTE % CHANGE	MEAN % ERROR	MEAN ABSOLUTE % ERROR
ACTUAL	107.	11.5	-1.08	7.00		
ESTIMATE	106.	10.5	-.256	9.09	-.442	6.05

SQUARED MEAN ERROR	.661
ROOT SQUARED ERROR OF FORECAST	7.802

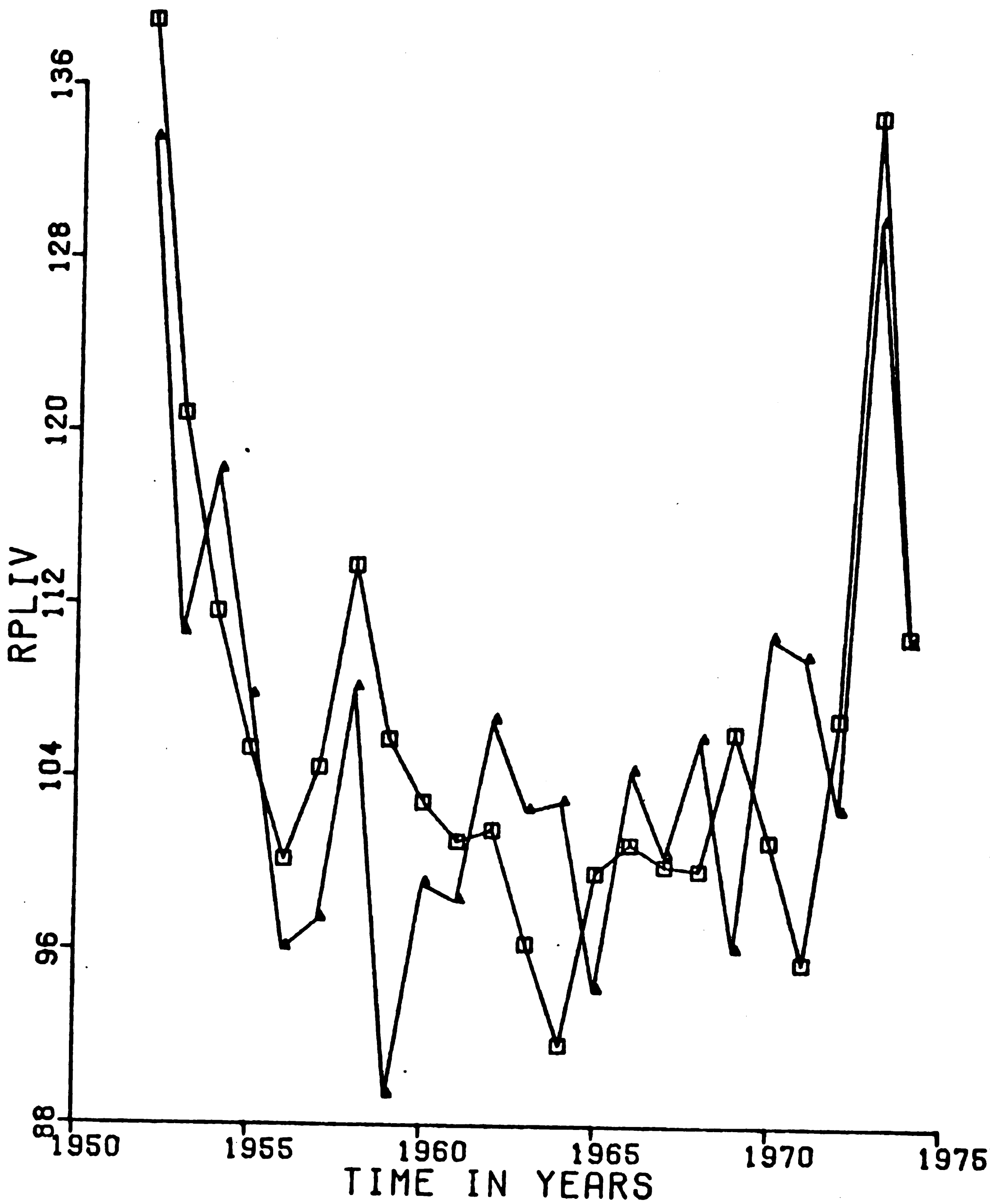

Figure 6.9

Real Price of Livestock

[]Actual
Δ Estimated

utilized. Thus with errors in RPLIV following the pattern of errors in RPCROP, the deviations of RPTOUT from actual would therefore follow the same pattern. These results are shown in Table 6.14 and Figure 6.12.

Demand for Variable Inputs

The demand equations for hired farm labor (LABOR), fertilizer and lime (FERT), and other nondurable inputs (OTHER) are recursive to the equations giving the variables previously discussed. These input demand equations include RPTOUT or RPCROP as explanatory variables. The equations with actual values for RPTOUT or RPCROP have the properties described in Chapter V. Thus, additional deviation in estimated values would depend upon the values of RPTOUT or RPCROP and their importance in the equations.

Real Feed and Seed Prices. The evaluative data for real price of seed and feed are presented in Tables 6.12 and 6.13 and in Figures 6.10 and 6.11, respectively.

The price dependent feed and seed supply equation are not recursive to the equations determining quantities utilized and crop price because of inclusion of current quantities utilized in the supply relationship. However, one can still say that RPCROP is a major determinant of feed and seed price because the coefficients of RPCROP are large in the structural equations. Thus, one would expect the resluts shown in the tables and figures for these variables. While the mean absolute percentage error for real seed price

Table 6.12. Evaluative Data for Real Price of Seed, RPSEED

Year	Actual	Estimate	Error	%Error
1952	140.	137.	-2.29	-1.64
1953	126.	124.	-2.01	-1.59
1954	117.	112.	-4.87	-4.17
1955	123.	115.	-8.40	-6.80
1956	107.	110.	2.66	2.49
1957	107.	108.	.865	.810
1958	103.	104.	1.11	1.08
1959	97.4	91.6	-5.81	-5.96
1960	100.	98.5	-1.88	-1.88
1961	98.2	97.9	-.297	-.302
1962	100.	103.	2.49	2.48
1963	106.	103.	-2.44	-2.31
1964	103.	105.	1.85	1.79
1965	106.	107.	.790	.746
1966	101.	102.	1.00	.993
1967	100.	113.	12.6	12.6
1968	99.8	109.	8.94	8.96
1969	96.5	95.1	-1.47	-1.52
1970	96.3	99.7	3.37	3.50
1971	102.	111.	8.96	8.77
1972	108.	93.9	-13.9	-12.9
1973	125.	124.	-1.45	-1.16
1974	146.	142.	-3.26	-2.24
Mean	109.	109.	-.149	.0758
Absolute	109.	109.	4.03	3.77

PERFORMANCE STATISTICS 1952-1974

	MEAN	STD DEV	MEAN % CHANGE	MEAN ABSOLUTE % CHANGE	MEAN % ERROR	MEAN ABSOLUTE % ERROR
ACTUAL	109.	13.8	.884	5.52		
ESTIMATE	109.	12.9	.677	7.76	.0758	3.77

SQUARED MEAN ERROR .022
ROOT SQUARED ERROR OF FORECAST 5.788

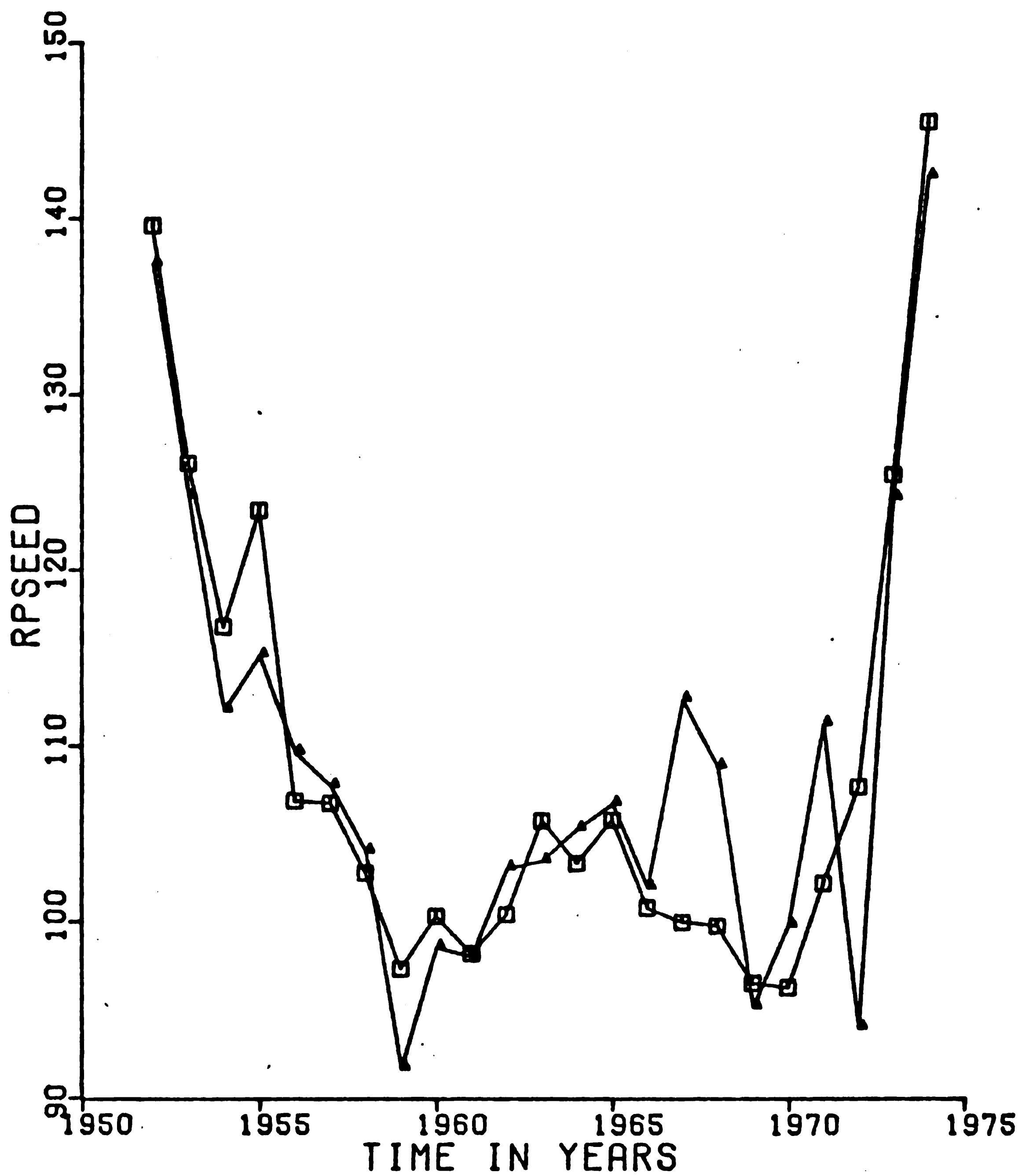

Figure 6.10

Real Price of Seed

[] Actual
Δ Estimated

Table 6.13. Evaluative Data for Real Price of Feed, RPFEED

Year	Actual	Estimate	Error	%Error
1952	148.	151.	2.56	1.73
1953	134.	131.	-2.97	-2.23
1954	132.	118.	-13.7	-10.4
1955	123.	121.	-2.29	-1.85
1956	119.	115.	-4.26	-3.58
1957	112.	111.	-.663	-.595
1958	107.	107.	-.554	-.516
1959	107.	87.0	-19.5	-18.3
1960	103.	96.5	-6.11	-5.95
1961	103.	99.3	-3.39	-3.30
1962	103.	108.	5.68	5.53
1963	106.	108.	2.53	2.39
1964	103.	110.	6.66	6.44
1965	103.	108.	5.81	5.66
1966	104.	99.9	-4.01	-3.86
1967	100.	108.	8.01	8.01
1968	90.2	102.	12.0	13.3
1969	87.4	84.0	-3.41	-3.90
1970	86.8	90.4	3.60	4.14
1971	86.6	104.	17.1	19.7
1972	84.6	81.8	-2.83	-3.35
1973	121.	115.	-6.21	-5.14
1974	131.	127.	-4.10	-3.12
Mean	108.	108.	-.435	.0397
Absolute	108.	108.	6.00	5.79

PERFORMANCE STATISTICS 1952-1974

	MEAN	STD DEV	MEAN % CHANGE	MEAN ABSOLUTE % CHANGE	MEAN % ERROR	MEAN ABSOLUTE % ERROR
ACTUAL	108.	17.0	.0566	5.16		
ESTIMATE	108.	15.7	.0507	9.83	.0397	5.79

SQUARED MEAN ERROR .189

ROOT SQUARED ERROR OF FORECAST 8.096

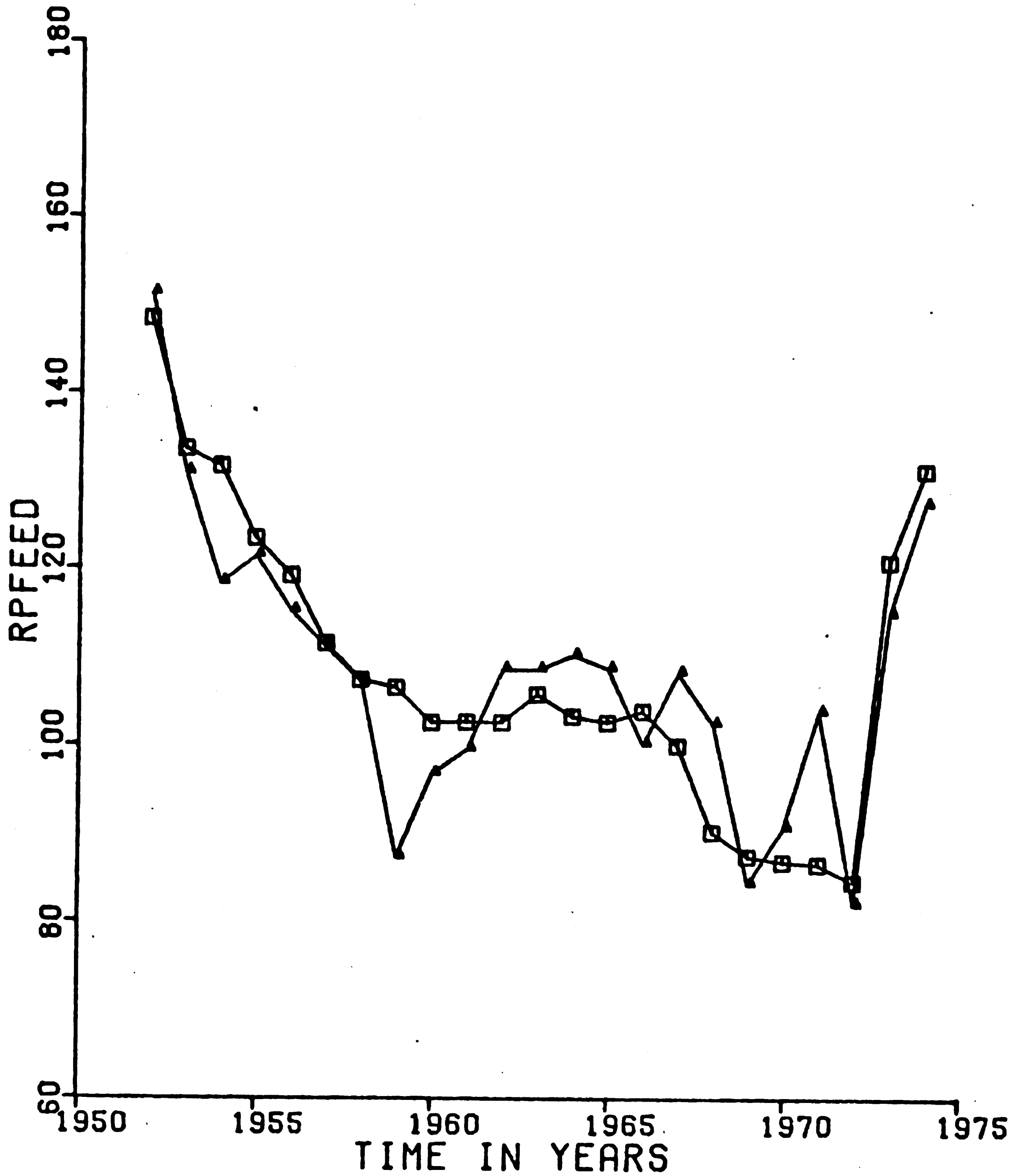

Figure 6.11

Real Price of Feed

[] Actual

Δ Estimated

Table 6.14. Evaluative Data for Real Price of Total Output, RPTOUT

Year	Actual	Estimate	Error	%Error
1952	143.	144.	1.44	1.01
1953	128.	122.	-6.38	-4.99
1954	120.	118.	-2.15	-1.79
1955	117.	116.	-.605	-.518
1956	112.	108.	-3.89	-3.48
1957	112.	108.	-4.03	-3.61
1958	113.	111.	-2.32	-2.06
1959	108.	88.4	-19.7	-18.3
1960	106.	99.4	-6.71	-6.33
1961	106.	101.	-4.62	-4.37
1962	107.	111.	3.75	3.51
1963	105.	108.	3.50	3.34
1964	103.	109.	6.56	6.38
1965	100.	105.	5.18	5.18
1966	104.	104.	.553	.533
1967	101.	108.	7.02	6.93
1968	97.9	107.	8.76	8.95
1969	97.0	89.4	-7.55	-7.79
1970	91.7	99.7	8.01	8.74
1971	91.8	108.	16.3	17.7
1972	95.8	88.5	-7.23	-7.55
1973	123.	123.	.156	.127
1974	128.	124.	-4.67	-3.64
Mean	109.	109.	-.379	-.0853
Absolute	109.	109.	5.70	5.51

PERFORMANCE STATISTICS 1952-1974

	MEAN	STD DEV	MEAN % CHANGE	MEAN ABSOLUTE % CHANGE	MEAN % ERROR	MEAN ABSOLUTE % ERROR
ACTUAL	109.	12.7	-.483	4.24		
ESTIMATE	109.	12.5	.0108	8.22	-.0853	5.51

SQUARED MEAN ERROR	.144
ROOT SQUARED ERROR OF FORECAST	7.617

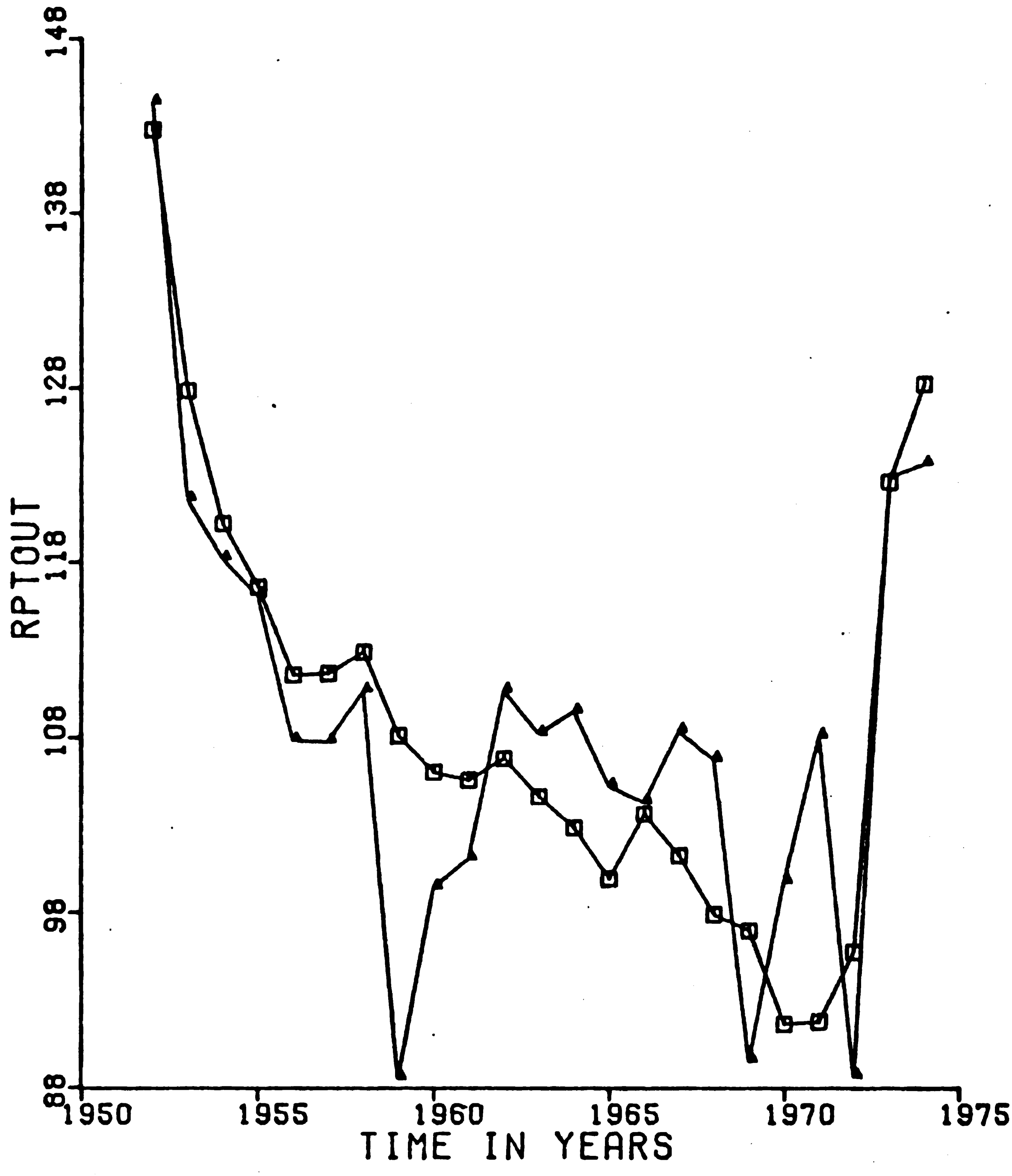

Figure 6.12

Real Price of Total Output

[] Actual

Δ Estimate

and real feed price are not as large as for real price of crops, they are similar. The largest deviations of estimates from actual also occur in the same years as for real price of crops.

