1985

An analysis of corn loan and reserve program provisions using endogenous loan and reserve behavioral models

Duane Schouten
Iowa State University

An analysis of corn loan and reserve program provisions using endogenous loan and reserve behavioral models

by

Duane Schouten

A Thesis Submitted to the

Graduate Faculty in Partial Fulfillment of the

Requirements for the Degree of

MASTER OF SCIENCE

Department: Economics
Major: Agricultural Economics

Signatures have been redacted for privacy

Iowa State University
Ames, Iowa

1985

TABLE OF CONTENTS

CHAPTER 1. INTRODUCTION

A fair amount of work on examining factors that influence ending stocks has already been completed. Farmer-owned reserve stocks have been found to influence the level of commercial carryover. Another factor, not previously considered at length, is stocks carried over under the nonrecourse loan program, also know as the nine-month loan program. This study specifically examines these subsidized portions of ending stocks, and in so doing develops an approach for endogenizing government loan activity in the inventory equation of a U.S. corn supply and demand model. Loan outlays have been a large component of program costs in recent years. A more thorough understanding of factors influencing loan activity is useful in predicting effects policy changes have on expenditures for the government's loan programs and on the level of government and commercial carryover.

In the first part of this chapter, the basic provisions of the government's loan programs are discussed. The remaining portion presents the problem statement, the objectives of this analysis, and a literature review.

Loan Programs

Since 1933, the CCC (Commodity Credit Corporation) has offered the nine-month loan program to producers. The basic program has since been modified, but its operation and purpose of supporting prices has not changed.

Farmers participate by presenting their grain as collateral when they obtain CCC loans. A farmer can redeem his loan at anytime prior to the end of the nine-months without penalty. All he must do is repay the loan plus the incurred interest. Farmers who haven't yet redeemed their loans at the end of the nine months when the loan expires, can either repay the loan plus interest or forfeit the stored grain to the CCC. If they choose to default on the loan and forfeit the grain, the CCC has "no recourse" but to accept the grain held as collateral as repayment for the loan.

The nine-month program accomplishes the following objectives. The CCC helps to support prices by providing incentives for producers to withhold grain from the market. Because they can default on the loans without penalty, the CCC is in a sense acting as an unlimited source of demand, which helps maintain depressed prices from falling farther. By allowing producers to redeem loans on demand, they can take advantage of their speculative activity if prices rise, but the released grain keeps prices from rising too high. Producers are not only exposed to less risk through the default and redemption mechanisms, but they are also being subsidized with higher than commercial loan rates and lower than commercial interest rates on their loans.

If the nine-month loan rate is continually above the market clearing price, the program can lead to large increases in CCC owned stock. The stock build up can be expensive to the government. In some years the CCC employs a supply side mechanism to assist the loan program in supporting prices by making participation in a set-aside or land diversion a prerequisite for participation in the loan program.

Legislation from the 1977 Food and Agriculture Act set up the farmer-owned reserve program, which provides another storage alternative to the farmers. This loan program is more restrictive and its purpose is to support and stabilize prices by removing grain from the market for a longer time.

To participate, the farmer signs a contract with the government to store grain for three years or until the market price reaches a preset release price. The participating farmer receives a loan plus storage payments, with the stored grain again acting as collateral. The reserve loan rate is usually higher than the nine-month loan rate. If the market price surpasses the release price, the Secretary of Agriculture is authorized to increase the interest rate on the loans and design other methods, such as halting storage payments, to induce farmers to redeem their loans and market the grain.

Original legislation from the 1977 Act specified the release as a fixed percentage of the reserve loan rate, but now it is determined by the Secretary. A call price was also originally specified as a percentage of the loan rate, but higher than the release. Producers were obligated to repay their reserve loans, unearned storage payments, and any interest charges during call status. They were not required to market their grain, but often had to in order to repay their loans. Currently, however, call status is reached only if the Secretary determines an emergency justifies such action.

The data in Table 1.1 show the composition of U.S. corn stocks by category, including the subsidized farmer-owned reserve and nine-month loan categories. It is clear that carryover under loan varies substantially from year to year.

Table 1.1. Total price support loans and end year private and government stocks of corn 1965/66-1982/83 (mil. bu.)

Oct./ Sept. Year	Total Loans Made	Private Stocks: Free: Under Loan? Yes	Private Stocks: Free: Under Loan? No	Private Stocks: Free: Total	Private Stocks: Farmer Owned Reserve	Govt. Owned Stocks	Total Ending Stocks
65/66	214.9	347.9	245.2	593.1	0	248.6	841.7
66/67	263.0	234.5	454.0	688.5	0	137.8	826.3
67/68	466.8	533.2	453.2	986.4	0	182.3	1168.7
68/69	403.4	442.1	381.2	823.3	0	295.1	1118.4
69/70	398.0	346.2	404.1	750.3	0	254.9	1005.2
70/71	323.3	237.6	324.1	561.7	0	105.0	666.7
71/72	954.5	563.7	403.1	966.8	0	160.1	1126.9
72/73	419.8	89.8	539.0	628.8	0	79.1	707.9
73/74	260.6	5.3	471.3	476.6	0	7.3	483.9
74/75	76.8	3.1	358.0	361.1	0	0.3	361.4
75/76	147.0	23.4	376.2	399.6	0	0.1	399.7
76/77	274.8	148.2	737.7	885.9	0	0.0	885.9
77/78	1159.0	415.3	367.5	782.8	315.5	13.1	1111.4
78/79	641.0	115.7	538.6	654.3	549.9	99.7	1303.9
79/80	558.0	82.6	642.2	724.8	636.4	256.3	1617.5
80/81	838.0	100.8	510.0	610.8	185.4	237.8	1034.0
81/82	1968.6	299.1	262.9	562.0	1310.0	302.4	2174.0
82/83	1576.3	109.8	293.2	403.0	1550.0	1166.0	3119.0

The portion of carryover held under nine-month loan is generally considered part of free commercial stocks. Free stocks are not very isolated from the market, because they can be used or sold at anytime; there are no restrictions placed upon them. This analysis, however, considers stocks carried over under the nine-month loan separately from the other free stocks. Free stocks under loan and those not under loan are different in that grain held in the nine-month loan program is held at a lower cost to the farmer compared with other private storage.

The reserve program, unlike the nine-month loan program, has provisions that discourage farmers from redeeming their loans on demand. These provisions make the reserve stocks far more isolated from the market. However, reserve storage is more heavily subsidized through direct storage payments and higher loan rates.

Problem Statement

One of the objectives of the government's loan programs is to stabilize the market price at a higher level than what would otherwise result. In trying to achieve this objective, program expenditures have been unpredictable and, especially in recent years, costly.

A web of interactions among government reserves, private carryover, future price expectations, and current price all influence the size and extent of participation in the loan programs and hence the size of the expenditures to finance them. Figure 1.1 illustrates some of these relationships. A step toward solving the problem of uncertainty and unpredictability with respect to financing the loan programs could be achieved with a better understanding of these relationships.

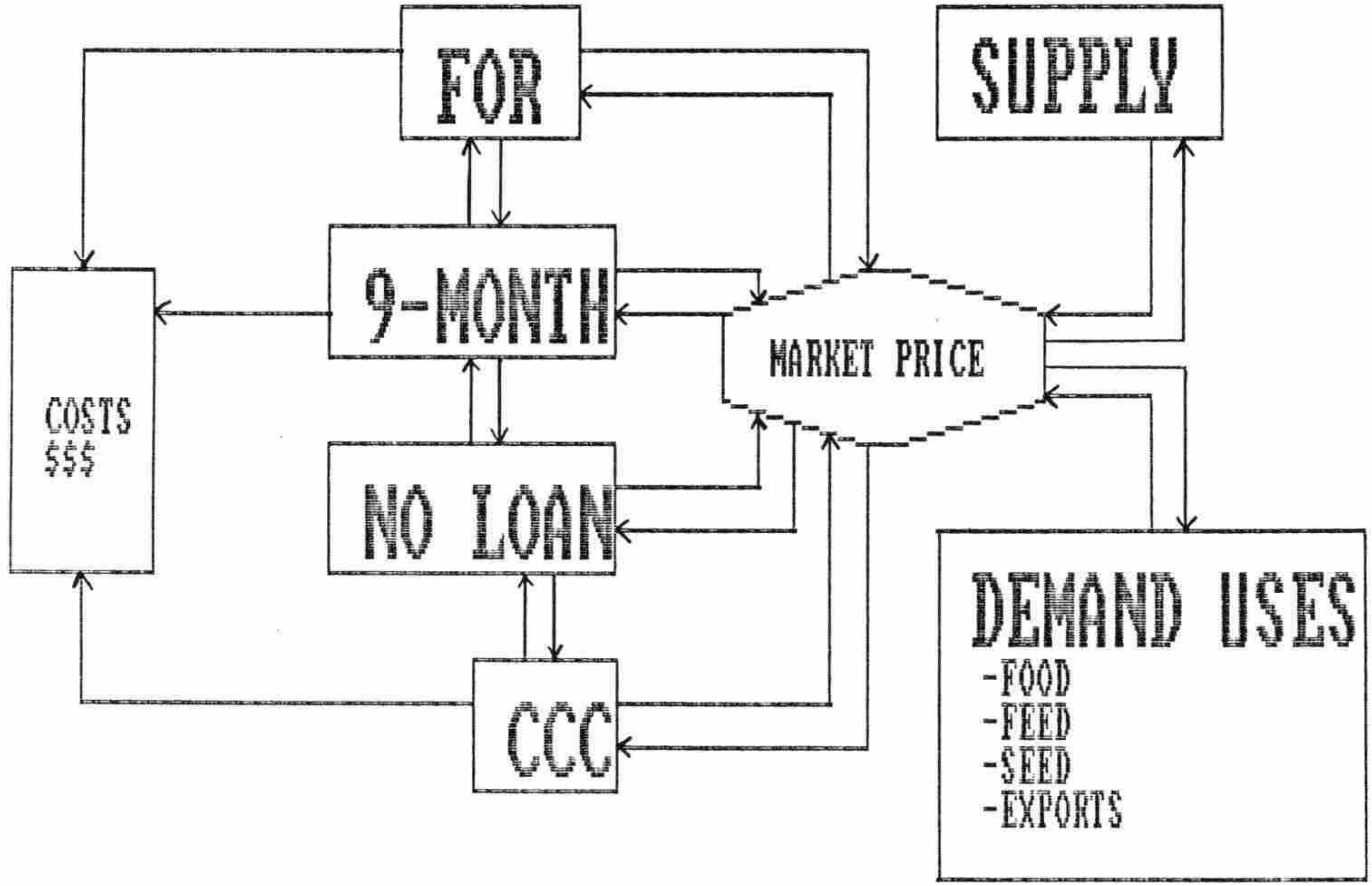

Figure 1.1. Interactions among supply and demand components and market price

Objectives

The objectives for carrying out this study are:

1) To develop an econometric model that endogenizes the effects of the government's subsidized storage programs.
2) To examine the interrelationships that exist between government subsidized stocks and private stocks.
3) To examine the effects changes in loan program provisions have on the size of the subsidized stocks.
4) To examine how government costs vary with changes in these provisions.

This research should have merit in that it will further the knowledge available on the interdependence between government owned and subsidized stocks and nonsubsidized producer stocks, and how this interdependence influences the cost and effectiveness of the stock programs.