Hired Farm Labor. The results of demand for hired farm labor are presented in Table 6.15 and Figure 6.13. The mean percentage error is .0708 percent and indicates little bias. The mean absolute percentage error is 3.23 percent, with the largest errors occurring when there are large errors in RPTOUT.

Fertilizer and Lime. The results for quantity demanded of fertilizer and lime are presented in Table 6.16 and Figure 6.14. The real price of crops is a very important variable in this equation (both current and lagged real crop price is included). Thus, the model does very poorly in years that RPCROP is poorly estimated, as well as in the following year because of the lagged effect.

Other Nondurable Inputs. The results for other nondurable inputs are presented in Table 6.17 and Figure 6.15. The model follows the general trend upward and catches the downturn in 1974. However, there are fairly large errors in the years in which RPTOUT is poorly estimated.

Further Model Evaluation

The previous part of this chapter presented results from using the model to simulate over the sample period used to estimate the equations in the model. This included the years 1951 to 1974. The procedure is sometimes referred to as ex post forecasting. The data

Table 6.15. Evaluative Data for Quantity of Hired Farm Labor, LABOR

Year	Actual	Estimate	Error	%Error
1952	4257.630	4307.340	49.7	1.17
1953	3945.900	3857.620	-88.3	-2.24
1954	3826.670	3883.132	56.5	1.48
1955	3829.510	3812.687	-16.8	-.439
1956	3757.140	3795.854	38.7	1.03
1957	3722.730	3829.537	107.	2.87
1958	3773.530	3841.488	68.0	1.80
1959	3626.390	3335.936	-290.	-8.01
1960	3725.680	3544.470	-181.	-4.86
1961	3776.320	3575.135	-201.	-5.33
1962	3803.850	3749.558	-54.3	-1.43
1963	3822.500	3755.062	-67.4	-1.76
1964	3842.680	3854.052	11.4	.296
1965	3816.280	3836.511	20.2	.530
1966	3618.280	3727.584	109.	3.02
1967	3417.000	3648.533	232.	6.78
1968	3346.300	3515.687	169.	5.06
1969	3225.210	3082.490	-143.	-4.43
1970	3146.880	3183.831	37.0	1.17
1971	3010.450	3305.867	295.	9.81
1972	2995.070	2861.589	-133.	-4.46
1973	3130.970	3221.534	90.6	2.89
1974	3156.740	3051.639	-105.	-3.33
Mean	$.359*10^4$	$.359*10^4$	.149	.0708
Absolute	$.359*10^4$	$.359*10^4$	112.	3.23

PERFORMANCE STATISTICS 1952-1974

	MEAN	STD DEV	MEAN % CHANGE	MEAN ABSOLUTE % CHANGE	MEAN % ERROR	MEAN ABSOLUTE % ERROR
ACTUAL	$.359*10^4$	340.	-1.62	2.72		
ESTIMATE	$.359*10^4$	345.	-1.35	4.65	.0708	3.23

SQUARED MEAN ERROR .022

ROOT SQUARED ERROR OF FORECAST 144.111

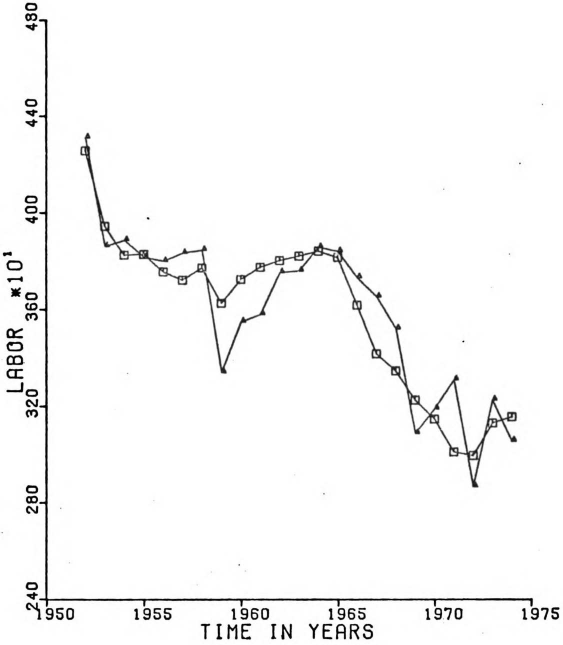

Figure 6.13

Quantity of Hired Labor

[]Actual

ΔEstimated

Table 6.16. Evaluative Data for Quantity of Fertilizer, FERT

Year	Actual	Estimate	Error	%Error
1952	1115.690	1094.195	-21.5	-1.93
1953	1102.970	1356.368	253.	23.0
1954	1124.830	814.772	-310.	-27.6
1955	1123.840	513.734	-610.	-54.3
1956	1127.640	944.244	-183.	-16.3
1957	1120.270	1101.244	-19.0	-1.70
1958	1158.710	1347.019	188.	16.3
1959	1288.180	779.627	-509.	-39.5
1960	1299.790	256.600	-1040.	-80.3
1961	1371.680	788.566	-583.	-42.5
1962	1483.450	1354.238	-129.	-8.71
1963	1655.680	1961.716	306.	18.5
1964	1837.990	2029.438	191.	10.4
1965	1928.410	2221.933	294.	15.2
1966	2189.210	2426.799	238.	10.9
1967	2429.000	2531.636	103.	4.23
1968	2592.740	3259.265	667.	25.7
1969	2655.190	3048.855	394.	14.8
1970	2723.490	2642.363	-81.1	-2.98
1971	2888.440	3331.169	443.	15.3
1972	2865.430	3406.117	541.	18.9
1973	2989.000	3150.011	161.	5.39
1974	3349.930	3080.763	-269.	-8.04
Mean	$.189*10^4$	$.189*10^4$	.831	-4.57
Absolute	$.189*10^4$	$.189*10^4$	328.	20.1

PERFORMANCE STATISTICS 1952-1974

	MEAN	STD DEV	MEAN % CHANGE	MEAN ABSOLUTE % CHANGE	MEAN % ERROR	MEAN ABSOLUTE % ERROR
ACTUAL	$.189*10^4$	761.	5.37	5.60		
ESTIMATE	$.189*10^4$	$.103*10^4$	15.4	35.0	-4.57	20.1

SQUARED MEAN ERROR .690
ROOT SQUARED ERROR OF FORECAST 418.784

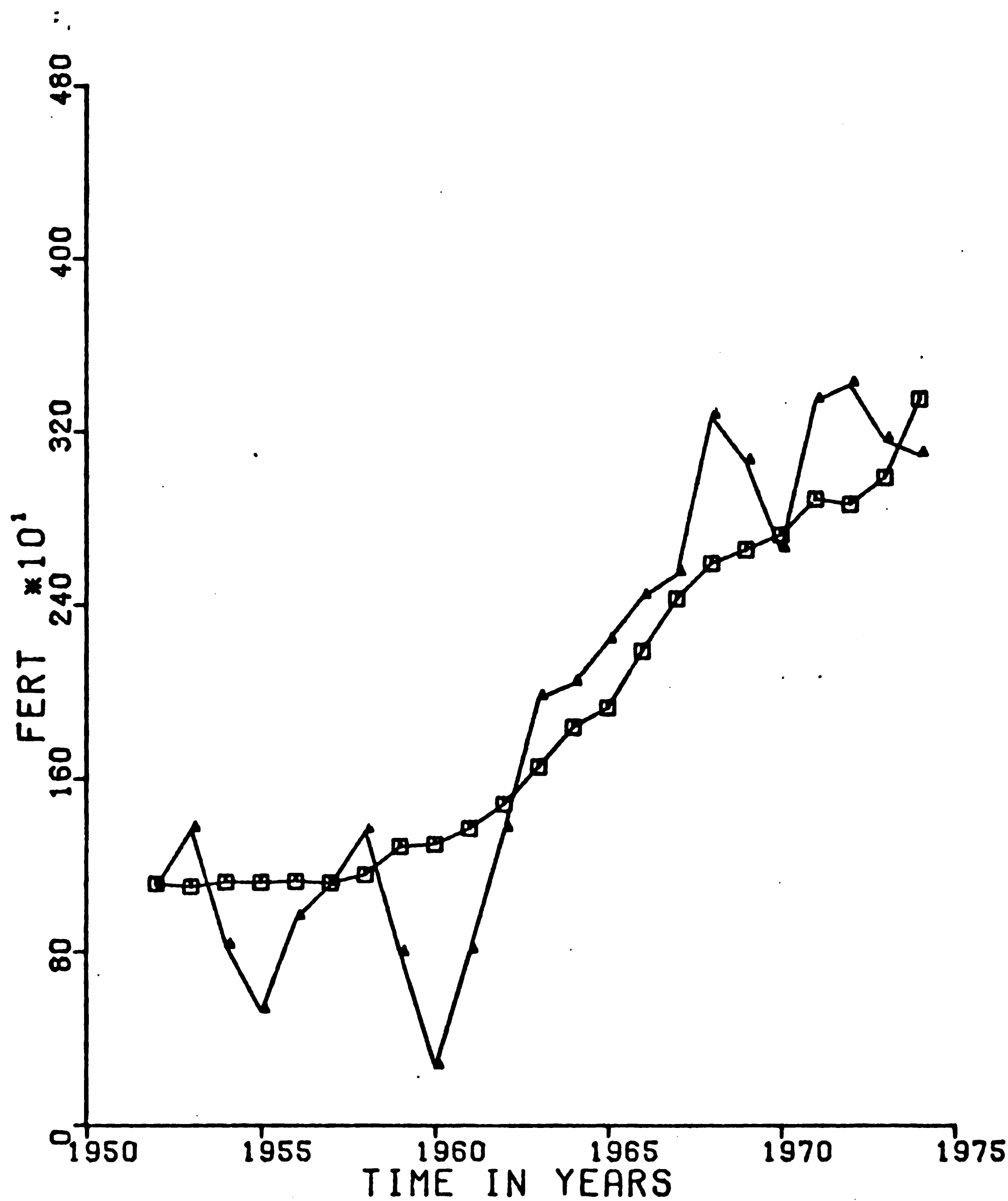

Figure 6.14

Quantity of Fertilizer

[] Actual
Δ Estimated

Table 6.17. Evaluative Data for Quantity of Other Non-Durable Inputs, OTHER

Year	Actual	Estimate	Error	%Error
1952	1810.360	1687.010	-123.	-6.81
1953	1872.840	1558.881	-314.	-16.8
1954	1959.520	2017.727	58.2	2.97
1955	2162.380	2113.837	-48.5	-2.24
1956	2285.790	2216.088	-69.7	-3.05
1957	2344.690	2558.515	214.	9.12
1958	2600.920	2848.856	248.	9.53
1959	3049.560	2472.207	-577.	-18.9
1960	3214.790	2955.160	-260.	-8.08
1961	3285.930	3046.360	-240	-7.29
1962	3458.600	3488.429	29.8	.862
1963	3576.420	3701.223	125.	3.49
1964	3733.760	3897.844	164.	4.39
1965	3885.730	3963.098	77.4	1.99
1966	4032.150	4232.047	200.	4.96
1967	4348.000	4457.332	109.	2.51
1968	4549.970	4657.842	108.	2.37
1969	4596.690	4556.232	-40.5	-.880
1970	4672.960	5023.328	350.	7.50
1971	5032.380	5267.448	235.	4.67
1972	5297.040	4845.101	-452.	-8.53
1973	5573.820	5611.262	37.4	.672
1974	4911.230	4820.149	-91.1	-1.85
Mean	$.358*10^4$	$.357*10^4$	-11.3	-.843
Absolute	$.358*10^4$	$.357*10^4$	181.3	5.63

PERFORMANCE STATISTICS 1952-1974

	MEAN	STD DEV	MEAN % CHANGE	MEAN ABSOLUTE % CHANGE	MEAN % ERROR	MEAN ABSOLUTE % ERROR
ACTUAL	$.358*10^4$	$.117*10^4$	4.52	5.63		
ESTIMATE	$.357*10^4$	$.123*10^4$	5.39	9.49	-.843	5.63

SQUARED MEAN ERROR	127.351
ROOT SQUARED ERROR OF FORECAST	238.011

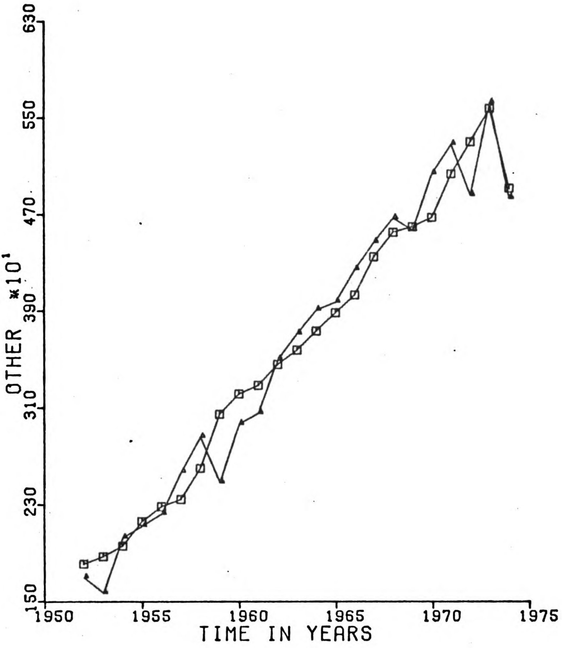

Figure 6.15

Quantity of Other Non-Durable Inputs

[] Actual

Δ Estimated

presented were from a dynamic simulation. Actual values were used for exogenous variables, but forecasted values were used for lagged endogenous variables after the first period. While this information is useful in model evaluation, it is also informative to compare results from the model with actual data for a period of years past those used in estimating the equations (ex ante forecasts). The following sections present results from ex ante forecasts and indicate modifications made to the model as a result of this testing.

Initial Ex Ante Simulation

An ex ante simulation was performed over the years 1975 through 1977 (1976-77 crop year) using known, preliminary, or estimated data for exogenous variables (the type of data depended on availability). For many of the endogenous variables, actual or preliminary data were available for comparison. The commodity supply and utilization aggregate data employed in the model were updated for comparison.

The description of the process of evaluating and altering the model is presented here in the sequence in which it occurred.

Crops Component

The initial ex ante simulation runs overestimated net farm income by a sizeable margin for 1975 and 1976. The errors were traced to overestimation of feed demand in 1975 and to underestimation of crop supply for 1976.

The actual quantity of crops used for feed dropped significantly in 1975 in response to the drop in crop output and resulting feed price increase. However, the model did not simulate a similar large decline. The adjustments during this period included a significant shift in the cattle industry to fewer grain-fed cattle. It was rationalized that the coefficients in the feed demand equation would reflect the impact on feed demand for crops of changing the intensity of grain feeding of livestock in response to price changes but not the larger kind of shift that occurred when a much larger proportion of livestock was marketed with very little or no grain feeding. Based on this reasoning, adjustments were made to the feed demand equation for the 1975 to 1977 period. The adjustments were made to the feed price coefficient (increased elasticity) and to the coefficient of beginning livestock inventory (decreased). The magnitude of the adjustment was based upon that required to forecast reasonably close estimates of the quantity of feed demanded.

Actual crop production made a large jump in 1976 and 1977. After adjusting the feed demand equation and getting close to actual crop prices, the crop supply equation forecasted lower than actual values. Simulation runs were made with the crop supply equation replaced by IF statements giving actual values of crop production for 1976 and 1977. Essentially, crop production was made an exogenous variable for these years. This procedure was maintained, in part, when making the projections presented in a later chapter.

A final adjustment to the crop component was made to the cash receipts "near" identity. As was indicated in Chapter V, the usage of a crop year price causes underestimation of cash receipts when prices are rising and overestimation when prices fall. The falling prices of crops over the 1975-77 period would thus cause error.

The model was programmed to make an adjustment to the price of crops (only in the cash receipts equation) based upon the difference between actual calendar and crop year prices in 1975, 1976, and 1977.

Livestock Component

The inventory of livestock falls sharply from the January 1, 1975 high. In the simulation runs, this fall had a significant depressing effect on livestock price when compared with simulations without the drop in inventory. However, the downward effects simulated for 1975 (after adjusting the crop component) were greater than actually occurred. Additionally, the simulated results gave higher prices in 1976 and 1977 than actually occurred. These results were improved when the decline in livestock inventory was "smoothed" to take place more evenly over the three years.

Other Components

The model underestimates the real estate price for 1975 and the following years. The variables in the equation for real estate price simply do not reflect values required to forecast the rise in real estate price that occurred between early 1975 and early 1976. The decision was made to treat this error as a permanent shift in the equation.

The net flow of loan funds was overestimated for 1975 and underestimated for 1977 by the model after adjustments. No changes were made in this component. However, the underestimation in 1977 is substantial and troublesome. The data used for comparison are from Agricultural Finance Outlook (November, 1977). The results simulated by the model differ from the preliminary data in the category of personal consumption and other cash uses (the category title is from Agricultural Finance Outlook). In the model, two of the major uses of funds in this category (purchase of nondurable goods and services and other uses of cash) are estimated, in part using net farm income. It would appear that purchases of nondurable goods and services of farm operator families and/or other uses of cash (which include investment in off-farm financial assets) did not decline in 1977 as the relationships in the model suggest.

Table 6.18 shows initial ex ante simulation results for a set of the important variables in the model. These are the results before adjustments were made to the model.

Table 6.19 shows ex ante simulation results after the previously described adjustments were made. Complete output from this run of the model is shown in Baker (1978).

Summary

This section has concentrated on results from simulating over the post-estimation period and on the subsequent modifications made to the model. The modifications were few relative to the number of equations in the model. The model gives logical results, and the magnitudes of most variables are within tolerable error. The interested reader may wish to consult published data to compare with the results in Baker (1978).

Table 6.18. Forecasted and Actual Results from Ex Ante Simulation with No Adjustments

	Variable							
	PCROP		PLIV		Net Farm Income		Net Flow of Loan Funds	
Year	Actual	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast
	-1967=100-				-Billion Dollars-			
1975	215.5	263	172	185	28.8	33.2	9.0	11.2
1976	198.3	265	177	172	24.1	35.4	11.0	5.8
1977	196.6	205	175	183	N.A.	18.3	14.5	9.6

N.A. = Not available.

Table 6.19. Forecasted and Actual Results from Ex Ante Simulation with Some Adjustment Made to the Model

	Variable							
	PCROP		PLIV		Net Farm Income		Net Flow of Loan Funds	
Year	Actual	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast
	-1967=100-				-Billion Dollars-			
1975	215.5	224	172	160	28.8	25.2	9.0	11.0
1976	198.3	205	177	170	24.1	25.0	11.0	10.9
1977	196.6	195	175	179	N.A.	23.3	14.5	9.4

N.A. = Not available.

CHAPTER VII

Financial Accounts and Other Performance Variables

Financial Accounts

The output of the model is summarized in several financial statements and related analytical ratios for the aggregate farming sector. Included are the Balance Sheet, Income Statement, and a cash basis Sources and Uses of Funds Statement. In addition to these statements, tables presenting capital gains, capital formation, and other data and analytical ratios are available as output from the model. Further statements such as the Capital Flows and Capital Finance accounts could be constructed from the internal data of the model.

Strengths and weaknesses of these and other farm sector accounts and data have been discussed in the agricultural economics literature on information and data systems (see American Agricultural Economics Association Committee on Economic Statistics, Bonnen, Carlin and Handy, and Weeks and others). In addition, an ERS sponsored workshop on farm sector financial accounts was held in April 1977 with a proceedings publication forthcoming.