Literature Review

This section briefly reviews some of the relevant research done on modeling government loans and the effects government reserves have on private stock carryover.

Miller, Meyers, and Lancaster (1978) developed a theoretical and empirical framework for analyzing the demand for corn and wheat CCC loans. They specified loan demand in their models to be a function of a ratio of the CCC loan rate and market price, a ratio of CCC and Production Credit Association interest rates, a risk variable, production, and a variable to reflect program compliance. The models showed strong loan rate/market price ratio effects.

Golden and Burman (1979) use a quarterly model to evaluate CCC loan activity for corn and wheat. They specified loan demand as a function of discounted future price, a price volatility variable, a loan rate/price ratio, production, and seasonal dummy variables.

Meyers, Jolly, and Smyth (1983a) examine farmer-owned reserve placements and develop a model for estimating parameters based on earlier theoretical work (Meyers and Jolly, 1980). Their monthly model specified placements as a function of quantities available for reserve placement, the market price, and a variable that reflects the present value of a bushel of grain placed in the reserve. The present value computation combined most of the program and market factors that producers would consider before joining the reserve program, e.g., loan rate, interest rate, storage payment, number of months interest is charged on the loan, storage cost, expected price, and discount rate. The present value variable was very significant in the model.

Baumes and Womack (1979) examine two structures for supply and demand models in the agricultural sector; one a stock adjustment model and the other a price adjustment model in which there is no specified ending stock equation. In their analysis, one of the things they examined was how the level of government stocks affected ending commercial stock levels for corn. They found a negative relationship between the two with a coefficient of -0.25 for government stocks.

Sharples and Holland (1981) analyzed the wheat farmer-owned reserve impact on private stocks. Their results imply that the wheat farmer-owned reserve acted as an additional demand for wheat. They also hypothesize that wheat stocks accumulated in the reserve may be a partial substitute for private stocks.

Peck (1977) examined how CCC stock levels affect private inventories for wheat. She found that larger levels of government stocks have a negative influence on private stocks. She says that the more abundant supplies are, in an accessible position, even if held by the government, the less the value a producer places on carrying his own stock privately. Hence, she hypothesized, government stocks may substitute for private stocks.

CHAPTER 2. CONCEPTUAL PRESENTATION OF MODEL

Graphical Presentation

Figure 2.1 shows a graphical illustration of the U.S. Corn Model. Total demand in diagram (f) is the sum of private stock demand, government stock demand, export demand, food demand, and feed demand. Seed demand is rather small and is omitted from the graphical analysis.

Private stocks, in diagram (a), include the demand for subsidized reserves, which are held privately. The kink in the demand curve illustrates how the subsidized storage programs tend to cause an increase in total private stock demand. The quantity demanded at the market price increases to Q_2 from Q_1. Free private stock demand, however, may decline.

Total supply, as it is shown in (f), is independent of current price, therefore is perfectly inelastic. Total demand, DT-T-R-DG, is kinked to reflect the effects of the government's subsidized storage programs; the result of which is a higher market price. The perfectly elastic portion of total demand curve, R-DG, reflects the CCC's role as a source of unlimited demand whenever the market price ends up being below the loan rate for the nine-month loan program or when price is below the entry price for the reserve. Producers can turn the grain over to the CCC at the end of the required storage time for each program.

The market price that results from the intersection of the total supply and demand curves is one factor that influences the next period's supply decision, made via acreage planted. Expected supply is shown in diagram (g).

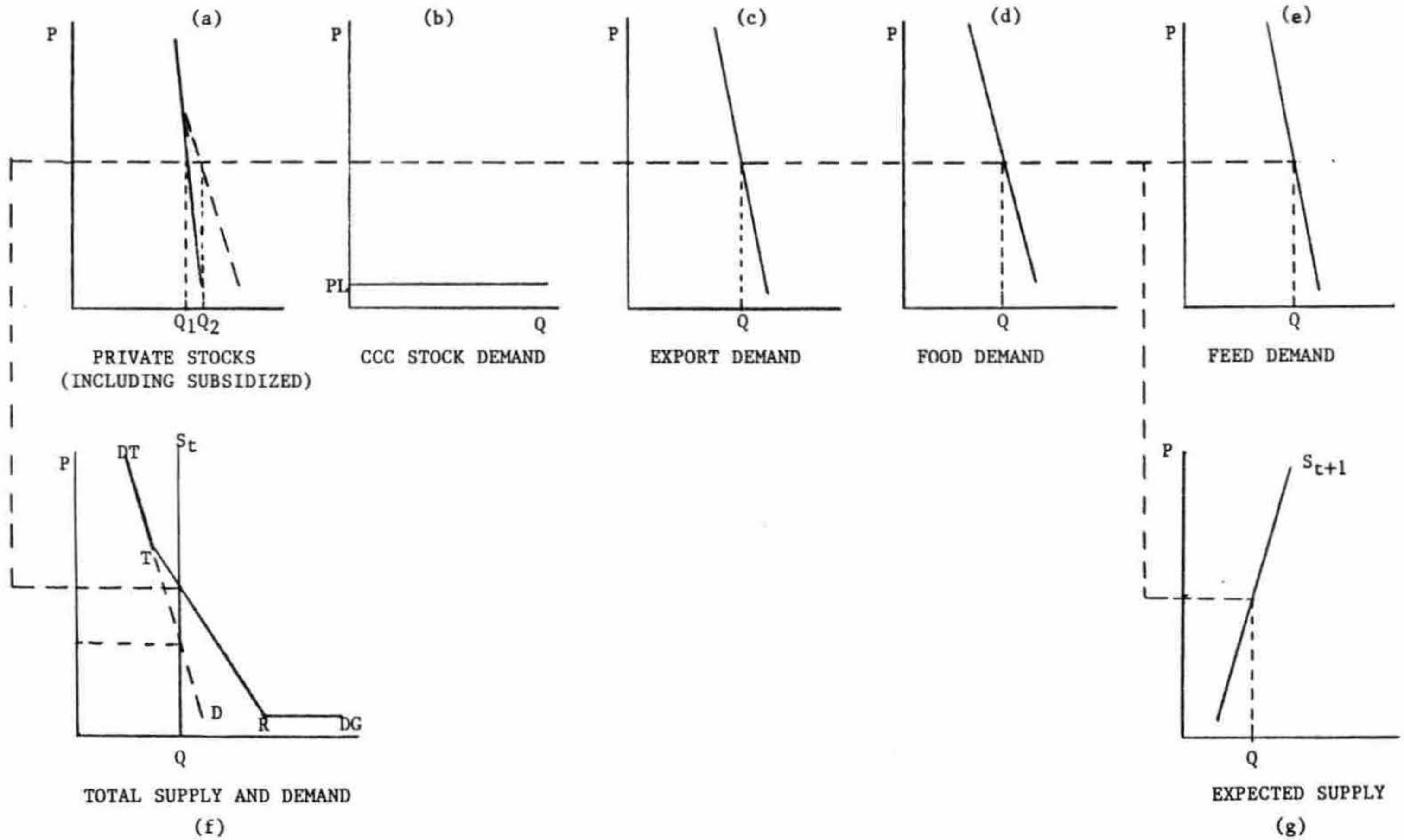

Figure 2.1. Graphical representation of U.S. corn model

Mathematical Presentation

The purpose of the simple mathematical model presented here is to provide additional theoretical underpinnings for the empirical analysis. The mathematical model will demonstrate the effects of selected exogenous shifts on key endogenous variables. The model is as follows:

$$(2.1)\quad D_t = a_1 - b_1P_t + u_1$$

$$(2.2)\quad STK_t = a_2 - b_2P_t + c_2QP_t - d_2R_t - e_2QP_{t+1} - f_2CCC_t + u_2$$

$$(2.3)\quad R_t = a_3 - b_3P_t + c_3Z_t + u_3$$

$$(2.4)\quad QP_{t+1} = a_4 + b_4P_t + u_4$$

$$(2.5)\quad QP_t + STK_{t-1} + R_{t-1} + CCC_{t-1} = D_t + STK_t + R_t + CCC_t$$

where $b_1, b_2, b_3, c_3, b_4 > 0$; $0 < c_2, d_2, f_2 < 1$; $e_2 > 1$;

CCC_t = ending CCC stocks,

CCC_{t-1} = beginning CCC stocks,

D_t = current period utilization,

P_t = equilibrium price,

QP_t = current crop year production,

QP_{t+1} = production for next crop year,

R_t = ending stocks for government subsidized reserves,

R_{t-1} = beginning subsidized stocks,

STK_t = ending private stocks,

STK_{t-1} = beginning private stocks,

Z_t = loan program policy variable.

The constant terms represent separate effects of other exogenous variables. For simplicity, the error terms are omitted from the remainder of the analysis.

Equation (2.1) represents demand utilization and is a function of various exogenous factors (a_1) and the equilibrium price. Demand is inversely related to price.

Equation (2.2) is the private ending stock equation. Private stocks are a function of price, production, government owned stocks, government subsidized stocks, expected production, and other exogenous factors. For simplicity, both the stocks in the farmer-owned reserve and nine-month loan programs are included in R_t. Subsidized reserves, expected production, and government owned stocks all negatively affect the level of ending stocks through an expected price effect. Also, it is expected that a high current price will reduce private inventories and a high current production level will increase private inventories.

The level of carryover in the reserve and under nine-month loan is expressed in Equation (2.3) and is a function of price, government policy provisions, and other exogenous factors. Price is expected to be inversely related to levels of subsidized carryover. The government policy variable (Z_t) is defined in such a way that it is positively related to R_t; any change that induces more participation raises R_t. For example, a policy change that raises the loan rate for government loans would expectedly induce more participation in the loan programs, hence raising the subsidized stock level.

Expected production in Equation (2.4) is a function of the market price and other exogenous factors. Price is positively related to expected production.

The market clearing condition is expressed in Equation (2.5). Production and beginning stocks are determined by last period's price.

To better understand the behaviorial relationships and interactions of this model, comparative statics analysis is performed. Several reduced form impacts are derived. The reduced forms for price, subsidized stocks, private stocks, and expected production are shown in Equations (2.6), (2.7), (2.8), and (2.9), respectively. The derivations are presented in Appendix A.

$$(2.6)\quad P_t = \frac{\alpha_0 - \alpha_1 QP_t + \alpha_2 Z_t + \alpha_3 CCC_t - \gamma_0}{\beta}$$

$$(2.7)\quad R_t = a_3 - \frac{b_3\alpha_0}{\beta} + \frac{b_3\alpha_1}{\beta}QP_t + \left(c_3 - \frac{b_3\alpha_2}{\beta}\right)Z_t - \frac{b_3\alpha_3}{\beta}CCC_t + \frac{b_3}{\beta}\gamma_0$$

$$(2.8)\quad STK_t = \lambda_0 + \left[\alpha_1\left(1 - \frac{b_1 + b_3}{\beta}\right) + c_2\right]QP_t - \left[\alpha_2\left(1 - \frac{b_1 + b_3}{\beta}\right) + d_2 c_2\right]Z_t - \left[\alpha_3\left(1 - \frac{b_1 + b_3}{\beta}\right) + f_2\right]CCC_t - \left(1 - \frac{b_1 + b_3}{\beta}\right)\gamma_0$$