Discussions of data and financial accounts usually occur at two levels, often simultaneously. The first discussed here might be called the macro level and is the most critical. It relates to the very nature of what and/or whom the accounts represent.

The accounts are intended to represent the financial position and operations of a sector. The method used to divide a country of individuals and/or institutions into sectors is important both in terms of what goes into the accounts and what uses can be made of the accounts.

Sectoring can be based on a product or establishment concepts. The product concept restricts entries in the financial statements to those relating to a certain type of activity. This concept is implied when using terminology such as "farm production sector." An establishment concept would focus on financial activities of a particular group of individuals or institutions, e.g., farm operator families.

In addition, there is the question of scope of the sector. This may be posed terms of the product concept as the question: where does the product begin and end? Traditionally, the concern has been related to a sector that begins and ends at the farm gate. Recently, interest has expanded to the food and fiber sector which includes a much broader set of activities relating to farm inputs and products.

These questions have significant impact upon the financial accounts, and changes relating to these have implications for data collection, equation estimation, and presentations in financial statements.

The second level, which might be called the micro level, relates to rather specific questions of how data are presented in the financial accounts. These included questions of terminology (different data transformations are often called the same thing, and different financial statements are sometimes labeled with the same name), grossing versus netting of the data, and how to present data, that is, which statement(s) to use.

A good portion of the micro questions is argument over what transformation of the data should be made and what subsets of the data and transformations should be presented in financial statements. Other micro questions do go deeper in that they have implications for data collection, for example, the grossing or netting argument. In the opinion of the author, most of the micro questions are reasonably easy to answer, given answers to the macro questions and the intended use of the financial statements (or problems to be addressed).

The financial statements used to present the output of the model will be discussed in the following paragraphs. Uses, limitations, and relationship to product and establishment concepts will be pointed out. In addition, differences between the statements used here and published USDA accounts will be noted.

The Balance Sheet

The Balance Sheet provides a major data limitation with respect to pursuing greater detail in a model in terms of either the establishment or product concept. The Balance Sheet contains farming assets and liabilities of all farm proprietors (operators and nonoperator landlords) and some of the assets of farm operator households. Lacking is a breakdown of ownership between operators and nonoperators, preventing a breakdown between these two "establishments." Included are some nonfarm assets; thus, there is not strict adherence to the product concept.

The absence of complete data on nonfarm investments of farm operator families is one of the major flaws in the product-establishment mixture adopted for this study (nearly complete coverage of farm operator families plus farm assets and liabilities of non-operator landlords).

A minor limitation is that imposed by not having the standard Balance Sheet breakdown of short, intermediate, and long term assets and liabilities.

The Balance Sheet constructed for use in the model is shown in Table 7.1. The Balance Sheet in Table 7.1 differs from that published by the USDA in The Balance Sheet of the Farming Sector in that real estate is divided into the components of dwellings, service buildings and other structures, and land with improvements. This breakdown is based on the published real estate value and constructed stocks (value measure) of dwellings and service buildings (Baker, 1978). These data are probably particularly weak, especially for dwellings. The breakdown was included in the Balance Sheet because of a basic difference between buildings, which reflects investment in real capital, and land, the quantity of which does not change substantially.

Data from the Balance Sheet can be used in combination with other data to compute capital gains, rate of return on equity, and leverage ratios such as liabilities/total assets.

Table 7.1. Balance Sheet of the U.S. Farm Production Sector, January 1

		- - -Million Dollars- - -
A. Assets		
A1. Real Estate		$
A2. Dwellings	$	
A3. Service Buildings and Other Structures		
A4. Land and Improvements		
A5. Non-Real Estate		$
A6. Livestock	$	
A7. Crops		
A8. Machinery and Motor Vehicles		
A9. Household Equipment and Furnishings		
A10. Financial Assets		$
A11. Deposits and Currency	$	
A12. U.S. Savings Bonds		
A13. Investments in Cooperatives		
A14. Total Assets		$
C. Claims		
C1. Liabilities		$
C2. Real Estate Debt		
C3. Non-Real Estate Debt	$	
C4. CCC Loans		
C5. Proprietor Equity		$
C6. Total Claims		$
RA. Financial Ratios (in Percent)		
RA1. Equity/Total Assets		
RA2. Liabilities/Equity		

Calculation of rate of return on equity, a measure of current earnings divided by equity, requires conceptual consistency between the earnings measure and the equity measure (discussed in greater detail in the following section on the Income Statement).

Analytical ratios such as those mentioned above are useful in monitoring the performance of the sector, subject to accuracy of data and consistency of concepts, in a historical context and are useful in policy analysis in a projections context, subject to accuracy of the model, ability of the model to handle policy scenarios, and the accuracy of projections of exogenous variables.

The Income Statement

The Income Statement is prepared largely as a product concept for it is intended to reflect income derived from farming activities. The USDA does not publish an Income Statement, per se, but publishes income related data (receipts, expenses, capital consumption, and inventory changes) in Farm Income Statistics.

It is the author's understanding that although nonoperator landlord expenses are estimated and published the data series is very weak. The subtraction of nonoperator landlord net expense gives the Income Statistics an establishment flavor (farm operators), but still maintains a product concept (only farm income and expenses are included).

Use of the income calculation as an indicator of the economic well being of farm operators is apparently a popular use of the account by policy makers but is severely limited by the product concept of the account and by aggregation.

The farming sector is increasingly acquiring a bi-modal distribution of farms by size. Thus, income of the aggregate (or average) may not reflect the economic well-being of any significant subset, much less of the whole sector. Aggregation also occurs across different types of farms. In a given year, there can be a great divergence between incomes of various farm types, a factor not reflected in the aggregate figure. In addition, the welfare of farmers is also affected by nonfarm activities such as off-farm income. A final point on the measurement of farmer welfare is that it is the particular nature of the farming sector to have low current or operating income (typically measured by the Income Statement) and relatively large capital gains. Surely, capital gains should be considered when discussing the well-being of farmers.

Still, as an indicator of current income of farm proprietors from farming, the Income Statement is useful. As a monitoring tool, the Income Statement gives outcomes for a sequence of years, and thus one can follow changes. In a projection mode, future income can be estimated and changes in expected future income resulting from various policies can be simulated.

Table 7.2 shows the Income Statement used to present the current income data generated by the model. Inventory changes and depreciation (capital consumption) are calculated in a manner similar to the USDA calculation in Farm Income Statistics. Inventory changes are quantity changes times the average price during the year. Depreciation is calculated using a replacement cost concept. This usage of depreciation causes the author some concern, as it is writing off the "current

Table 7.2. Income Statement for the U.S. Farm Production Sector, Year Ending December 31, 1974

	Million Dollars
R. Cash Receipts	
R1. Crop Marketings	$ 51,271
R2. Livestock and Livestock Product Marketings	41,377
R3. Government Payments	530
R4. Other Farm Income	894
R5. Total Cash Receipts	$ 94,072
E. Cash Expenses	
E1. Hired Labor (Cash Outlay)	$ 5,609
E2. Feed Purchased	14,901
E3. Livestock Purchased	5,131
E4. Fertilizer and Lime	5,822
E5. Seed Purchased	2,028
E6. Repairs and Operation of Capital Items	6,506
E7. Interest on Non-Real Estate Debt	2,729
E8. Interest on Real Estate Debt	3,044
E9. Property Taxes	3,043
E10. Other Operating Expenses	7,473
E11. Total Cash Expenses	$ 56,286
NET1. Net Cash Income	$ 37,786
NCE. Non-Cash Expenses and Adjustments	
NCE1. Perquisites to Hired Labor	$ 412
NCE2. Capital Consumption Allowances	10,624
NCE3. Change in Livestock Inventories	454
NCE4. Change in Crop Inventories	-2,065
NCE5. Total Non-Cash Expenses and Adjustments	$ 12,325
NMI. Non-Money Income	
NMI1. Value of Farm Products Consumed	$ 1,300
NMI2. Rental Value of Farm Dwellings	4,831
NMI3. Total Non-Money Income	$ 6,131
NET2. Net Farm Income	$ 31,592

value" of capital consumed in production (which includes capital gains) against current income. That is, some capital gains are written off against current income. A divergence from USDA data is that there is no estimate of net rent to nonoperator landlords. The decision to exclude net rent to nonoperator landlords was based on the following factors: the historical data series is weak and consists of a complex combination of cash and noncash items; there would be little theoretical basis for specifying structural equations to estimate this item for projections; and the income figure to use in calculating rate of return on equity should include returns from farm operations of farm proprietors whose farming related equity is calculated on the Balance Sheet. This includes nonoperator landlords.

Nominal Capital Gains

Capital gains are an important portion of the year to year wealth changes of farm proprietors. Fairly consistent year to year increases occur in the value of the land. Buildings and machinery and motor vehicles have gains associated with increasing prices but also incur depreciation because of use and obsolescence. Crops and livestock have gains and losses because prices are not stable (or stable upward). The gains calculated will be nominal capital gains in that there will be no adjustments for inflation. This is occasionally misleading for there may be a positive nominal gain but a negative real gain. See Melichar and Sayre (1975) for more on calculations of capital gains in the farming sector. Other studies of capital gains of interest include Hoover, Grove (1960), Boyne, and Bhatia.

One should keep in mind that there are major limitations in using capital gains to make welfare inferences. When summing gains across various assets, the total will not reflect the variance of net gains among individual owners of the assets. For example, the ownership of crops and livestock is obviously concentrated among crop and livestock farmers, respectively. Also, non-operator landlords probably own a proportionately large share of land and a small share of other assets.

Capital gains calculated here are unrealized (thus do not directly provide spendable income) and are before taxes (when realized, the gain would be taxed). One should not add capital gains and net farm income to get total income because of the substantial differences between the two.

Financial assets and liabilities will not enter capital gain calculations. In the following section, the procedure for calculating capital gains will be explained.

Land and Improvements

The gain associated with land is the end-of-year value minus the beginning-of-year value adjusted for intersector exchange of real estate and expenditures for land improvements.

The intersector flow adjustment is to add to the capital gain the value of net decreases in land in the farming sector (this would be negative if the flow were land into the sector). This adjustment is based on very weak information. The land in farms data are not particularly strong data, and there is no information as to the value of land entering or leaving the farming sector. It is assumed that acres leaving the sector have a value equal to the average value per acre.

Non-Land Durable Assets

In general, the capital gain associated with a nonland asset is the end of year value minus beginning of year value minus purchases during the year plus capital consumption plus withdrawals from the sector by discontinuing proprietors. These assets include machinery and motor vehicles, farm operator dwellings, service buildings and other structures, and household equipment and furnishings.

Capital consumption is computed at current prices, similar to the concept used for the Income Statement.

Crop and Livestock

The capital gain associated with crops and livestock is end of year value minus beginning of year value plus the changes in inventory charged on the Income Statement (change in quantity times average price during the year).

Table 7.3 shows the format for presenting implicit nominal capital gains in the model.

Sources and Uses of Funds

The third major financial statement included in the model output is a Sources and Uses of Funds Statement (SAUF) on a cash basis (see Table 7.4). This statement is presented, in part, because of the

Table 7.3. Implicit Nominal Capital Gains on Physical Assets for the U.S. Farming Sector, Year Ending December 31

		- -Million Dollars- -
CG1. Gain on Real Estate		$
CG2. Dwellings	$	
CG3. Buildings and Other Structures		
CG4. Land and Improvements		
CG5. Gain on Other Physical Assets		$
CG6. Livestock	$	
CG7. Crops		
CG8. Machinery and Motor Vehicles		
CG9. Household Equipment and Furnishings		
CG10. Total Nominal Capital Gains		$

view taken of demand for debt capital. The view is that components of the SAUF statement are individual demands for cash and internal supply of cash. Many of these are conceptually a function of the rate of interest (few of the empirically estimated equations include the interest rate). If the rate of interest, the price of debt capital, is exogenous--the agricultural sector is a perfect competitor with other sectors for funds--then the demand for debt is a residual. Debt is determined by calculating uses and subtracting internal sources. If the rate of interest were endogenous to the model, one would need to include a supply equation for debt (quantity supplied as a function of the interest rate and other factors). This equation would be solved along with other equations that back up the items on lines of the SAUF statement to solve for the level of debt, interest rate, and other sources and uses of funds.

Table 7.4. Cash Sources and Uses of Funds for the U.S. Farm Production Sector, Year Ending December 31

			Million Dollars
S. Sources of Cash			
S1.	Cash Receipts from Farm Operations		$
S2.	Off-Farm Income of Farm Operators		
S3.	Net Flow of Loan Funds		
S4.	Net Sale of Real Estate to Non-Farm Sector		
S5.	Total Sources of Cash		$
U. Uses of Cash			
U1.	Cash Farm Operating Expenses		$
U2.	Capital Expenditures		
	Machinery and Motor Vehicles	$	
	Service Buildings and Land Improvements		
	Farm Operator Dwellings		
	Household Equipment and Furnishings		
	Financial Assets		
	Autos and Trucks for Family Use		
U3.	Purchase of Real Estate from Discontinuing Proprietors		$
U4.	Purchase of Nondurable Goods and Services		$
U5.	Personal Tax and Non-Tax Payments		$
U6.	Other Uses of Cash		$
U7.	Total Uses of Cash		$

The definition of cash flows used in this study includes some transactions that, in a strict sense, may not involve cash. For example, all debt flows are considered cash transactions, even though the transaction may not have actually gone through a cash account.

Noncash flows can be included on the SAUF statement as both sources and uses. This type of SAUF statement has been suggested by Penson, Lins, and Irwin. A statement including noncash flows has not been presented here for the following reasons: 1) inclusion of noncash flows detracts from presentation of flows that require financing and the financing of these flows both from internal and external sources and 2) noncash flows, such as appreciation in assets are not controllable by individuals. For example, one cannot disinvest in real estate appreciation per se; one can only sell land, a decision that would incur cash flows.

Capital Formation in the Farming Sector

The statement presented in Table 7.4 includes information required to calculate gross capital formation, but it does not have the information required to calculate net capital formation. The information needed is capital consumption, change in crop and livestock inventories, and intersector flows of capital items.

These data are all available in the model. Thus Table 7.5, Gross and Net Capital Formation in the U.S. Farming Sector, is available as part of the model output. This table presents "sector" accounts for farming businesses and for farm households. In addition, a combined business and household account is presented for continuing farm proprietors.

Table 7.5. Gross and Net Capital Formation in the U.S. Farming Sector for the Year Ending December 31

		- -Million Dollars- -
Farm Business Account		
CF1. Capital Expenditures		$
CF2. Machinery and Motor Vehicles	$	
CF3. Service Buildings, Other Structure and Land Improvements		
CF4. Net Change in Farm Inventories		$
CF5. Livestock	$	
CF6. Crops		
CF7. Farm Business Gross Capital Formation		$
CF8. Capital Consumption		$
CF9. Depreciation of Machinery and Motor Vehicles	$	
CF10. Depreciation of Service Buildings and Other Structures		
CF11. Accidental Damage		
CF12. Net Real Estate Transfers to Other Sectors		$
CF13. Gross Capital Disappearance		$
CF14. Farm Business Net Capital Formation		$
Farm Household Account		
CF15. Gross Capital Formation		$
CF16. Automobile and Truck Purchases	$	
CF17. Purchases of Household Equipment and Furnishings		
CF18. Farm Operator Dwelling Expenditures		
CF19. Net Change in Financial Assets		
CF20. Gross Capital Disappearance		$
CF21. Depreciation of Dwellings	$	
CF22. Accidental Damage, Dwellings		
CF23. Depreciation of Household Equipment and Furnishings		
CF24. Depreciation of Automobiles and Trucks		$
CF25. Household Net Capital Formation		$

Table 7.5 (cont'd)

		- -Million Dollars- -
Business and Household Net Capital Formation of Continuing Proprietors		
CF26. Business and Household Net Capital Formation		$
Plus the Following:		
CF27. Withdrawals by Discontinuing Proprietors		$
CF28. Household Equipment and Furnishings	$	
CF29. Financial Assets		
CF30. Machinery and Motor Vehicles		
CF31. Real Estate		
CF32. Net Capital Formation of Continuing Proprietors		$

Financial accounts for continuing proprietors differ from accounts for the "sector" in the implications of flows associated with proprietors entering and leaving the sector. The most significant difference is in capital formation (and savings) by continuing proprietors versus capital formation (savings) by the sector. As one can see from Table 7.5, capital formation of continuing proprietors is equal to capital formation for the sector plus withdrawals of capital by discontinuing proprietors.

Other Data and Analytical Ratios

The final table presenting financial data from the model is a table providing other data and a set of analytical ratios. Table 7.6 presents the format available for output in the simulation model.

The analytical ratios presented in this table are identical in some instances and, in other instances, similar to the ratios suggested by Melichar (forthcoming) at the ERS sponsored workshop on farm sector financial accounts.

Savings

The issue of savings of the farming sector is one of the more confusing issues in the study of aggregate financial relationships. Penson (1977) and Simunek (1976) present quite different values for savings. Melichar (forthcoming) discusses these differences concluding that the major difference in the accounting used to derive savings is that Simunek attempts to measure savings used to finance farm capital formation, while Penson attempts to measure total savings

Table 7.6. Other Data and Analytical Ratios, U.S. Farming Sector, Year Ending December 31

01.	Net Cash Flow from Operations	$
02.	Total Capital Flow (Gross Capital Formation of Continuing Proprietors)	$
03.	Internally Financed Capital Flow	$
04.	Debt Financed Capital Flow	$
05.	Net Cash Flow Minus Business Capital Consumption	$
<u>Relative Burden of Capital Flows</u>		
RA3.	Capital Flow/Net Cash Flow	%
RA4.	Real Estate Purchases from Discontinuing Proprietors/Net Cash Flow	%
<u>Relative Sources of Financing</u>		
RA5.	Debt Financing/Capital Flow	%
RA6.	Internal Financing/Capital Flow	%
RA7.	Internal Financing/Debt Financing	%
RA8.	Debt Financing/Net Business Capital Formation	%
<u>Prospective Burden of Debt</u>		
RA9.	Debt Financing/Net Cash Flow	%
RA10.	Debt Financing/(Cash Flow Minus Business Capital Consumption)	%
RA11.	Debt Financing/Net Farm Income	%

(a large amount of savings apparently finances nonfarm[1] capital formation). Melichar is critical of Penson's exclusion of Simunek's net transfers of real estate to nonfarm sectors as a source of capital and of the specific treatment by Simunek of the same item.

Melichar suggests that only net sales of assets to nonfarm sectors by continuing proprietors represents a source of funds to be recorded in the capital finance account. In addition, Melichar maintains that purchases of real estate from discontinuing proprietors are not capital formation and are properly excluded from capital flows and finance accounts. These points bring into view and provide a basis for examining the issue of continuing proprietors versus the sector.

Melichar argues for a "sector" concept in deriving gross and net capital formation; however, he supports a "continuing proprietor" concept of capital flows. Net sales of assets, such as, real estate to nonfarm sectors, do represent a source of funds to the sector. The entire portion (not only net sales by continuing proprietors) is a source of funds, and the entire portion is part of the sector's gross capital disappearance. When capital formation of continuing proprietors is calculated, purchases of assets from discontinuing proprietors, or implied gross investment by continuing proprietor, are included in gross capital formation.

Melichar (forthcoming) argues for inclusion of net sales of assets by continuing proprietors as sources of funds in the capital finance account

[1]Nonfarm in the respect that the capital formation is not in the form of farming assets. The capital formation referred to here is under the ownership of farm proprietors.

rather than the total because, he reasons,

> ...in many cases, an intersector transfer involves no transaction whatsoever; that is a person simply ceases (or resumes) farming operations, which automatically moves his assets out of (or into) the farming sector. The effect is identical when a retiring farmer sells his real estate to the nonfarm sector and simultaneously also retires himself (and his cash and other assets and debts) into the nonfarm sector.

The reasoning described by Melichar is not in error; however, the solution, to include only net sales by continuing proprietors, is in error.

A reduction of acreage in the farming sector is a disinvestment in a capital item by the sector and provides a source of capital, regardless of the fact that some of the land may be sold by discontinuing proprietors.[1] Nearly all of the capital flows have differences between the flow financed by the sector and the flow financed by continuing proprietors. To adjust for this difference in only one item is inconsistent. The following gives an example of this for a use of funds in the capital finance account.

If a farmer retires his assets (e.g., bank deposits) into the nonfarm sector, then investment (capital flow to be financed) in bank deposits by the <u>sector</u> is the change in Balance Sheet values. But, investment by continuing proprietors has implicitly been the Balance Sheet change plus the amount withdrawn by the retiring farmer. This does not necessarily imply that the deposits were purchased from the

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[1] I would not argue with Melichar's criticism of the method of estimating this source of funds but can offer no solution to the problem without empirical data.

retiring farmer; it only implies that gross investment by continuing proprietors was greater than for the sector by that amount. Where it is clear that assets are purchased directly from discontinuing proprietors, the use of funds can be described as such (e.g., purchases of real estate from discontinuing proprietors).