$$(2.9) \quad QP_{t+1} = a_4 + b_4\alpha_0 - \frac{b_4\alpha_1}{\beta}QP_t + \frac{b_4\alpha_2}{\beta} Z_t + \frac{b_4\alpha_3}{\beta} CCC_t - \frac{b_4}{\beta}\gamma_0 .$$

where

$$\alpha_0 = a_1 + a_2 + a_3(1-d_2) - e_2a_4$$

$$\alpha_1 = c_2 - 1 \qquad \alpha_1 < 0$$

$$\alpha_2 = c_3(1-d_2) \qquad \alpha_2 > 0$$

$$\alpha_3 = 1 - f_2 \qquad \alpha_3 > 0$$

$$\gamma_0 = STK_{t-1} + R_{t-1} + CCC_{t-1} \qquad \gamma_0 > 0$$

$$\beta = b_1 + b_2 + e_2b_4 + b_3(1 - d_2) \qquad \beta > 0$$

A discussion of the implied reduced form impacts on price, subsidized reserves, private stocks, and expected production resulting from loan program policy variation follows. It is assumed all other variables are being held constant. These theoretical results help anticipate the outcome of the policy analysis in Chapter 5.

$$(2.10) \quad \frac{\partial P_t}{\partial Z_t} = \frac{\alpha_2}{\beta} > 0$$

A change in loan policy to induce more participation has a positive effect on the market price as shown in (2.10). As more grain is placed under loan, less is available for sale on the market, causing price to move upward.

$$(2.11)\quad \frac{\partial R_t}{\partial Z_t} = c_3 - \frac{b_3\alpha_2}{\beta} > 0, \text{ since}$$

$$c_3 - \frac{b_3\alpha_2}{\beta} = c_3 - \frac{c_3b_3(1-d_2)}{b_1 + b_2 + e_2b_4 + b_3(1-d_2)} > 0$$

The result from the impact in (2.11) shows that the policy variable is defined as being positively related to the level of subsidized reserves. Making the programs more attractive to producers by, say, raising the loan rate or lowering the interest rate will increase the expected returns from subsidized storage, causing that quantity stored to increase.

$$(2.12)\quad \frac{\partial STK_t}{\partial Z_t} = -\left[\alpha_2\left(1 - \frac{b_1 + b_3}{\beta}\right) + d_2c_3\right] < 0$$

The impact in (2.12), however, shows the negative effect the loan policies can have on private stocks. This may result from producers viewing the government's programs as an alternative to private storage and/or the producers may be considering what the effect on expected price will be. If they foresee a large build-up in reserves resulting from an attractive loan program, their price expectations may be lowered as a result. The potential for the grain to be released in some later period affects expected price.

$$(2.13)\quad \frac{\partial QP_{t+1}}{\partial Z_t} = \frac{b_4\alpha_2}{\beta} > 0$$

The result from the impact on expected production in (2.13) implies an interesting situation. If an attractive loan program draws heavy participation, there will be a positive effect on next period's production. This means that if the government wishes to have existing supplies shrink, it should also include some type of acreage reduction program for the loan program participants.

CHAPTER 3. MODEL SPECIFICATION

The model used in this analysis can be divided into two major parts. The first is a national corn model with estimated equations and identities for solving domestic consumption, export demand, ending stocks, and acreage response. The second part calculates government costs with respect to the loan programs. The cost portion of the model is solved recursively from the simultaneous solution of the national model.

The national model is similar to the Baumes and Meyers corn model (1980) except for the ending stock equation. In this model ending stocks are specified in such a way as to endogenize the nine-month and farmer-owned reserve loan programs within the simulation.

This chapter presents the specification for the behaviorial equations and the identities. These are shown in Table 3.1 and the variable definitions are in Appendix B. The following sections explain how the independent elements in the estimated equations are expected to be related to the dependent variable and how the identities are calculated. The expected signs are given above the the elements in the specified equations.

Table 3.1. Structure of the U.S. corn model[a]

Production

(3.1) $$\text{CORPGR1} = \text{CORSA1} * .86 * \text{CORSYGR1}$$

(3.2) $$\text{CORSA1} = f_1(\overset{(+)}{\text{CORNRE/SNRE1}},\ \overset{(+)}{\text{CORPE1/SOYPF}},\ \overset{(+)}{\text{CORSA}},\ \overset{(-)}{\text{CORPD1/CORPF}})$$

(3.3) $$\text{CORNRE} = (\text{CORPF} * (\text{CORSYGR1}_{-1} + \text{CORSYGR1}_{-2} + \text{CORSYGR1}_{-3})/3) - \text{CORVC}$$

Feed demand

(3.4) $$\text{CORDF} = f_2(\overset{(-)}{\text{CORPF/FPINDEX}},\ \overset{(+)}{\text{SOMPM/FPINDEX}},\ \overset{(+)}{\text{WHEPF/FPINDEX}},$$
$$\overset{(+)}{\text{GCAUTST}},\ \overset{(+)}{\text{LIVIF1}},\ \overset{(+)}{\text{CORDF}_{-1}})$$

Food demand

(3.5) $$\text{CORDH} = f_3(\overset{(-)}{\text{CORPF/WHEIW1}},\ \overset{(+)}{\text{CEN1}})$$

Export Demand

(3.6) $$\text{CORXTOT} = f_4(\overset{(-)}{\text{CORSOYEU}},\ \overset{(+)}{\text{LIVPEUJ1}},\ \overset{(-)}{\text{COR9SRF}},\ \text{SHIFT72},\ \text{SHIFT79})$$

(3.7) $$\text{CORSOYEU} = (\text{CORECPC} * \text{CORPA} + (1-\text{CORECPC}) *$$
$$(39.368 * \text{CORPF/SDROCT}))/(\text{SOMPM/SDROCT})$$