The implication of the "sector--continuing proprietor" problem for savings calculations is somewhat subtle. The Simunek and Penson accounts differ in this respect. The Simunek account calculated <u>sector</u> savings used to finance sector farm capital formation, while Penson's account calculates total savings of continuing proprietors. It would seem true that one could calculate savings by continuing proprietors to finance farm capital formation of continuing proprietors. However, total sector savings and total savings of continuing proprietors would be identical.

The concept of savings used in this study begins with computation of gross savings by continuing farm proprietors. Gross savings are defined as personal income of continuing proprietors less personal outlays by continuing proprietors. Personal income is defined as net cash income plus increases in inventories of crops and livestock plus off-farm income. Personal outlays are defined as personal taxes and non-tax payments plus purchase of nondurable goods and services plus repairs and maintenance of farm operator dwellings. Net savings are defined as gross savings less business and household gross capital disappearance.

Gross and net savings data in the output from the model are printed at the bottom of the table giving capital formation.

Values of Exogenous and Endogenous Variables

The financial data presented in the previously discussed tables do not show the values of many of the variables directly. The data are shown indirectly or transformed in that the values were used to calculate data presented in the financial accounts and table. Thus, a table of values for exogenous and endogenous variables is provided as part of the model's output. These data are useful in determining what is really going on in the model. Variable names, as listed in the glossary, are the lables placed on the values in the table.

Summary

This chapter has described the financial statements and other reports generated by the model. This description was necessary for the following: to clarify the nature of the accounts to the reader, to present some of the reasoning behind the decision to present results from the model in the formats chosen, to present some of the recent arguments relating to sector accounting, and to clarify some of the calculation procedures.

CHAPTER VIII

Projections under Alternative Scenarios

Introduction

The chapters to this point have described the purpose of the model, developed a theoretical model of system relationships, estimated parameters for the equations necessary to build a model of the system, evaluated the ability of the model to track historical data, and developed in detail the set of data desired as output from the model for evaluative purposes.

The intent of this chapter is to present results from using the model to project into the future under alternative scenarios. First, the methods of projecting exogenous variables are explained. Secondly, alternative scenarios for some exogenous variables are developed. Projections for one alternative are then presented in detail. Finally, indications of the direction and magnitude of change in some important endogenous variables resulting from simulations under alternative scenarios are presented.

The output from the model is extensive, and only summary tables for selected years are included in this chapter. Baker (1978) includes additional results from a simulation run of the model.

Projection of Exogenous Farm Input Prices

The model is programmed to provide prices of farm inputs from either of two sources. First, the user of the model can provide the values for some or all years to be simulated. The alternative is to use equations relating the input prices in a particular year to the CPI in that year. These equations are given in the following paragraphs.

Price of Motor Supplies

Regressing PMOTSUP against CPI gives an equation with reasonably small errors up to 1974 when the error is very large. It is reasoned that this jump was caused by large increases in energy prices. The equation available in the model was estimated over the 1951 to 1974 data period with a dummy variable for 1974. The value of the dummy variable is added to the constant in the equation for projections. This is assuming a one time permanent shift in the equation and a continuing constant relationship with the CPI. Equation (8.1) presents the estimated equation.

$$(8.1)\quad PMOTSUP = 46.5096 + \underset{(21.46)}{.543268} * CPI + \underset{(14.63)}{34.2496} * DUM$$

PMOTSUP = price of motor supplies

CPI = consumer price index

DUM = a binary variable with value 1 for 1974, 0 otherwise

Price of Buildings

The price index used as the price of service buildings and other structures can be determined in the model by equation (8.2).

The equation includes a shift variable for 1974, the last year of the data used in estimation. This is assumed to be a permanent shift upward in the function and is added to the constant term when used in the model.

(8.2) $$PBLD = 2.79 + \underset{(16.27)}{1.033} * CPI + \underset{(5.97)}{35.28} * DUM, \quad R^2 = .9664$$

PBLD = price of buildings.

CPI = consumer price index.

DUM = a binary variable with value 1 for 1974, 0 otherwise.

Price of Machinery and Motor Vehicles

The price of machinery and motor vehicles was regressed against the consumer price index. The equation seemed to fit well without adjustments. Equation (8.3) presents the equation available in the model for projecting the price of machinery and motor vehicles, given values of CPI.

(8.3) $$PMMV = 33.645 + \underset{(64.35)}{1.3122} * CPI, \quad R^2 = .9947$$

PMMV = price of machinery and motor vehicles.

Price of Dwelling

The price index for dwellings equation did not track as well as the above equations. However, a shift variable is included for 1974 to start the equation at the 1974 level for simulating beyond 1974. The equation available in the model is equation (8.4).

(8.4) $PDWL = 4.955 + 1.01 * CPI + 22.22 * DUM, R^2 = .9527$
$\qquad\qquad\qquad\qquad (14.72) \qquad\qquad (3.50)$

PDWL = price index for dwellings.

DUM = a binary variable, 1 for 1974, 0 otherwise.

Implicit Price Index for Household Equipment and Furnishings

The price index for household equipment and furnishings can be projected using equation (8.5). The equation is estimated from 1965 to 1974 data. This period was chosen because of increasing prices over the period. Earlier periods included year-to-year declines in price and thus would not be estimated well using the CPI.

(8.5) $PHEF = 37.093 + .6382 * CPI, R^2 = .9932$
$\qquad\qquad\qquad\qquad\qquad (34.20)$

PHEF = implicit price of household equipment and furnishings

Price of Fertilizer

The price of fertilizer did not fit well when regressed against the CPI. However, it was felt that a default internal mechanism should be available to make projections. The equation provided in the model, shown here as equation (8.6), will project the price of fertilizer based on the percentage change in CPI. That is, the 1974 price of fertilizer is increased by the percentage increase in the CPI since 1974.

(8.6) $PFERT_t = (CPI_t/CPI_{1974}) * PFERT_{1974}$

$= 1.469*CPI_t$

PFERT = price of fertilizer

Price of Supplies

The price of farm supplies, used as the own price variable for other nondurable inputs, can be projected on the same basis as the price of fertilizer. The equation available in the model is shown here as equation (8.7).

(8.7) $PSUP_t = (CPI_t/CPI_{1974}) * PSUP_{1974}$

$= 1.011*CPI_t$

PSUP = price of farm supplies.

Scenario Development

The projections in this chapter have been made using alternative time paths for some of the exogeneous variables. A set of the exogenous variables is treated in the same manner for all projection. The following sections first present the methods and equations for projecting the latter set. Additionally, projections for exogenous variables projected under alternative time paths are explained.

Base Scenario for Exogenous Variables

The set of exogenous variables which are treated in a similar manner for all scenarios includes: number of farms, harvested acres, government payments, investment credit, U. S. population, prices of all farm inputs, interest rates, livestock imports, livestock exports, and crop imports.

All exogenous variables for which data are readily available are given their actual values for 1975 and 1976. Additional years are projected as described in the following paragraphs.

Number of Farms. The number of farms is projected to decline at the rate of .01 million farms per year. The rate of decline per year in the number of farms has fallen over time to .014 million farms in 1974. However, the number of farms declined by .022 million farms in 1975.

Harvested Acres. Historically, the acres of cropland harvested have been affected a great deal by government programs. This is likely to occur again in the 1978-79 crop year. However, the acres of cropland harvested are projected for these scenarios at the 1975 level of 333 million (a high level).

Government Payments. Government payments to farmers have varied greatly over history. However, it is assumed for the scenarios here that there are no effective government price and income policies. Thus, government payments will be low. The value used is 807 million, the 1975 level for all years.

Investment Credit. Investment credit is projected at a constant rate of 10 percent, the 1975 level.

U. S. Population. Projections of U. S. population are based upon a modification of projections indicated in Volume 1 of

<u>1972 OBERS Projections: Regional Activity in the U.S. Series E Population</u>.

The equations used are:

$$POP = 214 + 2 * (YEAR - 1975), \quad 1975 \le YEAR < 1980$$

$$POP = 224 = 2.2*(YEAR - 1980), \quad 1980 \le YEAR < 1990$$

$$POP = 246 + 1.8*(YEAR - 1990), \quad YEAR \ge 1990$$

<u>Farm Input Prices</u>. The prices of farm inputs are projected for years after 1975 using the equations presented earlier. They are essentially "driven" by the rate of inflation.

<u>Livestock Imports</u>. Livestock imports are projected to grow at 1 percent per year from the 1974 level. The average annual compound rate of growth between 1950 and 1974 is 5.87 percent. However, growth has not been steady since 1963, (see appendix table A.3).

<u>Livestock Exports</u>. Livestock exports have been low and relatively unimportant over the historical data period. Livestock exports are projected at the 1975 level as a constant.

<u>Crop Imports</u>. The level of crop imports has varied within a reasonably small range over the historical data period. Imports of crops are projected as a constant at the 1975 level.

<u>Interest Rates</u>. The two interest rate variables in the model, the interest rate charged by banks (RBK) and the interest rate charged by Federal Land Banks (RFLB), have been projected at 7.8 and 8.8 percent respectively.

Alternative Scenarios for Exogenous Variables

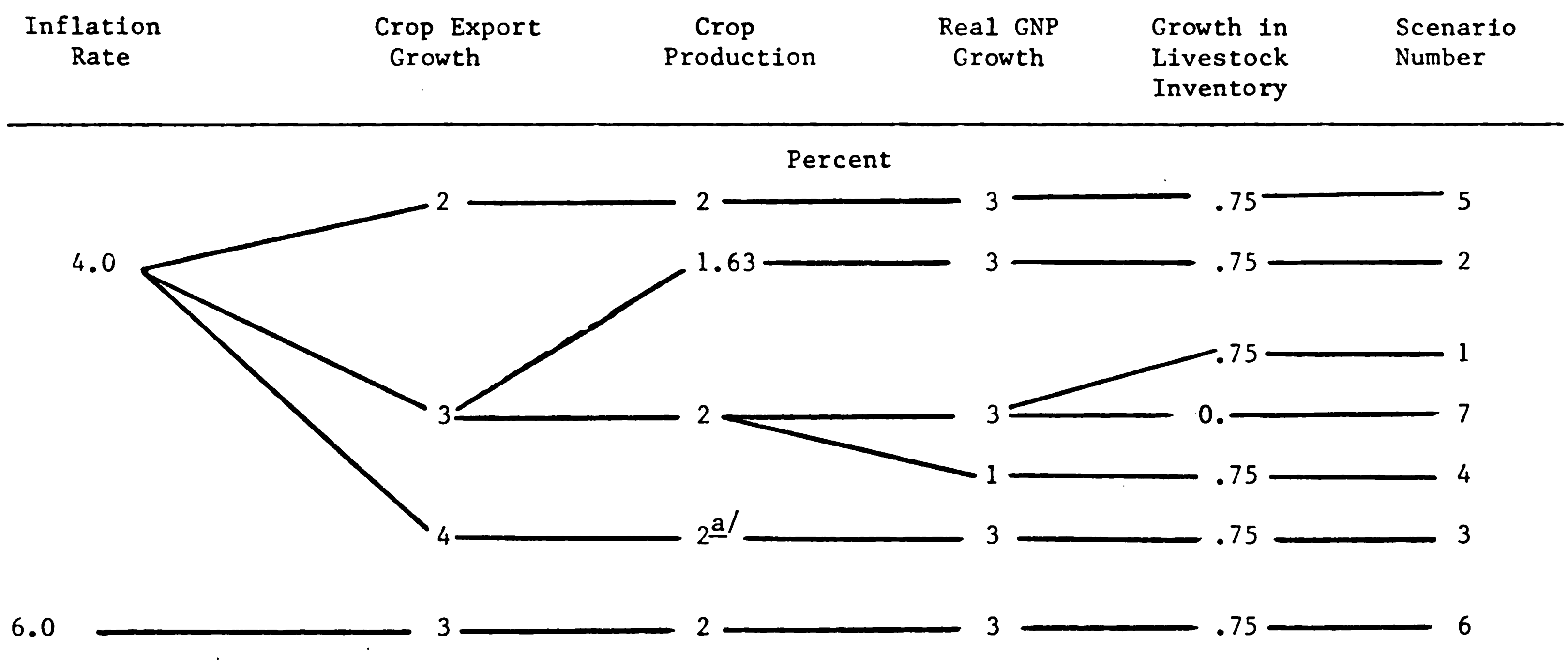
The exogenous variables for which simulations under alternative scenarios have been made are the rate of inflation, crop exports, productivity, real GNP, and livestock inventory growth. The various levels projected reflect, in part, a priori specification and, in part, feedback based on results of projections.

Figure 8.1 shows the levels of exogenous variables and labels each scenario with a number. The scenario numbers will be used later to refer to the set of conditions indicated in the figure.

Inflation rate. The rate of inflation, the annual compound rate of change in the CPI, is projected at two levels, 4.0 and 6.0 percent. While these rates seem low in light of recent rates of inflation, the author feels they are reasonable in a long run context. Over the period from 1955 to 1976, the average annual rate of inflation has been 3.6 percent. Over that period, a rate greater than 6 percent was not reached until 1973. The 4 percent level of inflation will be used as the "most likely" level.

Crop Exports. The level of crop exports is an important exogenous variable. The three levels of growth in crop exports are 2, 3, and 4 percent from the expected level of exports in the 1977-78 crop year (see appendix A, Table A.3 for the starting level).

These levels of exports are within the range of growth that would result from very slow growth in wheat exports, reasonable growth in feed grain exports, and fairly rapid growth in soybean exports.



a/ Two percent growth from a high value in 1977

Figure 8.1 Levels of Exogenous Variables and Scenario Numbers

<u>Crop Production</u>. The original intent of this project was to project alternative crop production growth via different rates of increase in the productivity index, an important variable in the crop supply equation. However, the poor performance of the crop supply equation for 1976 and 1977 has led to treating crop production as an exogenous variable. As will be seen later, the starting level of crop production (1978) has a significant impact upon income in the first few years of the projections. Thus, two starting levels have heen chosen. One level for the 1978-79 crop year is the average of 1976-77 and 1977-78 crop years. Production of crops is projected at two rates of growth from this level. The rate of growth used in the "most likely" scenario is 2 percent. This is the rate of growh over the most recent 25 years. A lower rate of growth (1.63 percent) is also used. The lower rate corresponds to the rate of growth over the period since 1940.

<u>Real Gross National Product</u>. The level of gross national product is projected in real terms. Thus, the growth in nominal gross national product depends upon the rate of inflation, as well as the growth of real GNP. The base rate of growth in real GNP is 3.0 percent, based in part upon the 1972 OBERS Projection. However, an alternative rate of 1 percent was also simulated. The level chosen for the most likely scenario is 3 percent. The historical growth between 1950 and 1975 was 3.25 percent. Recent increases in energy prices and other phenomena have caused negative

growth in 1974 and 1975. However, growth in real GNP was large in 1976.

The level of growth in real GNP is important over the long run, as it has significant influence in the demand for livestock equatin.

Growth in Livestock Inventory. The inventory of livestock has grown at a fairly steady rate (about 1 percent) over the 1950-1974 period. Thus, the rate of 1 percent initially was chosen for use in the model. However, this resulted in greater growth in inventory than production. When projected over a long period, a .75 percent compound rate of increase in inventory yields a more reasonable inventory relative to the level of production. The growth in inventory is an important variable in the model developed here, since it is one of the livestock demand components.

Inventories are often assumed constant in equilibrium models such as the National Interregional Agricultural Projetions (NIRAP) system developed in the Economic Projections and Analytical Systems program area of Economic Research Service. The reasoning is that in equilibrium there would be no change in inventories; thus, if one is interested in long-run projection, inventories can be ignored. Projections from scenario seven will give an indication of the difference in outcomes between the base growth in livestock inventory and zero growth.

Summary of Scenarios

The scenarios projected here should be partially interpreted as sensitivity analysis. Most of the exogenous variables are treated in a similar way for all scenarios, while five variables considered by the author to be very important are projected under alternative growth rates. The scenarios were developed by starting with one growth rate for each of the five variables, then deviations of these growth rates were considered. The initial growth rates were based upon historical growth rates or trends. It is important to project crop production and exports in a consistent manner. Thus a higher level of crop exports is projected at the higher level of production.

Scenarios one, two, and three represent different levels of crop production at 4 percent inflation, 3 percent growth in real GNP, and .75 percent growth in livestock inventory. Crop export growth is 3 percent at the lower two levels of crop production and 4 percent at the higher level. Scenario 1 has the middle level of crop production, scenario 2 has lower crop production, and scenario 3 has higher crop production.

Scenarios 4 through 7 are alterations of scenario 1. Scenario 4 has lower growth in real GNP, scenario 5 has lower growth in crop exports, scenario 6 has higher inflation, and scenario 7 has lower growth in livestock inventory.

Results from Projecting Alternative Scenarios

The model is capable of producing six pages of output for each year. It quickly becomes obvious that each year of every projection cannot be studied in even a cursory manner. Thus one is limited to selecting important variables and a few years to examine in greater detail.

Examination of output from the model can be approached in numerous dimensions. These might include: intensive analysis of a scenario for a particular year in the future; examination of effects of changes in exogenous variables on projections for a particular year; analysis of the projected path of a variable or set of variables under one or more scenarios; or comparison of historical and projected values. It is very difficult to examine the time paths of all of the variables for numerous years and numerous scenarios. However, one should be careful not to focus on a very narrow set of variables, for there is a great deal of interaction in the model within years and over time. Thus, unreasonable values in some components affect other components.

In the following sections, results from alternative scenarios projected to year 2025 are presented. While any projections should be viewed wtih extreme caution, projecting nearly 50 years into the future with a model estimated on half that many years data should probably be described as pure folly. However, the discussion of the projection will concentrate on the 1980's. The results from much longer projections are presented for several reasons.

The very distant projections give some indication of the stability of the model. They show that the model does not exhibit wide cyclical behavior. In addition, the results show that the model does not project prices and quantities outside of an intuitively acceptable range under reasonable scenarios. An exception to this would be the case of projecting a scenario that is reasonable over a portion of the projection but eventually fails because the growth rate in one (or more) variable(s) "swamps" the others. An additional reason for presenting the projections to 2025 is that trends that are somewhat subtle over the period to 1990 became explicit when the projections are extended another 35 years.

The task attempted in this section is to examine the values over time of a significant portion of the variables in the model under a "most likely" scenario. Some attempts will be made to compare these values with historical data, compare with other projections, discuss key equations or assumptions affecting the variables, and discuss the impacts of alternative projections of exogenous variables.

Time Paths of Exogenous Variables

It was useful to the author in selecting growth rates for exogenous variables to see the values implied by the growth rates. These are presented for selected variables in Table 8.1.

Table 8.1. Values of Selected Exogenous Variables, Selected Years, Scenario One

Variable \ Year	1955[a]	1975[a]	1980[b]	1985[b]	1990[b]	2000[b]	2025[b]
			Million Persons				
POP	165	214	224	235	246	264	309
			Index (1967=100)				
CPI	80.2	161.2	204.6	248.9	302.9	448.3	1195.2
			Billion Dollars				
GNP	399.3	1516	2311	3259	4597	9145	51044
RGNP	498	940	1130	1309	1518	2040	4271
			Million Farms				
FARMS	2.654	2.808	2.758	2.708	2.658	2.558	2.308
			Index (1967=100)				
PFERT	101.3	217	301	366	445	659	1756
PSUP	94.5	160	207	252	306	453	1208
PBLD	87.0	206	249	295	351	501	1273
PMMV	69.9	178	235	293	364	555	1535
PLABOR	61.0	192	283	362	458	717	2048
			Million Acres				
LDFRMS	1215	1082	1052	1023	994	938	802

[a] Actual.

[b] Projected.

It is interesting to note the size of the CPI by year 2025 at a 4 percent inflation rate. It is 7.4 times greater than in 1975. At a 6 percent rate of inflation (scenario six) the CPI reaches a value of 2982 by year 2025, about 2.5 times the value at the 4 percent rate of inflation.

It is also interesting to note the effect on nominal GNP of 4 percent inflation and 3 percent real growth. Real GNP increases by 4.5 times between 1975 and 2025, and nominal GNP increases by over 30 times the 1975 value.

Choosing different growth rates for the CPI has very significant impacts on nominal values in the model. However, the impact on real values is not certain a priori. Choosing different rates for variables such as imports, exports, inventories, or real GNP clearly will affect nominal and real values of many variables in the model.