(3.8) $$\text{CORECPC} = (\text{COSMNE9}/39.368)/\text{CORXTOT}$$

(3.9) $$\text{CORMX} = \text{CORXTOT} - ((\text{CORMXCC}-\text{CORMESR})/39.368) + \text{CORMXSPR} + \text{CORMG}$$

Ending Stocks

(3.10) $$\text{CORHCCIX} = f_5(\overset{(-)}{\text{CORPF/WHEIW1}},\ \overset{(-)}{(\text{CORHPRRE} + \text{CORHHUN})},$$
$$\overset{(-)}{\text{CORPGR1}},\ \overset{(+)}{\text{CORPGR}},\ \overset{(-)}{\text{NRL}},\ \overset{(-)}{\text{IPCA}})$$

(3.11) $$\text{CORHPRRE} = \text{CPLACE} - \text{CUMRED}$$

[a]See Appendix B for variable definitions.

Table 3.1. (continued)

$$(3.12)\ CPLACE = f_6(\overset{(-)}{CORPF}, \overset{(+)}{CORRE}, \overset{(+)}{PRES}, \overset{(-)}{ICCC}, \overset{(-)}{TBILL}, \overset{(+)}{CORPGR}, \overset{(+)}{CPART}, \overset{(+)}{SPMT})$$

$$(3.13)\ NRL = CORTPSL - CORPRES - CORNTRED - CORFCCC + EXTCARRY$$

$$(3.14)\ CORTPSL = f_7(\overset{(+)}{CPRATW}, \overset{(-)}{ICCC/IPCA}, \overset{(+)}{CRISK}, \overset{(+)}{CORPGR}, \overset{(+)}{CPART}, WAIVE81, RSHIFT)$$

$$(3.15)\ CPRATW = (Z(CORPL) + (1-Z)CORRE)/CORPF$$

$$(3.16)\ Z = (CORTPSL - (CPLACE - CPLACE_{-1}))/CORTPSL$$

$$(3.17)\ CRISK = 1/3 \sum_{i=0}^{2} (CORPF_{t-i} - (CORPF + CORPF_{-1} + CORPF_{-2})/3)^2$$

$$(3.18)\ CORPRES = CPLACE - CPLACE_{-1} - CYRED$$

$$(3.19)\ CORNTRED = f_8(\overset{(+)}{CORPNML}, \overset{(-)}{CORPL/CORPF}, \overset{(-)}{ICCC/IPCA}, \overset{(+)}{CORPGR1})$$

$$(3.20)\ CORPNML = CORTPSL - (COREXTL + CORPRES)$$

<u>Market clearing identity</u>

$$(3.21)\ CORDH + CORHT + CORMX + CORDS = CORPGR + CORHT_{-1} + CORMI$$

<u>Government loan outlays</u>

$$(3.22)\ NMLOAN = CORPL * (CORTPSL - (CPLACE - CPLACE_{-1}))$$

$$(3.23)\ NMRED = CORPL * (CORTPSL - (CPLACE - CPLACE_{-1}) - NRL - CORFCCC$$

$$(3.24)\ NETNM = NMLOAN - NMRED$$

$$(3.25)\ FORLOAN = CORRE * (CPLACE - CPLACE_{-1})$$

$$(3.26)\ FORRED = ((CORRE + CORRE_{-1} + CORRE_{-2})/3) * (CUMRED - CUMRED_{-1})$$

$$(3.27)\ NETFOR = FORLOAN - FORRED$$

$$(3.28)\ TSPMT = SPMT*((CORHPRRE+CORHPRRE_{-1})/2 + (CORHHUN+CORHHUN_{-1})/2)$$

$$(3.29)\ DEFPAY = CORSA*CPART*100*(CORPT-MAX(CORPL,CORPF-.10))$$

$$(3.30)\ NETCOST = NETNM + NETFOR + TSPMT + DEFPAY$$

Production

Equation (3.1) is the identity for calculating expected production (CORPGR1), which is equal to expected corn acreage planted (CORSA1) times the expected yield (CORSYGR1) adjusted by a harvesting rate, a constant 0.86.

Corn acreage planted in the next period is estimated with the acreage response function specified in Equation (3.2). The first term in this equation is a corn to soybean net returns per acre ratio (CORNRE/SNRE1). The calculation for corn net returns per acre is shown in Equation (3.3). The expected sign for this ratio is positive, since producers will be more inclined to devote acres to corn if the net returns from doing so are greater. On the other hand, higher net returns per acre from soybeans will tend to decrease corn acreage planted, since soybeans act as a substitute for corn.

The sign on the expected effective support price for the corn to soybean price ratio (CORPE1/SOYPF) is positive; higher corn support prices induce producers to plant corn, while higher soybean prices induce producers to plant less corn and more soybeans. There is an effective support price for soybeans, but it is not used in this equation. The soybean price has been above the support price throughout most of the historical period, as a result, producers may mainly consider the soybean price itself and not the effective support price when they make their planting decisions.

Current acreage planted (CORSA) represents the time lag involved in increasing or decreasing corn acres planted. Corn production is time consuming and costly; it is not usual that producers can immediately increase or reduce acreage. Therefore, a positive sign is expected for this variable.

The expected diversion payment is one important policy variable used to regulate supply. Any increase in this ratio (CORPD1/CORPF) is expected to decrease corn acreage planted.

Feed Demand

Feed demand is shown in Equation (3.4) and is inversely related to the market price (CORPF). Higher prices make it more expensive for producers to use corn as feed, and they may even substitute soybean meal (SOMPM) or wheat (WHEPF) instead.

Grain consuming animal units (GCAUTST) and the livestock price index (LIVIF1) are positively related to corn feed demand. Larger livestock numbers create more total feed use, including feed from corn. Higher livestock prices shift out feed demand as producers increase their herd sizes.

Lagged feed demand ($CORDF_{-1}$) reflects the time and expense facing producers who wish to change their herd sizes. Due to the relatively fixed sizes of their yards and confinements, producers are restricted from changing the sizes of their operations, and hence their feed use, immediately. As a result, the expected sign for lagged feed demand is positive.

Food Demand

Equation (3.5) is the specification for food use. Food use is inversely related to the price. Personal consumption expenditures on nondurable goods and services (CEN1) act as a proxy for the amount consumers spend on food produced from corn. If these expenditures increase, we assume corn food demand will increase also.

Export Demand

Total U.S. exports for corn are calculated from the identity in Equation (3.9) and are derived from a world export demand equation (CORXTOT) shown in (3.6). CORXTOT reflects the total world export demand facing major exporters and is specified similarly to the model developed by Westhoff and Meyers (1984).

The corn/soymeal price ratio (CORSOYEU) in Equation (3.6) reflects the substitutability between corn and soymeal. Equations (3.7) and (3.8) show how this ratio is calculated. The U.S. corn and soymeal prices are deflated by the standard drawing rate which is used to adjust prices for changes in exchange rates. The expected sign on CORSOYEU is negative.

The livestock index variable (LIVPEUJ1) in (3.6) reflects the EEC and Japanese hog and poultry production. Larger production of these commodities will shift export demand outward.

Competing supplies in the major corn importing countries is measured by EEC corn supply and Japanese rice fed to livestock (COR9SRF). This variable is expected to be negatively related to export demand.

SHIFT72 and SHIFT79 are dummy variables used to account for unexplained shifts in exports in 1972 and 1979, 1980.

Ending Stock Demand

Equation (3.10) shows the specification for ending commercial stocks. CORHCC1X represents free stocks excluding those held under government loan. Most ending stock models include nine-month carryover as part of the dependent variable. The specification used here, however, gives clearer indications as to how the government sponsored loan programs affect producers' private storage decisions.

The first term in Equation (3.10) is the real price for corn (CORPF/WHEIW1) and equals the corn price received by farmers divided by the wholesale price index. A negative expected sign for price indicates producers' desires to market corn instead of holding it when prices are rising.

The sum of reserve and CCC stocks (CORHPRRE + CORHHUN) and nine-month loan carryover (NRL) act as proxies for the expected price next crop year. Relatively large reserve, CCC, and nine-month stocks influence expected price through their potential to be released on the the market. The expected price effect for outstanding nine-month loans is probably larger since these stocks are not isolated from the market. However, reserve and CCC stocks are more isolated due to restrictions placed on their release and storage that the impact on next period's expected price may be less, but may last longer, especially if these stock quantities are large.

Expected production (CORPGR1) can affect ending stocks not only through expected price but also through producers' precautionary motive for holding inventory. For instance, if there are forecasts for a good crop next period, producers may maintain lower inventories since they will be able to replenish them through an abundant harvest.

The Production Credit Association's interest rate (IPCA) in Equation (3.10) reflects the general market interest rate and acts as a measure of opportunity cost. If this rate increases, producers would be more inclined to sell corn and invest the cash from sales at the higher interest rate.

Current production (CORPGR) influences ending stocks through the market price and is positively related to the level of ending stocks.

Equation (3.11) is the identity used to solve for reserve ending stocks. Cumulative reserve placements (CPLACE) less cumulative reserve redemptions (CUMRED) yield the reserve stock level at the period's end.

Cumulative placements are specified in Equation (3.12). This equation reflects both market and program influences on reserve stocks. Price received (CORPF) is a market influence and is expected to negatively influence placements in the reserve. Another market influence is the three-year treasury bill rate (TBILL) which reflects the long term general interest rate and acts as a measure of opportunity cost. If this rate increases, potential reserve participants would be less inclined to place corn in the reserve. Instead, they would alternatively sell the grain and invest the cash receipts at the higher interest rate reflected by TBILL.

Current production (CORPGR) in (3.12) has a positive expected sign, because large levels of production may drive down the market price, inducing more reserve placement.

The remaining elements of (3.12) reflect program influences on cumulative placements. The reserve entry price (CORRE) is the reserve loan rate. Higher loan rates tend to induce more participation in the program by increasing producers' expected returns from storage. The release price (PRES) is a predetermined price at which grain from the reserve is allowed to be redeemed without penalty only after it is reached by the market price. At this point direct storage subsidies cease. Higher release prices would expectedly increase reserve placements. The CCC interest rate (ICCC) is the interest charged on reserve loans. A higher rate means that the interest expense to participants will be greater, which acts as a disincentive to reserve participation. Storage payments (SPMT) are a direct subsidy paid to reserve participants to store their grain. Currently set at $.265/bushel, this payment, if raised, will induce more placements.

Equation (3.13) is the carryover held under nine-month loan (NRL) identity. The last term in this equation, extended carryover (EXTCARRY), includes grain that was placed in the old reseal program from 1953 through 1971. This program was similar to the reserve in that it allowed producers to keep grain under loan after their nine-month loans expired. They were given the option of extending their loans with the CCC paying the storage costs. The major difference from the reserve program, however, was that corn placed under extended loan was redeemable on demand, whereas loans under reserve are not. Extended carryover in (3.13) becomes 0 after 1971 when the resale program was terminated.

The other exogenous variable in Equation (3.13) is forfeitures to the CCC (CORFCCC). Forfeitures are deliveries to the CCC that result when producers default on their nine-month loans.