Commodity Supply, Utilization, and Prices

Some of the more important endogenous variables in the model are commodity supply and utilization quantities and commodity prices. These variables have impacts either directly or indirectly on nearly all money flows in the model. This section presents results for real and nominal prices of livestock, crops, and real estate. In addition, projections for the supply and utilization of crops and livestock are presented.

Price of Crops. Projections of nominal and real prices of crops are presented under two scenarios. Results from scenario one are presented in Table 8.2, and results from scenario three are presented in Table 8.3. These scenarios differ largely in regard to the level of crop production beginning in the 1978-79 crop year.[1/] Both Scenarios have a 2 percent growth rate in crop production.

The beginning level for scenario one assumes that 1978-79 production will not grow from the high production levels of the three recent crop years but will be between the 1976-77 and 1977-78 crop year production levels. The interested reader might consult appendix table A.3 to examine the historical data for crop production.

Scenario one shows an increase in nominal price of crops between 1978 and 1979 (175 to 188), while scenario three shows a decline from 175 to 160. Thus, scenario one has a 17.5 percent greater price for 1979. A later section will examine the impact of this on net farm income.

Under scenario one, the real price of crops is projected to increase slowly, but for practical purposes the projection shows a real price nearly equal to the real price in 1967 throughout the 1980's.

[1/] Exports grow at 4 percent for scenario three and 3 percent for scenario one. However this has little effect relative to to production level for the first few years of the projection.

Scenario three projects a decline in real price of crops through 1983 and significant gains in real price between 1985 and 1990. The 4 percent growth in export "catches" up with the growth in production between 1990 and 2000, thus causing significant gains in the real price of crops. A similar phenomon occurs with scenario one. However, it takes longer for this to occur.

Price of Livestock. Projections of real and nominal prices of livestock are presented for scenarios one and three in Tables 8.2 and 8.3 respectively.

Both scenarios projected gains in both nominal and real prices of livestock. This is the reflection of an inelastic supply equation and shifts in the demand for livestock caused by population growth, growth in real income, and growth in livestock inventory. It might be noted that while there is a time trend in the livestock demand equation, the growth in livestock price is not caused by this factor, since the time trend is negative.

Scenario one projects a higher level of livestock prices than does scenario three. This is a result of the relationships between the livestock and crops components of the model. Essentially, the projection of higher crop prices results in a shift to the left in the supply of livestock equation and thus gives a higher price of livestock. It should be noted that the adjustments are actually simultaneous, not recursive as the description might imply.

Table 8.2. Projections of Selected Farm Prices, Scenario One

	Real Estate[a]		Crops		Livestock	
Year	PREAL	RPREAL	PCROP	RPCROP	PLIV	RPLIV
	Index 1967 = 100					
1955[b]	55	68	103	129	84	105
1975[b]	213	132	224	139	172	107
1977[b]	314[c]	156[c]	197	108	175	96
1977	314	156	195	107	179	98
1978	323	155	175	92	196	104
1979	351	163	188	95	217	110
1980	373	168	198	97	226	110
1981	399	173	209	98	242	114
1982	424	178	218	99	256	116
1983	451	183	228	99	272	118
1984	480	188	238	99	288	120
1985	512	193	248	100	306	123
1990	705	223	305	101	413	137
2000	1354	295	446	99	745	166
2025	8719	727	2006	168	3598	301

[a] Price as of February 1 and March 1 of the following year.
[b] Actual data.
[c] Preliminary.

Table 8.3. Projections of Selected Farm Prices, Scenario Three

	Real Estate[b]		Crops		Livestock	
Year	PREAL	RPREAL	PCROP	RPCROP	PLIV	RPLIV
	Index 1967 = 100					
1955[a]	55	68	103	129	84	105
1975[a]	213	132	224	129	172	107
1977[a]	314[c]	156[c]	197	108	175	96
1977	314	156	195	107	179	98
1978	326	156	175	92	196	104
1979	339	157	160	81	209	106
1980	354	158	153	75	216	106
1981	374	162	152	72	230	108
1982	397	166	156	71	243	110
1983	423	171	164	71	260	112
1984	453	176	174	73	276	115
1985	486	183	188	75	294	118
1990	704	222	285	94	410	135
2000	1529	334	665	148	790	176
2025	14760	1232	7046	590	4559	381

[a] Actual data.

[b] Price as of February 1 or March 1 of the following year.

[c] Preliminary.

Price of Real Estate. Projections of the index of average value per acre of farm real estate are presented in Tables 8.2 and 8.3 for scenarios one and three respectively.

The real estate price equation was particularly troublesome for the ex ante simulation. There were substantial increases in the real estate price index over the 1975 through 1977 period that the equation was unable to forecast. These increases were treated as exogenous shifts in the equation.

Under scenario two, the model forecasts a small increase, 2.9 percent, in the nominal price index between 1977 and 1978 (actually between February 1978 and February 1979). This is a result of low income projected for 1978. A larger increase, 9.7 percent, is projected for the next year. The rate of increase between 1980 and 1990 is 6.6 and 2.9 for the nominal and real price indices of average value per acre of farm real estate, respectively. These rates of increase are small in comparison to the recent history. However, the lower growth in real estate prices may be consistent with the rate of inflation assumed for scenarios one and three (4 percent).

Livestock Quantities. The projections for livestock supply and utilization quantities are shown in Table 8.4 for scenario one. The actual data for 1976 are shown as a basis of comparison. Appendix Table A.4 shows data since 1950, if the reader desires greater historical perspective. Livestock production is projected to grow at a .99 percent annual rate between 1980 and 1990, while

Table 8.4. Projections of Supply-Utilization of Livestock, Scenario One

Year	Beginning Inventory LIV(1)	Production LIV(2)	Imports LIV(3)	Exports LIV(4)	Consumption LIV(5)
1976[a]	21250	19390	789	239	19268
1977	21062	19770	805	293	20853
1978	20491	20265	813	293	20975
1979	20301	20701	821	293	21077
1980	20453	20928	829	293	21311
1981	20607	21109	838	293	21499
1982	20761	21325	846	293	21722
1983	20917	21530	854	293	21934
1984	21074	21746	863	293	22157
1985	21232	21961	872	293	22380
1990	22040	23093	916	293	23551
2000	23750	25470	1012	293	26010
2025	28629	33676	1298	293	34466

[a] Actual data, the units are the summation of quantities of commodities in year t weighted by the farm prices of the commodities in a base year (1967).

livestock consumption increases at a nearly identical rate. The effects of growing inventories and growing imports very nearly off-set each other. Per capita consumption of livestock and livestock products is projected to increase slightly (less than 1 percent in total) between 1980 and 1990.

Crop Quantities. The projections, under scenario one, of crop supply and utilization quantities are shown in Table 8.5. As indicated earlier, this scenario assumes a small decline in crop production for the 1978-79 crop year. Figure 8.2 shows historical data for crop production and projections under the three alternatives for which results are present in this chapter.

Crop inventories are projected to decline in 1979 and later years. This is largely caused by increasing real price of crops (the inventory demand equation has a negative coefficient on change in real price of crops). The formulation of the inventory equation has zero long run price elasticity of demand. This formulation of the equation seemed reasonable, since there would be little cause to hold grain per se other than as a "pipe-line" quantity. It is possible that the inventory quantities projected for years 2000 and 2025 are too low relative to the level produced and utilized. However, the projections through 1990 appear to maintain a reasonable relationship between inventory and production.

Feed use of crops is projected to increase at a 1.7 percent compound rate between 1980 and 1990. This is approximately 1.7 times the rate of increase in livestock production. The food

Table 8.5. Projections of Supply-Utilization of Crops, Scenario One

Year	Beginning Inventories CROPS(1)	Production CROPS(2)	Imports CROPS(3)	Exports CROPS(4)	Seed CROPS(5)	Feed CROPS(6)	Food-Industrial CROPS(7)
1976[a]	8320	26557	708	7157	510	10227	8937
1977[b]	9308	26402	1106	6912	457	10468	9063
1978[b]	9916	17367	1106	6935	459	11299	9189
1979	10508	26885	1106	7143	463	11309	9280
1980	10304	27427	1106	7357	467	11445	9377
1981	10187	27971	1106	7578	470	11632	9483
1982	10101	28531	1106	7805	474	11821	9592
1983	10045	29101	1106	8040	477	12026	9704
1984	10006	29683	1106	8281	481	12237	9818
1985	9978	30277	1106	8529	484	12455	9936
1990	9904	33428	1106	9888	497	13601	10560
2000	9912	40749	1106	13288	517	16151	11911
2025	8712	66853	1106	27872	553	22751	16923

[a] Actual data. See Appendix A for description of the data.

[b] Production and exports are "actual" values estimated using prelimary data

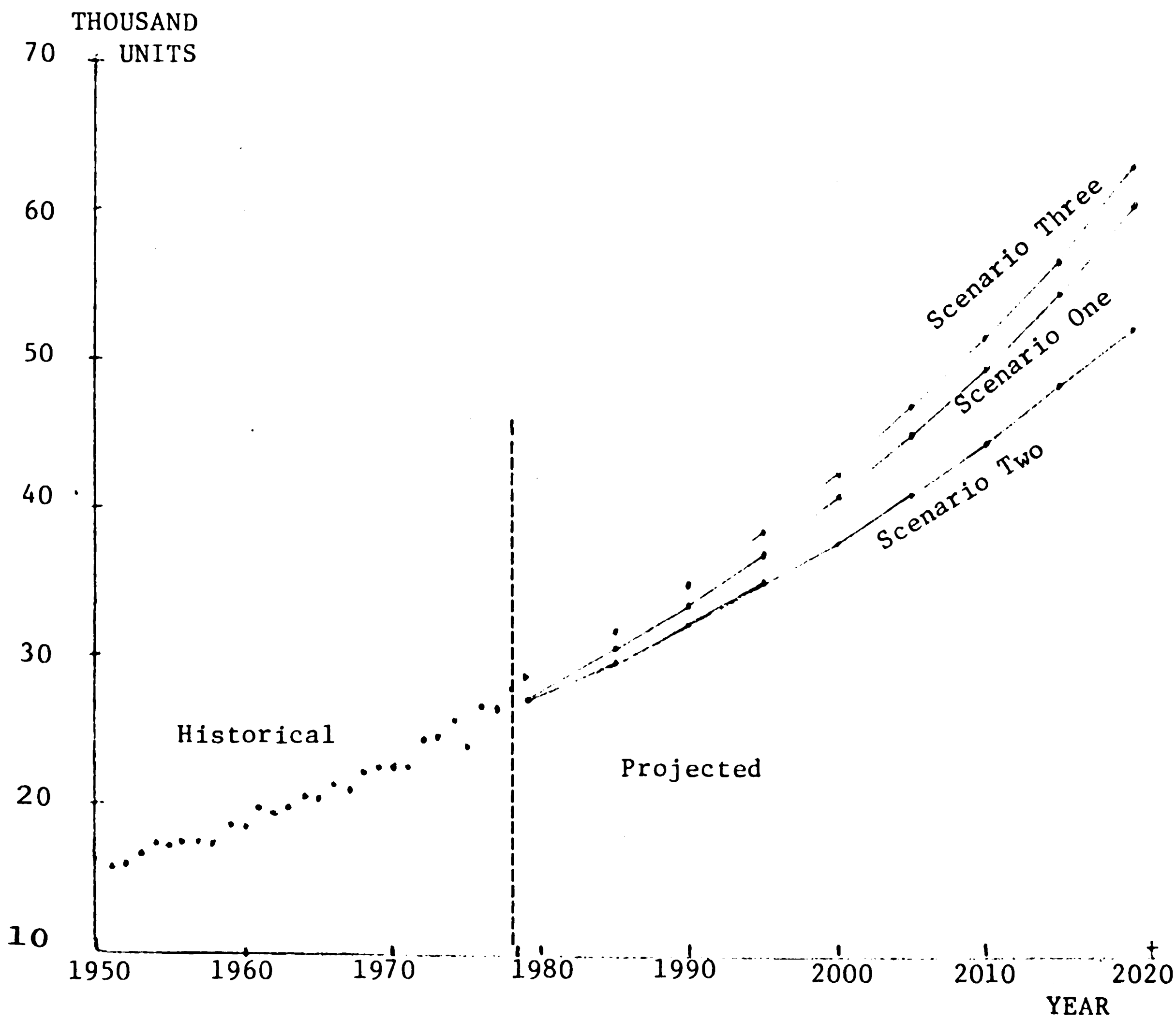


Figure 8.2

Historical Data and Alternative Projections of Crop Production and industrial use of crops is projected to increase at the rate of 1.2 percent per year. The per capita food and industrial use increases at the rate of .25 percent per year.

Projections for Indicators of Farmer Welfare

A major use of the financial accounts for the farming sector is to provide indicators of farmer welfare or well-being. The most popular figure used is total net income from farming (Farm Income Statistics, Table 2H). The net farm income projected in this study as the residual on the Income Statement is similar to the data in Farm Income Statistics, with the exception that net rent to nonoperator landlords is not subtracted out.

A second major source of wealth increase in the farming sector is capital gains. Very large capital gains are a relatively recent phenomenon. While it is true that there have been relatively few declines in real estate value since the early 1930's, the nominal capital gains on physical assets in the 1970's have dwarfed all previous gains.

Table 8.6 presents historical data for nominal and deflated net farm income (as defined in this study) and capital gains (close to the definition used in this study). The data on nominal capital gains are from Melichar and Sayre.

The reader can see from Table 8.5 that nominal capital gains have been relatively large in the 1970's. Nominal capital gains in the first seven years of the 1970's have been more than 1.5 times the sum of nominal capital gains in the previous 30 years since

Table 8.6. Historical Data for Capital Gains and Net Farm Income

		Capital Gains[a]		Net Farm Income	
Year	CPI	Nominal	Deflated[b]	Nominal	Real[b]
	Index 1967=100			Billion Dollars	
1950	72.1	16.4	22.7	14.8	20.5
1955	80.2	3.2	4.0	12.4	15.5
1960	88.7	1.2	1.4	12.6	14.2
1961	89.6	7.7	8.6	13.3	14.8
1962	90.6	7.1	7.8	13.6	15.0
1963	91.7	6.7	7.3	13.4	14.6
1964	92.9	8.8	9.5	12.2	13.1
1965	94.5	14.2	15.2	14.8	15.7
1966	97.2	12.2	12.6	16.0	16.5
1967	100.	10.0	10.0	14.2	14.2
1968	104.2	11.7	11.2	14.3	14.9
1969	109.8	10.0	9.1	16.4	14.9
1970	116.3	9.4	8.1	16.3	14.0
1971	121.3	21.1	17.4	16.8	13.8
1972	125.3	40.4	32.2	22.2	17.7
1973	133.1	79.8	60.0	39.0	29.3
1974	147.7	41.0	27.8	31.2	21.2
1975	161.2	60.9	37.8	28.9	17.9
1976	170.5	78.4	46.0	24.1	14.1

[a] Gain on physical assets.

[b] The nominal value deflated by the CPI (1967=100).

Table 8.7. Projections of New Farm Income, Alternative Scenarios

	Scenario One		Scenario Two		Scenario Three	
Year	Nominal	Real	Nominal	Real	Nominal	Real
	- - - - - - - - - - -Billion Dollars- - - - - - - - -					
1976[a]	24.1	14.1	24.1	14.1	24.1	14.1
1976	25.0	14.7	25.0	14.7	25.0	14.7
1977	23.3	12.8	23.3	12.8	23.3	12.8
1978	21.6	11.4	21.6	11.4	23.4	12.4
1979	27.9	14.2	27.7	14.1	22.8	11.6
1980	31.0	15.1	31.3	15.3	22.0	10.7
1981	35.4	16.6	36.7	17.2	23.6	11.1
1982	39.1	17.7	42.0	19.0	26.0	11.8
1983	43.0	18.7	47.8	20.8	29.4	12.8
1984	47.2	19.7	54.4	22.8	33.9	14.2
1985	52.0	20.9	61.8	24.8	39.5	15.9
1990	80.5	26.6	107.9	35.6	79.9	26.4
2000	172.3	38.5	273.0	60.9	256.9	57.3
2025	1534.0	128.4	2936.7	245.7	4375.8	366.2

[a]Actual data.

the Balance Sheet of the Farming Sector was begun. The nominal capital gains in 1973 alone were 90 percent of the gains over the ten years 1960 through 1969.

The reader may wish to refer to Table 8.6 to provide a basis for comparing projections. The deflated data are provided to facilitate comparisons over the fairly wide historical and projected periods.

Net Farm Income. Projections of real and nominal net farm income are presented in Table 8.7. Results from three scenarios are shown. Scenario one is the base scenario. Scenario two has a lower growth rate in crop production. Scenario three has the same growth rate in production as the base scenario (but from a higher 1979 level) and a higher growth in exports.

The critical nature of the assumption concerning the level of crop produciton in the 1978-79 crop year can be seen in Table 8.7. Scenario three projects net farm income in 1980 to be $22 billion. Scenario one projects 1980 net farm income at $31 billion, that is, 40 percent higher.

Scenario one projects nominal net farm income to match the historical high (1973) by 1983. However, real (deflated) net farm income under scenario one does not reach the 1973 level in the 1980's. While real net farm income is not projected at the high level of 1973, the projections for the 1980's compare favorably with the 1960's (compare results in Table 8.7 and historical data in Table 8.6).

Table 8.8 Projections of Capital Gains, Alternative Scenarios

	Scenario One		Scénario Two		Scenario Three	
Year	Nominal	Deflated	Nominal	Deflated	Nominal	Deflated
	- - - - - - - - - - Billion Dollars - - - - - - - - - - -					
1976[a]	78.4	46.0	78.4	46.0	78.4	46.0
1976	63.2	37.1	63.2	37.1	63.2	37.1
1977	51.3	28.2	51.3	28.2	51.3	28.2
1978	19.3	10.2	19.3	10.2	24.4	12.9
1979	51.1	25.9	50.6	25.7	24.7	12.5
1980	38.9	19.0	41.3	20.1	27.1	13.2
1981	45.4	21.3	49.4	23.2	36.5	17.1
1982	44.8	20.3	50.5	22.9	40.8	18.5
1983	47.7	20.7	54.7	23.8	46.2	20.1
1984	50.5	21.1	58.8	24.6	51.7	21.6
1985	54.1	21.7	63.6	25.5	57.1	22.9
1990	72.8	24.0	85.6	28.3	84.0	27.7
2000	134.8	30.1	171.3	38.2	175.3	39.1
2025	843.7	70.6	1232.7	103.2	1938.9	162.3

[a]Actual data.

The projection of crop production at the longer term growth rate (scenario two) results in a 34 percent higher net farm income by 1990. The relatively small difference in crop production growth, 1.63 percent versus 2.0 percent, points out the critical nature of the crop production assumption on net farm income projections.

Capital Gains. Projections of nominal and deflated capital gains on physical assets are presented in Table 8.8. Results from scenarios one, two, and three are shown.

One of the major variables affecting the level of capital gains is the real estate price. Projection of PREAL for scenarios one and three have been presented and discussed in an earlier section.

Scenario one indicates a significant decline in the level of nominal capital gains for 1978. This may be unreasonably low, since the real estate price may be underestimated. The projections from scenario one show a jump in capital gains in 1979, a reflection of higher crop and livestock price projections. The level of nominal capital gains projected for the 1980's are not quite as high as for 1973, 1975, and 1976. However, the values projected are much nearer the high years than the level of the 1960's. The deflated capital gains projected for the 1980's are approximately one half of the 1971 to 1976 average but are over twice the level of the 1960's.

A later section presents projections of capital gains under a higher rate of inflation.

The capital gains projected under the high crop production, low income, scenario three show significantly lower capital gains for 1979 through the early 1980's. This is a reflection of the lower rate of increase in the price of real estate. However, in the later 1980's, scenario three has capital gains that exceed scenario one. This is partially a result of improved crop prices. Scenario three has higher crop export growth, in addition to higher crop production, which also contributes to capital gains.

Scenario two (lower crop production) projects higher capital gains in the 1980's than does scenario one. However, the relative difference in nominal capital gain projections of the two scenarios (18 percent greater in 1990) is much less than the relative difference in net farm income (34 percent).

Consumption and Other Uses of Cash. Projections for consumption of nondurable goods and services by farm operator households, gross capital formation of farm operator households, and other uses of cash under scenario one are presented in Table 8.9. The data for other uses of cash are presented here for two reasons. First, a major component of this use of funds is hypothesized to be investment in off-farm financial assets. Secondly, the calculation of other uses of cash historically is based on an assumed (estimate based on one observation) consumption relationship. Thus, the two data series should not be viewed independently. Historical data for 1971-76 are presented in Table 8.9 to provide perspective for the projections.

Table 8.9. Historical Data and Projections of Farm Operator Household Expenditures and Other Uses of Funds, Scenario One

Year	Consumption of non-durable Goods & Services		Other Uses of Cash		Gross Farm Household Capital Formation	
	Nominal	Real	Nominal	Real	Nominal	Real
	- - - - - - - - - - Billion Dollars - - - - - - - - - -					
1971[a]	14.4	11.9	8.2	6.8	5.0	4.1
1972[a]	15.7	12.5	12.1	9.7	6.1	4.9
1973[a]	20.0	15.0	23.1	17.4	5.6	4.2
1974[a]	23.1	15.6	19.0	12.9	5.6	3.8
1975[a]	25.3	15.7	12.3	7.6	6.5	4.0
1976[a]	24.1	14.1	15.9	9.3	6.1	3.6
1976	23.5	13.8	16.2	9.5	6.2	3.6
1977	23.4	12.9	15.7	8.6	6.4	3.5
1978	24.0	12.7	15.2	8.0	7.0	3.7
1979	25.5	12.9	19.2	9.7	7.3	3.7
1980	27.6	13.5	21.4	10.4	7.6	3.7
1981	30.6	14.4	24.4	11.5	8.0	3.8
1982	33.3	15.1	27.0	12.2	8.4	3.8
1983	36.1	15.7	29.7	12.9	8.7	3.8
1984	39.1	16.4	32.7	13.7	9.0	3.8
1985	42.2	16.9	36.0	14.5	9.3	3.7
1990	61.2	20.2	55.7	18.4	11.5	3.8
2000	119.5	26.7	117.9	26.3	16.3	3.6
2025	774.2	64.8	953.3	79.8	40.0	3.3

[a]Historical data calculated using assumptions consistent with those used in the model.

The projections show both nominal and real consumption growing in the 1980's. However, the model forecasts declines in real comsumption in 1976, 1977, and 1978. This decline is a reflection of declining net farm income over the period and the assumption of consumption as a constant percentage of nominal disposable farm income. It is probably unrealistic to project declining real levels of consumption over this period. This statement is based partially on the knowledge that the model underestimates the sum of consumption and other uses of cash for 1977.[1/] The resulting error in projecting the net flow of loan funds has been discussed in Chapter VI and is discussed further in this chapter.

Gross farm household capital formation is the sum of expenditure for household automobiles and trucks, household equipment and furnishings, farm operator dwellings, and net change in financial assets. The nominal expenditure for these items is projected to grow at approximately the rate of inflation in the 1980's since the projected deflated expenditure remains about 3.9 billion dollars over this period.

Farm Input Projections

Projections of selected farm inputs under scenario one are shown in Table 8.10. The nondurable inputs included are: hired labor (LABOR), fertilizer and lime (FERT), and other nondurable inputs

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[1/] Calculated based on preliminary data in Agricultural Finance Outlook.

Table 8.10. Projections for Selected Farm Inputs, Selected Years, Scenario One[a]

Year / Variable	1955[b]	1974[b]	1980[c]	1985[c]	1990[c]	2000[c]	2025[c]
LABOR	3,830	3,157	2,010	1,803	1,603	1,500	1,500
FERT	1,124	3,350	2,800	2,800	2,800	2,800	4,814
OTHER	2,162	4,911	4,432	4,728	4,908	5,004	5,203
EXPMMV	4,508	4,822	4,497	4,728	4,981	5,265	8,318
EXPBLD	980	1,701	1,573	1,649	1,743	1,822	2,281
SM4	51,836	58,229	60,169	61,059	62,379	67,140	95,621
DM4	2,276	4,147	4,509	4,323	4,565	4,781	6,211
SB4	10,620	5,940	8,860	9,991	10,679	12,780	19,069
DB4	538	453	1,291	1,469	1,624	1,602	1,914

[a] The units are million dollars deflated by the respective input prices.

[b] Actual data.

[c] Projected.

(OTHER). The quantities of gross investment in machinery and motor vehicles (EXPMMV) and buildings, other structure and land improvement (EXPBLD) are shown, as well as the stocks (quantity measure) and estimated scrappage of the same items. More complete historical data for the durables are shown in Baker (1978).

Hired Farm Labor. The quantity of hired farm labor is projected to decline throughout the 1980's. This is a reflection of the demand for labor equation being fairly responsive to increasing real wages (the scenario projected with respect to wages paid to hired farm workers) and the increasing stock of machinery and motor vehicles, a substitute for hired labor. The computer program places a lower bound on the level of hired farm labor (at about one half of the 1975 level), which is reached by year 2000. The author felt it was unreasonable to allow the value to go lower than this level.

Fertilizer and Lime. The demand for fertilizer equation used in the model indicates that fertilizer demand is responsive to the real price of crops. The drop in real crop prices that occurred after 1973 resluted in the equation forecasting very low fertilizer demand. The decision was made by the author to put a lower bound on fertilizer quantity at a quantity near the level used in 1970 and 1971, which was significantly greater than the level used in the 1960's but less than the high levels of use following the high crop prices of recent years. With the projection under scenario one showing a nearly constant real price of crops (near 100) during the 1980's, the fertilizer quantity is projected at the lower bound over this period.

Other Nondurable Inputs. The quantity of other nondurable inputs is projected to grow throughout the 1980's. However, the growth begins from a level that is low relative to the quantities utilized in the early 1970's. This is a result of lower crop prices after 1974.

Gross Investment in Machinery and Motor Vehicles. The quantity of machinery and motor vehicles purchased is projected to increase throughout the 1980's. The data since 1951 exhibit no distinct trend in the quantity purchased (measured as the expenditure deflated by the price index for machinery, PMMV). While the quantity purchased projection for 1980 is less than the quantity for 1974 (see Table 8.10), the level of the stock of machinery is higher in 1980, indicating that investment over the period preceding 1980 was higher than over the period preceding 1974.

Gross Investment in Service Buildings, Other Structure, and Improvements to Land. Data for 1974 and later years for this category have recently received a large, 22 percent revision upward. To the best of the author's knowledge, this revision has not been explained in a published source. Given the historical lack of reliability of the data, the decision was made to treat this change as a shift in the entire equation.

Table 8.11. Projections of the Net Flow of Loan Funds, Alternative Scenarios

	Scenario One		Scenario Two		Scenario Three	
Year	Nominal	Deflated	Nominal	Deflated	Nominal	Deflated
	- - - - - - - - - - -	- Billion	Dollars -	- - - - - - -	- - -	
1976[a]	11.0	6.5	11.0	6.5	11.0	6.5
1977[a]	14.5	8.0	14.5	8.0	14.5	8.0
1977	9.4	5.2	9.4	5.2	9.4	5.2
1978	10.1	5.3	10.1	5.3	10.1	5.3
1979	9.5	4.8	9.6	4.9	10.5	5.3
1980	10.5	5.1	10.4	5.1	10.7	5.2
1981	12.3	5.8	12.1	5.7	11.1	5.2
1982	13.8	6.2	13.8	6.2	11.9	5.4
1983	14.9	6.5	15.1	6.6	12.5	5.4
1984	16.0	6.7	16.4	6.9	13.5	5.6
1985	17.3	6.9	18.1	7.3	14.8	5.9
1990	25.9	8.5	29.3	9.7	25.1	8.3
2000	50.5	11.3	63.7	14.2	60.8	13.6
2025	364.1	30.5	539.1	45.1	663.7	55.5

[a] Actual Data.

In a manner similar to that of the other inputs discussed above, EXPBLD is projected to increase slowly throughout the 1980's from a level in 1980 that is less than recent high levels.

Projections of Financial Variables

This section presents projections for a set of variables that might be referred to as financial variables. Most of the variables are not quantities or prices resulting directly from the economic structural relationships but are transformations of the underlying economic variables.

Net Flow of Loan Funds. Table 8.11 presents projections of the net flow of loan funds (nominal and deflated) under scenarios one, two, and three. Actual data for 1976 and 1977 are presented for comparison.

There is a substantial error in the forecast by the model for 1977. As discussed earlier, the underestimation can be traced to error in projecting the sum of consumption of nondurable goods and services and other uses of cash. No adjustment has been made to the model for this error. Logical alternatives for making adjustments must be traced to assumptions about the economic structure. One line of reasoning would be that the level of consumption attained in 1973, because of high net farm income, will be maintained in spite of falling income. This reasoning is unsatisfactory because the model forecasts the level of net flow of loan funds reasonably well for 1976. However, the reader will recall from Chapter V that consumption is a percentage of a three year moving average of disposable farm income, including the current year. Thus, 1976 would have only one low income year (1976) averaged in with two higher years (1974 and 1975). The projections of real consumption show that the 1974 and 1975 level is not reached again until 1983. If the hypothesis that farm operators are reluctant to adjust consumption downward is correct, then the net flow of loan funds is probably underestimated over this period.

A somewhat different view would be that there has been a permanent shift in farm operators' demand for nondurable consumer goods, as opposed to a "sticky downward" view.

The author is reluctant to accept either of the above alternatives. The level of net flow of loan funds indicated by the preliminary 1977 data is very large relative to other years. Table 8.12 below shows historical data for net flow of loan funds, excluding CCC loans.

The net flow of loan funds projected by the model, although small in comparison with the 1977 level, is large when viewed over a longer historical period. Thus, the author has chosen not to make an adjustment to the model based upon the 1977 data. This is making the assumption (implicitly) that the demand for loan funds will be reduced in 1978 from the actual 1977 level but will be up from 1977 predicted value.

Table 8.12. Historical Data for Net Flow of Loan Funds (Billion Dollars)

Year	Amount	Year	Amount	Year	Amount
1950	1.5	1960	1.2	1970	2.3
1951	1.8	1961	1.8	1971	4.2
1952	.9	1962	2.7	1972	6.7
1953	- .4	1963	3.1	1973	9.8
1954	.9	1964	2.8	1974	8.1
1955	1.5	1965	4.0	1975	9.0
1956	.9	1966	3.6	1976	11.0
1957	1.4	1967	3.1	1977	14.5
1958	2.0	1968	1.8		
1959	2.4	1969	2.6		

The net flow of loan funds is projected (under scenario one) to increase at the rate of 9.4 percent per year between 1980 and 1990.

Scenario three (which has lower income) projects a slightly smaller time path over most of the period but has a higher value for 1979.

Scenario two (lower crop production--higher income) projects a higher net flow of loan funds than scenario one after 1982. This is probably because of the higher real estate price and thus higher purchases of real estate from discontinuing proprietors.

Selected Balance Sheet Data. Projections of total liabilities, proprietor equity, and the debt to equity (leverage) ratio under scenario one are shown in Table 8.13. Both nominal and deflated values are presented.

Both the nominal and real levels of liabilities are projected to increase rapidly in the 1980's. The projected growth rates are 8.7 and 4.5 percent per year for nominal and deflated liabilities.

The level of equity is projected to grow in the 1980's at rates of 4.75 and .74 percent in nominal and real terms. This slower rate of growth in equity than in debt leads to an increasing leverage ratio for the sector.

The projection of an increasing leverage ratio under conditions of increasing real income is a bothersome result, especially when projected to year 2025. Historically, the debt/equity ratio has fallen from the early to mid-1940's, risen from that point through the late 1960's, stayed about constant for several years, then has fallen to a lower level after the large jumps in land prices began in 1973. It would appear that, had it not been for the recent period of high farm income and associated large capital gains, the ratio would have continued to rise. Two further points should be mentioned relative to the rising leverage ratio. First, one source of increase in equity, investment in off-farm financial assets, has been systematically excluded from the Balance Sheet. This results in an upward bias in the leverage ratio over time (also over the historical data). Secondly, a major use of funds throughout the projection is the continual purchase by remaining proprietors of the equity of discontinuing proprietors. The projection is for a continuing turnover and shrinkage of the human resource base in the agricultural sector and, at the same time, an increasing base of nonhuman

Table 8.13. Projections of Selected Balance Sheet Data, Scenario One

Year Ending Dec. 31	Liabilities Nominal	Liabilities Real[b]	Proprietor Equity Nominal	Proprietor Equity Real[b]	Debt/Equity of Leverage
	---- Billion Dollars ----				Percent
1955[a]	17.7	22.1	151.4	188.8	11.7
1965[a]	40.7	43.1	220.4	233.2	18.5
1975[a]	90.8	56.3	502.0	311.4	18.1
1976[a]	102.7	60.2	568.3	333.3	18.1
1976	103.7	60.8	528.4	309.9	19.5
1977	113.1	62.1	569.0	312.6	19.9
1978	123.3	65.2	577.2	305.4	21.4
1979	132.8	67.4	617.8	313.6	21.5
1980	143.3	69.9	645.7	315.0	22.2
1981	155.6	73.1	678.8	318.7	22.9
1982	169.4	76.7	710.0	321.3	23.9
1983	184.4	80.2	742.9	323.0	24.8
1984	200.4	83.8	777.3	325.2	25.8
1985	217.7	87.4	814.2	327.0	26.7
1990	329.3	108.7	1027.1	339.0	32.1
2000	707.8	158.0	1654.6	369.3	42.8
2025	4722.9	395.2	7152.8	598.6	66.0

[a] Historical data.

[b] Deflated using the CPI.

capital. This is projected to occur at the same time that substantial equity is leaving the sector. The implication of the rising leverage ratio is that the level of savings (a source of internal financing) by continuing proprietors is not large enough to offset the outward equity flow, and thus the need for external funds grows relative to equity.

Capital Formation, Real Estate Transfers, and Savings. Projections of capital formation, real estate transfers to other sectors, and net savings of continuing proprietors under scenario one are presented in Table 8.14. The reader may wish to refer to Chapter VII to examine the capital formation accounts more completely, both in terms of the data and the definitions (calculations).

Gross capital formation (farm business account) is projected to increase at the rate of 5.5 percent per year between 1980 and 1990. Net capital formation is negative throughout the projection. However, it should be noted that the calculation of net capital formation subtracts an estimate of net real estate transfer to other sectors. Thus, if this were added back, net capital formation would be positive (see Table 8.14).

Net capital formation of farm businesses and households is the sum of net capital formation from the business and household accounts. Thus it can be seen from Table 8.14 that net capital formation on the household account is projected to be large enough to offset a negative value on the business account for most of the 1980's.

Table 8.14. Projections of Capital formation, Real Estate Transfer, and Savings, Scenario One

Year	Gross Capital Formation: Farm Business Account	Net Capital Formation: Farm Business Account	Net Real Estate Transfer to Other Sectors	Net Capital Formation Business and Household	Net Capital Formaiton of Continuing Proprietors	Net Savings of Continuing Proprietors
	- - - - - - - - - - - - - - - - - - Billion Nominal Dollars - - - - - - - - - - - - - -					
1977	12.6	-2.6	2.3	-1.3	12.9	16.2
1978	13.2	-2.5	2.5	- .9	13.7	15.0
1979	13.7	-2.5	2.6	- .8	15.0	21.5
1980	14.6	-2.3	2.8	- .4	16.3	23.7
1981	15.7	-1.9	3.0	0.	17.8	26.2
1982	16.8	-1.6	3.1	.4	19.3	28.4
1983	17.4	-1.9	3.3	.2	20.3	30.8
1984	18.2	-2.0	3.5	.1	21.4	33.6
1985	19.2	-2.0	3.7	.2	22.8	36.7
1990	24.9	-2.1	5.0	.4	31.2	54.5
2000	39.6	-4.7	9.4	-1.9	56.3	112.1
2025	162.4	-27.4	57.7	-22.9	345.1	867.9

Table 8.15. Projections of Financing of Capital Flow,[a] Alternative Scenarios

	Scenario One		Scenario Two		Scenario Three	
Year	Debt	Internal	Debt	Internal	Debt	Internal
	Percent					
1976	33.7	66.3	33.7	66.3	33.7	66.3
1977	28.3	71.7	28.3	71.7	28.3	71.7
1978	29.1	70.9	29.1	70.9	28.7	71.3
1979	26.0	74.0	26.0	74.0	28.9	71.1
1980	27.0	73.0	26.7	73.3	28.6	71.4
1981	29.6	70.4	29.1	70.9	28.1	71.9
1982	31.5	68.5	31.0	69.0	28.4	71.6
1983	32.4	67.6	32.2	67.8	28.6	71.4
1984	33.1	66.9	33.2	66.8	29.2	70.8
1985	33.9	66.1	34.4	65.6	30.2	69.8
1990	38.5	61.5	41.1	58.9	37.3	62.7
2000	44.2	55.8	49.5	50.5	48.2	51.8
2025	63.8	36.2	71.3	28.7	73.1	26.9

[a] The table shows the percentage of capital flow (gross capital formation) of continuing proprietors) financed by internal and external (debt) sources. Capital flow here includes purchases of real estate from discontinuing proprietors.

Table 8.14 also shows net capital formation and savings of continuing proprietors. These calculations take into account intersector transfers and other uses of funds respectively. An earlier section indicated a projection of increasing leverage. An indication of financial strength of the farming sector (those remaining in the sector) is the projection of large net capital formation and savings by continuing proprietors. It should be noted that the savings figure assumes that the other uses of funds category is applied (100 percent) to uses which would contribute to equity, that is not to consumption, gifts, and so forth.

Table 8.15 shows projections for the percentage of gross capital formation of continuing proprietors (including intersector flows) that is financed via internal and external sources. Results from scenarios one, two, and three are shown.

The results are as one would expect, given the increasing leverage projection. Namely, the percentage of capital flow financed with debt is projected to increase over time. Under scenario two (higher income), the percentage financed by debt is lower than scenario one for years 1980 through 1983 and is higher in later years. Under scenario three (lower income in the 1980's) the percentage of debt financing is higher than scenario one in the early 1980's but lower in the later 1980's.

Selected Analytical Ratios. The projected increase in leverage leads one to some possible concern over the ability of the farming sector to handle the increasing debt load without inflows of outside

Table 8.16. Projections of Selected Analytical Ratios, Scenario One

Year	Prospective Burden of Debt			RA(4)	RA(1)
	RA(9)	RA(10)	RA(11)		
	Percent				
1977	29.6	54.4	40.3	44.1	83.4
1978	34.1	68.5	46.9	48.5	82.4
1979	26.0	44.6	34.3	42.6	82.3
1980	26.4	43.8	33.9	41.5	81.8
1981	27.7	44.0	34.7	39.8	81.4
1982	28.8	44.6	35.4	38.8	80.7
1983	28.7	43.5	34.8	38.0	80.1
1984	28.4	42.1	33.9	37.2	79.5
1985	28.1	41.0	33.3	36.3	78.9
1990	28.4	38.5	32.2	33.4	75.7
2000	27.0	33.7	29.3	30.9	70.0
2025	22.9	25.0	23.7	28.0	60.2

RA(1) = (equity/total assets) * 100.
RA(4) = (real estate purchases from discontinuing proprietors/net cash flow) * 100.
RA(9) = (debt financing/net cash flow) * 100.
RA(10) = (debt financing/net cash flow - business capital consumption) * 100.
RA(11) = (debt financing/net farm income)/100.

equity capital. Table 8.16 presents projections of several analytical ratios that might give some perspective to the size of the net flow of loans relative to several indicators of ability to repay loans. These ratios are: debt financing/net cash flow; debt financing/net cash flow minus business capital consumption; and debt financing/net farm income. The fourth ratio in the table is a relative measure of the equity flow leaving the sector, real estate purchases from discontinuing proprietors/net cash flow. The fifth ratio is equity/total assets to again show the projection of increased leverage.

The three ratios indicating the prospective burden of debt all show the same pattern. In 1978, when low income is projected, the ratios are projected to be high. A decline is projected for 1979 (a jump in income is projected for 1979). Increases in the ratio are then projected until 1983 when a declining pattern begins.

The lack of increase in these ratios throughout the projections and the decline in real estate purchases from discontinuing proprietors relative to net cash flow would seem to lessen the concern over the future financial stability of the farming sector.

Comparisons of Results from Alternative Scenarios

The discussion and presentation of results from the projections have, up to this point, concentrated largely on scenario one, with some discussion of scenarios two and three. This section will present projections of selected variables for scenarios four, five, six, and seven. Referring back to Figure 8.1 will show that each of these scenarios differs from scenario one in the projection for one exogenous variable. Scenario four has a lower growth in real gross national product. Scenario five has a lower growth in crop exports. Scenario six has a higher rate of inflation, and scenario seven has a lower (zero) growth in livestock inventory.

Tables 8.17 through 8.21 will provide the data referred to in the following discussion. Most of the tables contain data for a particular variable for several projections in order to facilitate comparison of alternative projections. However, the discussion follows a different pattern. The effect of each scenario on the time path of several important variables will be the focus of discussion.

Low Growth in Real Gross National Product. Scenario four is identical to scenario one except that the rate of growth in real GNP is 1 percent rather than 3 percent. It was shown earlier that scenario one projects (through 1990) a nearly constant real price of crops (at about 100) and a rising real price of livestock (see Table 8.2). The results from scenario four indicate a rapid decline in RPCROP and very little increase in RPLIV (Table 8.17).

The livestock component is affected directly in terms of the income elasticity of livestock demand. The crops component is affected via food-industrial demand and reduced feed demand resulting from adjustments in the livestock component. The income elasticity of crop demand is greater than that of livestock demand (the calculations take into account the simultaneous effects). This is demonstrated in Baker (1978).

The projected effects of lower real income growth on nominal net farm income and capital gains are shown in Tables 8.19 and 8.20 respectively. Under scenario, one net farm income increases in the 1980's; with lower real GNP growth, net farm income decreases. In 1985, the projection under scenario four is only 60 percent of scenario one. Capital gains are reduced under the low real GNP assumption, but not nearly to the extent that net farm income is. The 1985 projection is 74 percent of the scenario one value. Under scenario four, the net flow of loan funds is lower than under scenario one (Table 8.21). The projection for 1985 is 86 percent of the value under greater real income growth.

Lower Growth in Exports. Scenario five provides a projection assuming a lower growth in crop exports (2 percent versus 3 percent for scenario one). The largest impact of lower exports is on the crops component. The real price of crops falls throughout the projection (Table 8.17). However, there is an impact on the livestock sector in that the real price of livestock is only 94 percent of the scenario one value in 1990. The RPCROP is 65 percent of the scenario one value in 1990.

Net farm income and nominal capital gains are both lower under scenario five than under scenario one. The values of net farm income and nominal capital gains projected for 1985 are 80 and 85 percent respectively of the scenario one values. Under lower exports, the projected net flow of loan funds is also lower (Table 8.21). The 1985 value is 94 percent of the scenario one value. Thus, the net flow of loan funds falls less than net farm income.

Higher Inflation. Scenario six includes a 6 percent rate of inflation versus 4 percent in scenario one. Table 8.18 shows the projection of nominal real estate price, nominal and real price of crops, nominal and real price of livestock, and the debt/equity ratio. The projected real prices of livestock and crops do not differ greatly from those projected under scenario one. However, nominal real estate price grows at 9.7 percent between 1980 and 1990 versus 6.6 percent for scenario one. These convert to growth rates in real terms of 3.5 and 2.5 percent for scenarios six and one respectively. The resulting increase in equity is large enough to significantly reduce the rate of increase in the leverage ratio. The 1990 value projected under high inflation is 24.7 percent, while the 4 percent inflation scenario projects a value of 32.1 percent (see Tables 8.18 and 8.13).

Under 6 percent inflation, net farm income (Table 8.19) is projected to grow at a rate of 12.4 percent between 1980 and 1990, compared with 10 percent under scenario one. These nominal rates convert to 6.0 and 5.8 percent rates of increase in real net farm income for scenarios six and one respectively. Thus real net farm income is projected to rise at a slightly faster rate under higher inflation.

Nominal capital gains are projected at a much higher level under the higher inflation level (Table 8.20). This is clearly a reflection of the previously discussed high rate of increase in the nominal real estate price.

Table 8.17. Projections of RPCROP and RPLIV, Alternative Scenarios

Year	Scenario Four		Scenario Five		Scenario Seven	
	RPCROP	RPLIV	RPCROP	RPLIV	RPCROP	RPLIV
	- - - - - - Index 1967 = 100 - - - - - -					
1978	91	102	92	104	92	104
1979	92	107	94	110	94	107
1980	91	105	94	110	93	108
1981	89	106	93	113	91	110
1982	86	106	91	114	88	111
1983	83	107	89	116	85	113
1984	80	107	86	118	81	114
1985	76	107	83	119	76	116
1990	56	109	66	129	55	124

Table 8.18. Projections of Selected Variables, Scenario Six

Year	PREAL	PCROP	RPCROP	PLIV	RPLIV	D/E
	- - - -Index 1967 = 100 - - - - - - - -					Percent
1978	332	178	92	200	104	20.7
1979	371	195	95	225	110	20.3
1980	404	210	97	239	110	20.3
1981	444	225	98	261	114	20.6
1982	485	241	99	281	116	21.0
1983	531	257	99	305	118	21.4
1984	582	273	100	330	121	21.8
1985	638	290	100	357	123	22.2
1990	1016	392	101	530	137	24.7
2000	2668	695	100	1155	166	29.4
2025	38780	5015	168	8978	301	40.8

Table 8.19. Comparison of Net Farm Income Projections under Alternative Scenarios

Year	Scenario One	Scenario Four	Scenario Five	Scenario Six	Scenario Seven
	- - - - - - - -	-Billion Dollars-	- - - - - - - -	- - -	
1978	21.6	20.4	21.6	22.4	21.6
1979	27.9	25.2	27.4	29.7	26.3
1980	31.0	26.3	29.6	34.0	28.8
1981	35.4	28.3	32.8	39.9	31.3
1982	39.1	29.2	35.0	45.2	33.1
1983	43.0	29.9	37.1	50.9	34.5
1984	47.2	30.5	39.2	57.3	36.0
1985	52.0	31.1	41.5	64.5	37.5
1990	80.5	28.8	50.9	109.3	42.8
2000	172.3	Not Real-istic	Not Real-istic	279.8	Not Real-istic
2025	1534.0	Not Real-istic	Not Real-istic	3660.4	Not Real-istic

Table 8.20. Comparison of Nominal Capital Gains Projections under Alternative Scenarios

Year	Scenario One	Scenario Four	Scenario Five	Scenario Six	Scenario Seven
	-Billion Dollars-				
1978	19.3	14.6	19.3	35.4	19.3
1979	51.1	45.7	49.2	70.1	45.8
1980	38.9	31.5	35.8	60.4	36.6
1981	45.4	36.9	41.1	70.2	38.7
1982	44.8	34.9	39.6	72.8	38.0
1983	47.7	36.6	41.5	79.5	39.0
1984	50.5	38.0	43.4	86.6	41.0
1985	54.1	40.2	46.0	95.0	43.3
1990	72.8	48.5	57.7	146.8	55.3
2000	134.8	Not Realistic	Not Realistic	368.5	Not Realistic
2025	843.7	Not Realistic	Not Realistic	4760.6	Not Realistic

Table 8.21. Comparison of Net Flow of Loan Funds under Alternative Scenarios

Year	Scenario One	Scenario Four	Scenario Five	Scenario Six	Scenario Seven
	- - - - - - - - - - - - -	Billion Dollars	- - - - - - - - - -		
1978	10.1	10.2	10.1	9.9	10.1
1979	9.5	9.6	9.6	9.4	9.4
1980	10.5	10.3	10.6	10.7	10.2
1981	12.3	11.8	12.2	12.9	11.8
1982	13.8	13.0	13.7	15.0	13.2
1983	14.9	13.6	14.5	16.6	13.9
1984	16.0	14.2	15.3	18.3	14.6
1985	17.3	14.8	16.2	20.3	15.3
1990	25.9	19.1	22.1	34.5	20.3
2000	50.5	Not Realistic	Not Realistic	91.2	Not Realistic
2025	364.1	Not Realistic	Not Realistic	1449.4	Not Realistic

The projected net flow of loan funds (Table 8.21) is higher under scenario six than under scenario one. This would be a result of many factors, but an important one would be the increased requirement for purchases of real estate from discontinuing proprietors (caused by the high real estate price). The nominal capital gains projected are more closely aligned in value with the gains in recent years, when inflation has exceeded 6 percent, than are the projections under 4 percent inflation.

Zero Growth in Livestock Inventory. The assumption of no growth in livestock inventory (scenario seven) has a large impact on the livestock and crop sectors. The major source of impact on the livestock component is via the direct livestock demand reduction. The crops sector is hurt by the reduced feed demand (from the simultaneous adjustments) and by the reduction in feed demand resulting from the livestock inventory being included in the feed demand equation (with a positive coefficient). The reduced real livestock and crop prices that result under this scenario lead the author to believe that ommission of the livestock inventory from the model would be a serious error.

Summary

This chapter began with an explanation of the methods of projecting exogenous variables. Seven scenarios with minor variations in selected exogenous variables were developed.

Results from the projections were then discussed. Major findings include: (1) farm prices and associated income flows are sensitive to projections of crop production; (2) under moderate rates of inflation, leverage in the farming sector increases; (3) leverage increases less rapidly under higher inflation; (4) measures of the prospective burden of debt do not increase, even though leverage does; and (5) farm prices and incomes are sensitive to changes in real GNP, crop export growth, and level of livestock inventory.

CHAPTER IX

Summary and Conclusions

Introduction

The purpose of the research reported here was to develop and test an aggregate farming sector economic projection model emphasizing financial aspects of the sector. The specific objectives were to:

1) Develop a theoretical model of the aggregate U.S. farming sector to provide a conceptual framework for estimation of an empirical model
2) Identify structural relationships among variables within the U.S. farming sector and the effects of variables exogenous to the sector through empirical investigation
3) Construct an operation aggregate economic projections model of the U.S. farming sector capable of making long-run projections of alternative futures to provide input into public and private decision making

The purpose of this chapter is to review the overall research effort, summarize some of the significant findings, discuss limitations of the model, and suggest areas in which further work would be useful.

The System to be Modeled

An important dimension to developing an economic model is to identify the exact system to be modeled. This includes identification of the boundaries of the system, identifying variables as endogenous or exogenous, and determining performance variables.

For the model developed here, it was determined that the system to be modeled would include all economic activities of farm operator families and the farming activities of nonoperator landlords. This definition is a mixture of the product and establishment concepts but was determined to be an optimal choice, given the data constraints.

The performance variables of interest were determined to be best described as those appearing on financial statements of the aggregate farming sector. This includes flow variables such as those on the Income Statement and Sources and Uses of Funds Statement as well as stock variables which appear on the Balance Sheet. Many of the financial variables such as noncash flows, intersector flows, or numerous financial ratios can be calculated using the basic data underlying the previously mentioned financial statements.

While the major performance variables of interest relate to financial statements, these variables are largely transformations of underlying prices and quantities resulting from economic activities. Thus to construct a simulation model to project the financial variables of interest, the underlying economic structure needed to be modeled and then the equations transforming the economic variables had to be formulated.

The Simulation Model

Modeling a system involves at least two levels of abstraction. First, a theoretical representation of the system must be constructed. This representation is based on "standard" economic theory in this study. Static, nonstochastic concepts of supply and demand with only minor modifications provided the basis for specification of equations to be included in the model. A theoretical model is the first level of abstraction from the real system.

Secondly, an empirical model must be constructed. This is most appropriately viewed as parameterization of the theoretical model. The estimates of parameters for this model were derived using statistical techniques where possible. Some parameters were based upon single observations. Other parameters were based upon untested assumptions. The empirical model is the second level of abstraction.

A third level of abstraction involves going from the empirical model to the computer model. The model developed in this study is a discrete time approximation to continuous time processes. Other types of abstraction associated with computer models would involve numerical techniques, such as numerical integration or numerical solution to non-linear simultaneous equations.

The researcher and policy maker should be careful not to forget that any model (and results) is at best an approximation to the "real" system and not, in fact, the real system.

Empirical Results

The approach to modeling the underlying economic structure was an aggregate economic approach. The decision was made to stop short of aggregating the commodities produced in the farming sector into a single variable. The aggregation was made to two products: (1) aggregate crops and (2) aggregate livestock and livestock products. In an open economy with storable commodities, production in a given year is not likely to equal consumption. Thus, there was a need for historical data providing aggregate supply and utilization of crops and livestock. Because of the simultaneous nature of the economic structure to be modeled, the data needed to be of the nature that addition and subtraction, such as required in the supply and utilization identities, would hold (e.g., the crops identity is: beginning inventory + production + imports = exports + feed + seed + food-industrial use + ending inventory). Data of the type required for this study were not available. Thus the author constructed the data by using secondary supply and utilization data for individual commodities weighted by 1967 farm level prices for each commodity and then summed across the individual commodities. Therefore, the crop and livestock aggregates in a particular year are the sum of individual commodity quantities in that year weighted by prices from the base year (1967).

Based on these data, equations were estimated for: livestock supply, livestock demand, crop supply, feed demand, seed demand, food-industrial crop demand, crop inventory demand, feed supply, and seed supply. These nine equations plus the two identity equations for crop and livestock supply and utilization are the structural equations for the following eleven variables: livestock production, livestock consumption, crop production, feed use, seed use, food-industrial use of crops, inventory of crops, price of livestock, price of crops, price of feed, and price of seed.

The theoretical model specified a set of equations for factors of production that were recursive to the above equations. This included: three categories of nondurable inputs, based largely on categories required for the Income Statement: (1) hired labor, (2) fertilizer and lime, and (3) other nondurable inputs. The third category was composed of gross investment demand and repair and maintenance demand for: machinery and motor vehicles; service buildings, other structures, and land improvements; and equations for real estate price and quantity transferred. A number of additional equations were estimated. They might be categorized as follows: equations intended to reproduce USDA procedures,[1/] "near" identity equations converting prices and quantities into levels of receipts or expenses, time trend equations for relatively unimportant variables, and equations to project exogenous input prices (as a function of the CPI).

Other components of the model, including intersector flows and farm operator household activities, were specified. These were, in general, based on very little empirical data.

[1/] Numerous data series published by the USDA have little empirical basis. Often the procedure is to estimate one data series based upon a benchmark and movements in another data series. Where this procedure was known to be used, an attempt was made to reproduce the procedure, since the author felt the data were not sufficient to support estimation of structural equations.

The theoretical specification of the investment demand equation required data for stocks and scrappage of durables based upon a productive capacity concept. It was anticipated that published data based upon a value concept would not adequately represent the variables required to estimate the desired structural equations. Data were constructed to represent the desired concepts. The construction was based in part on concepts which were not empirically tested. However, the USDA data based on the value concept have little, if any, greater empirical content. When used in regression equations to estimate the desired structural relationships, the coefficients of the constructed stock and scrappage variables were of reasonable statistical significance and of theoretically appropriate sign. These results were improvements over equations estimated (but not reported here) using the value concept measures of stocks and depreciation, as well as improvements over results from previous research using the value concept data.

Evaluation of the Model

The first method of valuating the model would be to evaluate each equation individually. Statistical criteria such as "goodness of fit" measures and the statistical significance of individual coefficients are useful in this regard. Further criteria such as correspondence of coefficient signs to the theoretical expectations and elasticities are used when evaluating individual equations. These criteria are presented in earlier chapters for the equations estimated.

When there are simultaneous (or recursive) equations and/or lagged endogenous variables in a model, the single equation criteria are not sufficient[1] to support conclusions about the model's ability to forecast. Further evidence considered useful relates to the model's ability, as a set of equations, to forecast both within the sample period and beyond the sample period.

Forecasting within the sample period can mean (1) using actual values for lagged endogenous variables or (2) using forecasted values for lagged endogenous variables (after the initial period). Models that are to be used for one period forecasts are normally evaluated using actual values for lagged endogenous variables. The model developed here is to be used for projecting longer periods and thus was evaluated using forecasted values for lagged endogenous variables. The results from simulating a set of the important structural equations over the entire sample period have been presented in Chapter VI. The results indicate that the model tracks quantities reasonably well. The model also tracked the overall level of prices well but had fairly large errors in some years.

An ex post simulation, forecasting beyond the sample period using actual values of exogenous variables, was performed for the years 1975, 1976, and 1977. The model forecasted significantly greater crop prices than occurred in 1975 and 1976. These errors were traced to overestimation of feed demand for crops in 1975 and underestimation of crop supply in 1976. In addition, the real estate price equation underestimated significantly. Adjustments were made for these factors when making the projections reported in Chapter VIII.

1/ In general, however, the single equation criteria are normally considered necessary.

A significant (and disturbing) error is forecasted by the model for the 1977 net flow of loan funds (underestimated). Based on preliminary USDA data, it was determined that the model error came in the areas of consumption of nondurable goods and services and other uses of cash. It appears that these uses of funds did not decrease in 1977 as the relationships in the model suggest. It should be noted that these relationships are based on little empirical data. Both categories are functions of current net farm income. Thus it appears that neither consumption nor investments in off-farm capital, to the extent that other uses of cash reflect investment in off-farm capital, have fallen significantly in response to falling net farm income.

Projections

A number of scenarios was generated based on alternative assumptions with respect to important exogenous variables. Exogenous variables in this category included the rate of inflation, the rate of growth in crop exports, the level and rate of growth in crop production, the rate of growth in real gross national product, and the rate of growth in livestock inventory.

The projections for the later 1970's and early 1980's proved to be sensitive to the level of crop production. The model appears to reflect the intuitively appealing behavior that "boom or bust" in the farming sector can be induced via events in the export market or in domestic crop production that are within the reasonable range of outcomes.

The base projections indicate an increasing real net farm income (from a fairly low value in 1978). This was largely the result of increasing real livestock prices (the real price of crops was nearly constant). Nominal capital gains were projected to increase from 1980. with a very small increase in deflated nominal capital gains.

The net flow of loan funds to the sector is projected to increase throughout the 1980's. The increase in liabilities is sufficient to result in an increasing debt/equity ratio. While the increase is fairly dramatic, several ratios (of the net flow of loan funds to cash flow or income indicators) intended to be indicators of the prospective burden of debt are projected to improve over the 1980s.

Net capital formation of the sector (business and household) is projected to be near zero if one subtracts an estimate of net real estate transfers to other sectors. However, net capital formation of continuing proprietors, which includes purchases of equity capital from discontinuing proprietors, is projected at a fairly high and growing level.

Projections under the assumption of low growth in real gross market product result in a nearly constant projection of the real price of livestock and a rapidly falling real price of crops. This scenario results in significantly lower projected net farm income and capital gains than in the base scenario.

Projections under the assumption of no growth in livestock inventory result in a reduced rate of increase in real price of livestock and a declining real price of crops. As in the case of low growth in real GNP, net farm income and capital gains are significantly reduced when compared with the base scenario.

Projecting the rate of inflation at a higher level (6 percent versus 4 percent) has interesting results. While there is very little change in the projected real prices of farm output and only a small increase in real net farm income, there is a large increase in deflated capital gains. This is a result of the specification of the real estate price equation. The increased rate of gain in equity from capital gains significantly reduces the increase in the debt/equity (leverage) ratio.

Focus of Research

The focus of the research project reported here has largely been oriented toward putting together data and estimating a set of equations to describe the economic and financial activities of the aggregate farming sector. In the process of doing this, the day-to-day concerns of how historical data series are constructed, "t" statistics, variance-covariance matrices, predicted versus actual resuts, etc., have swamped the author's thinking. While there has been significant thinking about the usefulness of the proposed effort and intermittent reflection on the product-establishment nature of accounts and other items of more general nature, there has not been a really concentrated and productive effort toward determining what information can be extracted from the accounts.

Additional Research

While there are many "detail" problems with the model that could use additional work, very significant work needs to be done toward analysis of financial accounts.

Initial thoughts would be to explore further the usefulness and/or meaning of savings and capital formation and relate changes in these over the historical data to changes anticipated via projections. In addition, it seems that if the accounts, especially net farm income and capital gains, are to be used to make welfare inferences that capital formation and savings should be calculated for continuing farm proprietors rather than for the sector (at least for welfare inferences if not for all purposes). This leads to the need for a more complete analysis of the difference between accounts prepared for continuing proprietors and for the sector.

Policy Analysis

The usefulness of a model for direct policy analysis depends in part on the model's ability to handle policy scenarios (e.g., price floors and ceilings, storage policies and related payments to farmers, or monetary policy). Many policies require programming of the model beyond the minimum required to get basic projections. Little of this programming has been completed to date but needs to be done to improve the usefulness of the model.

Model Improvements

The model could be improved greatly through the incorporation of additional data or better information on intersector flows and household activities. The relationships used in the model are based largely on empirically untested assumptions in these areas.

Other improvements could be made in the model. Some of these are described in the following sections.

Livestock Capital Stock

The model currently incorporates no information concerning the capital portion of the livestock inventory. It is the impression of the author that while a great deal of data is not available, there are some data available such that reasonable assumptions could be incorporated into the model.

Crop Price

Currently, crop price is the unweighted season average. Errors in the crop identity and estimates of crop price coefficients might be improved if the crop price were weighted by quantities marketed. Use of calendar year rather than crop year price should be explored.

Supply-Utilization Aggregates

The implications of different price weights for the supply utilization data have not been explored. In addition, the incorporation of additional data on important excluded commodities such as citrus and noncitrus fruits might improve the data.

Productive Durables

Construction of "quantity" stocks and scrappage of durable assets for use in demand equations would benefit from incorporation of empirical information on length of life and survival rates.

Lack of real investment data for some categories of durables prevented estimation of structural equations. In addition, empirical data on scrappage of durables would allow greater detail in estimation of investment equations.

Prices of Farm Inputs

As is typical of the approach of agricultural economists, the model has assumed that input prices are exogenous (supply perfectly elastic). Clearly, the supply functions of fertilizer and farm machinery have some simultaneous effects, as witnessed by increased machinery prices resulting from excess demand in recent years and the lack of substitutes or substitute uses for fertilizer. Incorporation of supply equations for farm inputs would improve the model, provided that an additional large set of exogenous variables does not accompany endogenizing input prices.

Further Model Evaluation

The dynamic properties of the model have not been explored to the extent desired. Interim and dynamic multipliers for the model should be derived. The basic linear nature of the model should make it feasible to derive these analytically. Related analysis would be to investigate mathematically the stability of the model. This would involve investigation of the eigenvalues of the model.

APPENDICES

APPENDIX A

Construction of Aggregate Commodity Supply Utilization Data

Construction of Commodity Aggregates

The view taken in this study is that it is reasonable to aggregate output of the agricultural sector into two categories, crops and livestock. These categories are based upon supply and demand similarities and demand for input considerations. The breakdown into two categories, while only one step away from viewing the sector as having one output, offers more flexibility and provides greater intuitive appeal than the single output approach.

On the demand for output side, there are numerous and significant differences between crops and livestock. With respect to livestock, imports and exports are relatively insignificant, and demand is derived fairly directly from final consumer demand. Crop demand, on the other hand, is quite different. Feed demand, export demand, and direct consumer and industrial demand are all important. In consideration of the workability of this breakdown in a simulation model, there are significant possibilities in terms of policies that are often applied to the crop sector alone (e.g., storage, price, and export policies).

On the output side, the effect of technology and weather appear to have greater direct effect upon the crop sector; the effects are often indirect in the livestock sector (e.g., through feed price). In addition, policies such as acreage controls or scenarios on variables such as fertilizer prices can be applied in a realistic and direct manner.

With respect to the demand for inputs, there are some inputs such as seed and fertilizer which are directly related to crops, and there are others such as feed demand which are directly related to livestock.

To develop a fairly detailed model of the supply and demand for farm commodities in which prices and quantities are simultaneously determined, one needs a set of quantity data for which the standard identities hold (i.e., for crops: production + beginning inventory + imports = exports + feed use + seed use + food and industrial use + ending inventory). The author was not able to find published aggregate data in this detail. Thus, the effort to construct the desired data is described in the following sections.

The basic approach used to aggregate the various farm commodities was to weight the supply-utilization quantities (from published sources) of important commodities by 1967 farm level prices. Thus, the common denominator used to aggregate is 1967 farm value (million dollars).

Baker (1978) contains the individual commodity data used in the construction of aggregate data for the calendar years 1950 to 1977.

Livestock and Livestock Products

The individual commodity data for livestock and livestock products did not take changes of inventory into account. At these sources, production was basically livestock slaughter, eggs produced, and milkand milk products produced. Consumption was calculated by subtracting net exports from production.

The beginning and ending stocks for the livestock aggregate were based upon the index of livestock and poultry farms (Agricultural Statistics, 1975, Table 501), 1967 = 100, and the 1967 balance sheet value of livestock on farms (Balance Sheet of the Farming Sector, 1976, Table 40). Inventories were calculated by multiplying the 1967 value of livestock by the index of livestock on farms. The change in inventory (ending - beginning) was added to the summation of the individual commodity production, weighted by 1967 farm prices, to get livestock production for use in the model as the quantity-supplied variable. Thus, the aggregate production data includes livestock produced and held on farms, as well as livestock and products marketed. Table A.1 shows the livestock commodities included, price weights used, and source of data.

Crops

Nearly all of the individual crop data were derived from sources with complete supply-utilization data on a crop year basis. Exceptions are noted below.

Corn and sorghum silage production was assumed to equal feed use in each year. Data were not available on inventory changes. Complete data were not available for vegetables; thus, production was assumed to equal food use.

Minor errors are present in the soybeans and soybean meal data because of differences in bushels of soybeans crushed in the supply and disappearance of soybeans (Agricultural Statistics, 1975, Table 172). and the supply and disppearance of soybean oil and meal (Agricultural Statistics, 1975, Table 173).

Table A.2 shows the price weights used, commodities included, and the sources of data used in construction of the crop aggregates.

Data

The aggregate supply and utilization data constructed and used in the development of the model are shown in Tables A.3 and A.4. The data have been updated and extended as far as possible beyond 1974, the last year used in the estimation.

Table A.1 Commodities, Price Weights, and Data Sources Used in Construction of Livestock Aggregates

COMMODITY	UNITS	PRICE $		DATA SOURCES
Beef and Veal[1/]	lbs. lvwt.	.2045	Production	Agricultural Statistics, 1975, Table 430
				1972, Table 457
			Imports	1975, Table 494
				1972, Table 524
			Exports	USDA Statistical Bulletin No. 522 and Supplement for 1975
Pork[1/]	lbs. lvwt.	.1704	Production	Agricultural Statistics, 1975, Table 445
				1972, Table 473
			Imports	1975, Table 494
				1972, Table 524
			Exports	USDA Statistical Bulletin No. 522 and Supplement for 1975
Lamb and Mutton[1/]	lbs. lvwt.	.1981	Production	Agricultural Statistics, 1975, Table 463
				1972, Table 492
			Imports	1975, Table 494
				1972, Table 524
			Exports	USDA Statistical Bulletin, No. 522 and Supplement for 1975
Chicken	lbs. lvwt.	.1770	Production	Agricultural Statistics, 1975, Table 556
				1972, Table 590
Turkey	lbs. lvwt.	.2380	Production	Agricultural Statistics, 1975, Table 572
				1972, Table 607
Eggs	doz.	.3523	Production	Agricultural Statistics, 1975, Table 580
			Imports and Exports	1972, Table 617

Table A.1 (cont'd.).

COMMODITY	UNITS	PRICE $	DATA SOURCES	
Milk and Milk Products	cwt. milk equivalent	4.17	Production	Agricultural Statistics, 1975, Table 522 1972, Table 553 1967, Table 561
			Imports & Exports	USDA Dairy Situation, various reports

1/ Import and export original data were in carcass weights. Carcass weights were converted to liveweights via division by the dressing percentage for each class of livestock in each year.

Table A.2. Commodities, Price Weights, and Data Sources Used in Construction of Crop Aggregates

COMMODITY	UNITS	PRICE $		DATA SOURCES
Wheat	bushel	1.80	Seed Use	Agricultural Statistics, 1974 Wheat Situation (WS234), November 1975
			All Other	Agricultural Statistics, 1975, Tables 4, 9 1972, Tables 11, 6
Rice	cwt.[1/]	4,65	All Data	USDA, ERS Agricultural Economics Report No. 138 and Supplement for 1974, Table 82
Corn	bushel	1.09	All Data	Agricultural Statistics, 1975, Table 37 1972, Table 45
Grain Sorghum	bushel	.94	All Data	Agricultural Statistics, 1975, Table 63 1972, Table 78
Oats	bushel	.61	All Data	Agricultural Statistics, 1975, Table 46 1972, Table 55
Barley	bushel	.88	All Data	Agricultural Statistics, 1975, Table 54 1972, Table 63
Rye	bushel	1.07	All Data	Agricultural Statistics, 1975, Table 18 1972, Table 23
Soybeans	bushel	2.01	All Data	Agricultural Statistics, 1975, Tables 172, 173, 70 1972, Table 196 1967, Table 199

Table A.2 (cont'd.)

COMMODITY	UNITS	PRICE $	DATA SOURCES	
Soybean Meal	tons	76.9 2/	Stocks, Exports	Agricultural Statistics, 1975, Table 172 1972, Table 195 1967, Table 198
			Feed	1975, Table 70 1972, Table 80 1967, Table 80
Soybean Oil	lbs.	.084 2/	All Data	Fats and Oils Situation (FOS-283), Table 8 Agricultural Statistics, 1973, Table 193 1972, Table 195
Peanuts	lbs. 3/	.102	All Data	USDA, ERS Agricultural Economics Report No. 138 and Supplement for 1974, Table 61
Tobacco 4/	lbs.	.91	All Data	Agricultural Statistics, 1975, Table 133 1972, Table 151 1967, Table 154
Sugar 5/	tons	180.6	All Data	USDA, ERS Agricultural Economics Report No. 138 and Supplement for 1974, Table 86
All Hay	tons	24.5	Stocks	Agricultural Statistics, 1975, Table 376 1972, Table 400
			Production	1975, Table 375 1972, Tables 393, 397
Flaxseed	bushel	2.95	All Data	Fats and Oils Situation (FOS-282) April 1976 Table 1 Agricultural Statistics, 1975, Table 150 1972, Table 171

Table A.2 (cont'd.).

COMMODITY	UNITS	PRICE $		DATA SOURCES
Cotton	bales	128.14	All Data	Cotton Situation Agricultural Statistics, 1975, Table 78 1972, Table 88
Corn and Sorghum Silage 6/	tons	10.0	Corn	Agricultural Statistics, 1975, Table 35 1972, Table 38
			Sorghum	1975, Table 61 1972, Table 71
Potatoes	cwt.	1.82	All Data	USDA, ERS Agricultural Economics Report No. 138 and Supplement for 1974, Table 75
Vegetables	tons	69.6	All Data	Agricultural Statistics 1975, Table 197 1972, Table 221

1/ Rough equivalent basis.

2/ Soybean oil and meal prices were adjusted from those stated here to get a combined price equivalent to the farm price for soybeans ($2.01). The adjustment was made on the assumption of 47.5 pounds of meal and 10.9 pounds of oil per bushel. This resulted in using 73.305 percent of the price stated.

3/ Kernal basis. Conversion from kernal basis to farmer stock basis (or vice versa) is made using the relationship that kernal basis times 1.33 equals farmer stock basis.

4/ Farmers sales weight basis, types 11-72.

5/ Cane and beet sugar, raw value.

6/ Unweighted summation of corn and sorghum silage.

Data

Baker (1978) shows the individual commodity data used to construct aggregate crops and livestock. The data shown for crops are the data for the crop year ending in the calendar year indicated. Note that this is the way the crop year data are indexed, with respect to time, in the model.

Tables A.3 and A.4 give the livestock and crop aggregates used in the model. Data through 1974 were used in estimation. The data were extended beyond 1974 for testing the model. Some of the individual commodity data for the most recent years were based on preliminary data. Where these were not available (largely for the 1977-78 crop year), the author estimated the data on an ad hoc basis.

Table A.3 Aggregate Crop Supply-Utilization Data

Crop Year	CROPS(1) Beg. Inv.	CROPS(2) Production	CROPS(3) Imports	CROPS(4) Exports	CROPS(5) Seed	CROPS(6) Feed	CROPS(7) Food-Indus.
1951	7949	15417	1163	2138	359	7144	7469
1952	7394	15941	1145	2450	358	7328	7234
1953	7102	16693	1207	1842	372	7096	7148
1954	8437	16564	1238	1760	359	7041	7216
1955	9866	16376	1134	1911	351	7046	7122
1956	10971	16968	1186	2140	353	7509	7296
1957	11814	17059	1252	3161	332	7502	7463
1958	11650	16871	1209	2801	340	7739	7247
1959	11607	18808	1203	2570	333	8391	7623
1960	12705	18348	1251	3324	328	8726	7591
1961	12351	19819	1102	3599	340	8726	7661
1962	12936	19466	1029	3748	322	9009	7928
1963	12455	19884	1051	3433	330	8921	8003
1964	12672	20622	1030	4292	332	8919	8015
1965	12785	20103	838	4030	341	8921	8084
1966	12315	21309	911	4512	346	9527	8301
1967	11860	20815	972	4432	378	9700	8391
1968	10743	22062	1029	4461	376	9655	8479
1969	10814	22545	1043	3753	366	10125	8672
1970	11496	22596	975	4360	352	10734	8492
1971	11196	21923	1045	4762	365	10580	8574
1972	9879	24338	1073	4581	362	11254	8692
1973	10397	24549	1041	6703	395	11391	8670
1974	8767	25787	999	7049	422	11334	8756
1975	7991	23666	1103	5979	425	9769	8375
1976	8320	26557	708	7157	510	10227	8937
1977	8840	26402	827	6912	501	10215	8505
1978[a/]	9767	27367	785	6935	501	10727	8714

a/ Projected by the author based in part upon information in Agricultural Outlook.

Table A.4. Aggregate Livestock Supply-Utilization Data

Calendar Year	LIV(1) Beg. Stock	LIV(2) Production	LIV(3) Imports	LIV(4) Exports	LIV(5) Consumption
1950	15178	16170	169	210	15369
1951	15937	16867	222	257	15883
1952	16886	16586	213	137	16093
1953	17455	16067	166	166	16257
1954	17265	17058	151	184	16645
1955	17644	17079	147	395	16832
1956	17645	16362	135	388	16679
1957	17077	16166	199	246	16499
1958	16696	17281	411	199	16924
1959	17265	17746	486	145	17708
1960	17645	17142	380	125	17207
1961	17834	18049	482	120	18031
1962	18214	18373	652	138	18318
1963	18783	18640	737	328	18670
1964	19163	18683	510	420	18773
1965	19163	17682	478	178	18361
1966	18783	18520	687	136	18882
1967	18973	18899	721	127	19493
1968	18973	19040	756	175	19432
1969	19163	19018	792	180	19441
1970	19352	20183	860	143	20331
1971	19922	20320	806	237	20509
1972	20301	20423	922	216	20750
1973	20681	20491	987	205	20323
1974	21629	20225	802	347	20411
1975	22009	18013	789	239	19268
1976	21250	19390	784	277	20467
1977	20681	NA	NA	NA	NA

APPENDIX B

Statistical Considerations in Model Development

Simultaneous Nature of the Model

Chapter V discusses the empirical results from estimating equations. Included is a matrix (Table 5.23) showing placement of coefficients for a set of the endogenous variables. From this matrix, it can be seen that a set of the equations are simultaneous.

Ordinary least squares (OLS) would give biased estimates of the parameters in these equations because of the inclusion of the current endogenous variables and thus has not been used. The simultaneous equations for the model are estimated using two stage least squares (2SLS).

The following discusses some of the factors one needs to consider when estimating simultaneous equations.

Identification

The requirements for identification in simultaneous equations are referred to as the rank and order conditions (see any good econometrics text for full explanation). The order condition is necessary but not sufficient for identification.

The order condition requires that the number of excluded exogenous variables in the system of equations exceeds the number of included endogenous variables minus one. All of the equations in the model meet the order condition.

Results of the generalized classical linear identifiability test statistic are reported in Table B.1. The null hypothesis is that the coefficients of the endogenous variables excluded from the equation are zero. The actual distribution of the test statistic is known only in the limiting sense. However, Basmann (1960) indicates that if the predetermined variables are completely exogenous, if the disturbances in the equations are jointly distributed normal, and if a moderately high degree of precision can be obtained in reduced form estimation, then the exact finite sample distribution of the statistic can be closely approximated by Sendecor's F with the appropriate degrees of freedom. The validity of the null hypothesis implies that the rank condition holds (see Koopman and Hood); the converse however, is not true. The test can be applied only in the case of over-identified equations.

Table B.1. Identifiability Test Statistics

Equation	PHI Ratio	Numerator d.f.	Denominator d.f.	Sig. Prob.
(5.2) Food-Industrial Crop Demand	1.45	14	7	.319
(5.3) Feed Demand	3.80	12	7	.043
(5.4) Feed Supply	4.67	14	7	.024
(5.6) Seed Demand	1.39	12	7	.340
(5.7) Seed Supply	1.39	15	7	.340
(5.9) Livestock Demand	1.72	14	7	.239
(5.10) Livestock Supply	2.62	13	7	.103

As one can see from the significance levels, the results of the test are not encouraging.

Properties of 2SLS Estimates

The major reason for using 2SLS rather than OLS to estimate the simultaneous equations is that OLS estimates are biased. However, 2SLS is only asymptotically unbiased. The small sample properties of 2SLS estimates are, in general, not known. One implication of this is that with a small sample the estimated coefficient divided by its estimated standard error (t ratio) is not distributed t. Thus, it is technically incorrect to make statements of probability based on small sample use of 2SLS.

R^2 in 2SLS

A question of interpretation arises when reporting R^2 coefficients for 2SLS equations. The residuals used to calculate R^2 when using 2SLS can be computed using either observed jointly dependent variables or the computed variables from the first step. The original (observed) values are used in computation of the R^2's reported for the equations in the model. One should be aware that in this case the range for R^2 is not $(0,1)$, for its range is $(-\infty,1)$. See Tomek (1973) and Basmann (1962) for greater detail.

Instrumental Variables

Estimation by 2SLS is basically an application of the method of instrumental variables. In actual estimation, one has to specify the variables to use as instruments. In practice, this often becomes a problem. If the number of instruments is equal to or exceeds the number of observations, the procedure breaks down. This was not a problem for the equations in the model. The variables used as instruments were the exogenous variables in the system of equations less the exogenous variables in the particular equation being estimated.

Summary Statistics

The summary statistics reported for the equations typically include: 1) the coefficient of determination (R^2), 2) t values, 3) the Durbin-Watson statistic (D.W.), and 4) occasionally the estimated standard error (S.E.) for the equation.

The R^2 reported is unadjusted for degrees of freedom. The meaning of the R^2 reported for the simultaneous equations is discussed above.

Critical t values are listed at the bottom of tables giving empirical results. The values reported are for a one tail test. This is appropriate for most of the coefficients as theory and experience clearly indicate the expected sign of the coefficient.

The estimated standard errors for the regression equations were important criteria for selecting equations but are not always reported because the values are meaningless unless one knows the magnitude of the dependent variable.

Linearity

In general, all variables and parameters in the model are linear. Exceptions should be obvious. These include: 1) transformations of the time variable, such as logarithms or squaring; 2) multiplication of two variables, such as a price index times a quantity; and 3) division of two variables, such as division by population. There are no structural equations estimated completely in logarithm or other functional forms nonlinear in the variables.

Lag Structures

There are, in general, no lagged dependent or normalized variables in the model. However, lag structures are included for other variables in the equations. These typically are cases of quantities demanded or supplied being dependent upon current and past prices. The lags are estimated by direct inclusion of the variables in the equations. No special techniques, such as polynomial distributed lags, are employed.

Autoregressive Nature of the Model

When dealing with annual time series data, one often runs into problems with first order autoregression (sometimes referred to as serioal correlation). OLS estimates are inefficient when there is autoregression, although OLS still provides unbiased estimates of regression coefficients. However, the estimates of the variances of the regression coefficients are biased. The "t" ratios used in testing significance are larger when ρ is > 0; thus, the confidence intervals calculated (or significance level) indicate a "better" fit than actually exists.

A widely used test for first order autoregression is the Durbin-Watson test. The test statistic (d) is reported for equations in the model. For testing the hypothesis that $\rho = 0$ versus the alternative that $\rho > 0$, the decision rules are as follows:

1) Reject if $d < d_L$.

2) Do not reject if $d > d_U$.

3) The test is inconclusive if $d_L < d < d_U$.

The values of d_L (lower limit) and D_u (upper limit) are given in the table provided by Durbin and Watson and are reproduced in numerous econometrics and statistics textbooks.

The problem of autoregressive disturbances is complicated by the inclusion of lagged endogenous variables in the regression equation. This, in itself, can be shown theoretically to induce autoregressive disturbances. The Durbin-Watson statistic does not provide an unbiased estimate when endogenous variables are included as explanatory variables (either lagged endogenous or current and/or lagged endogenous variables in the case of simultaneous equations). However, because of popular usage, the values of the Durbin-Watson statistic have been reported in this study for equations that are simultaneous, as well as for those with lagged endogenous variables. The reader should be aware that they are not reported to provide a legitimate statistical test for first order autoregression.

The often used Cochrane-Orcutt iterative procedure for correcting first order autoregression does not provide unbiased estimates of the correlation coefficient when there are lagged endogenous variables. In addition, the procedure does not necessarily "purge" first order autoregression but only adjusts the data until one cannot tell if there is first order autoregression.

In general, the equations in the model have been estimated without correction for first order autocorrelation. No structural equations estimated via OLS have lagged endogenous variables; thus, the Durbin-Watson is a legitimate test for these equations. Among these equations,only hired labor demand has clear evidence of a problem. In this case, the author is much more comfortable with the unbiased but inefficient OLS estimate than with the estimates generated by the Cochrane-Orcutt procedure.

Two of the simultaneous equations include lagged endogenous variables. The unavailability of an unbiased simultaneous equations estimator at the time these equations were estimated prevented proper treatment. No proper statistical test is used to test for first order autoregression for any of the simultaneous equations.

One final comment relative to testing for autoregressive disturbances is that the above discussion, and most of the discussion in the literature, concentrates only on first order autoregression. The only legitimization for this fact that the author is aware of is that one often deals with annual observations. This fact would not seem to prevent the possibly frequent occurence of higher order autoregression.

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