Total price support loans (CORTPSL) issued during the period in (3.13) are specified in the behavioral Equation (3.14). This equation is modeled following the method of Miller et al. (1978). The loan/price ratio (CPRATW) takes into account the different loans rate for the reserve and nine-month loan programs. Its computation is shown in (3.15) and (3.16). The way this ratio is computed implies corn is placed either under nine-month loan or reserve loan, when it can actually move from the nine-month program into the reserve. Nevertheless, this variable does capture producers' concerns for each program's loan rate. Prices received by producers (CORPF) in this ratio reflect the loan rates of private financial institutions like the PCA, since they lend at a rate proportional to the value of the collateral. One expects a positive sign for this ratio because, for example, as CCC loan rates increase more producers would be inclined to acquire CCC loans; their returns from storage would be greater.

The interest rate ratio (ICCC/IPCA) in Equation (3.14) reflects producer concerns for the program interest rates verses private financial institutional interest rates. The expected sign is negative because the interest expense will induce potential borrowers to borrow from the lenders with a lower rate.

The risk variable (CRISK) is a three year moving variance of the market price. Its computation is shown in Equation (3.17). An expected positive sign for risk reflects the notion that producers see the CCC as an assumer of risk.

Current production (CORPGR) in (3.14) affects total loan demand through a price effect. Larger production levels place downward pressure on price, inducing producers to place more corn under price support loans.

CPART represents the proportion of producers who are eligible for CCC loans. In some years, only farmers participating in land set-asides are eligible.

The last elements in (3.14) are dummy variables. WAIVE81 reflects the unusually large number of loans issued in 1981. That was the year interest was waived on reserve loans. The purpose of the interest waiver was to induce more participation in the reserve in order to remove excess grain from the market that resulted from the Carter administration's grain embargo. RSHIFT reflects the shift in the level of CCC loan demand since the beginning of the reserve program in 1977.

Equation (3.18) shows how to calculate reserve placements during the crop year (CORPRES). It is the difference between current and lagged cumulative placements less any reserve crop year redemptions. CORPRES is used in (3.13) to solve for nine-month loans outstanding.

Nine-month loan redemptions (CORNTRED) are specified in Equation (3.19). The element CORPNML reflects the amount of nine-month loans available for redemption and is simply the difference between the quantity of corn placed under total price support and reserve placements during the year. A functional form which is appropriate for estimating nine-month redemptions is a logistic function shown below:

$$(3.31)\ \text{CORNTRED} = \text{CORPNML}/1+\exp[-(\alpha+\beta X_i)]$$

where CORNTRED approaches CORPNML in the limit as $(\alpha+\beta X_i)$ increases.

The sign for the loan/price ratio (CORPL/CORPF) in Equation (3.19) is expected to be negative because higher relative loan rates mean producers must repay more to the CCC when the loan is redeemed. On the other hand, higher relative corn prices would tend to increase loan redemptions.

The interest ratio (ICCC/IPCA) in Equation (3.19) is expected to be negative because higher relative CCC interest rates mean larger loan repayments to the CCC upon redemption. In this equation, too, the PCA interest rate reflects the general market interest rate and acts as a measure of opportunity cost.

Expected production (CORPGR1) in Equation (3.19) proxies expected price. For instance, if expected production for next year is large, the future price would expectedly be less than if future production were small. Producers will be more inclined to redeem their loans now rather than carry them into the next period and receive a lower price.

Equation (3.21) shows the market clearing identity, and the calculations for government outlays associated with the loan programs are shown in Equations (3.22) through (3.30).

CHAPTER 4. EMPIRICAL ANALYSIS AND VALIDATION

This chapter presents the results of the estimation and simulation procedures. The first section presents the calculated coefficients for the cumulative placement equation and a description of the technique used to calculate them. The second section presents the results from the simultaneous estimation of the other parameters and an analysis of the entire model through a dynamic simulation.

Computation of the Cumulative Placement Coefficients

The specification for farmer-owned reserve cumulative placements, which was first shown in the last chapter, is listed below:

$$(4.1)\ \text{CPLACE} = f_1(\text{CORPF, CORRE, PRES, ICCC, TBILL, CORPGR, CPART, SPMT})$$

This annual placement function includes most of the major market and policy factors that affect producers' placement decisions.

A special technique, independent of the rest of the model, must be employed to estimate the coefficients for this equation. Because the reserve has been in operation only since 1977, there are not enough annual observations for a regression analysis. There are, however, enough monthly observations to permit an analysis using a monthly model. The coefficients for the annual placement equation listed above are derived from the simulation of a monthly reserve placement model during "direct entry" years only (1979, 1981, 1982). Once the coefficients for the annual placement equation are derived, we then place it back into the complete U.S. corn model to be used in the estimation of the other parameters and the simulation analysis. For the years 1977, 1978, and 1980, the exogenous values for cumulative placements are used.

The monthly model used in this technique was initially developed by Meyers and Jolly (1980) and further developed by Meyers, Jolly, and Smyth (1983a,b). In the development and use of their model they assume 1) that farmers rationally compare the expected returns and benefits from reserve participation to the expected returns from alternative uses of the grain, 2) there is a cash price as the alternative to which reserve participation is compared, and 3) there is a maximum quantity of grain available for placement.

What follows is a brief description of the Meyers et al. (1983b) placement model. The general specification for monthly reserve placements is shown below:

(4.2) $QP_t = f_2(MKT_t, PPV_t, QAP_t, PART_t)$

where the t subscripts represent monthly periods and where

MKT = market price for corn,

PART = participation rate for the acreage reduction programs,

PPV = present value from storage,

QAP = quantity of corn available for placement,

QP = quantity placed into the reserve.

The market price is inversely related to monthly placements. The present value variable is a summary variable that includes most of the policy and market factors that affect the present value from reserve storage. Any policy or market factor that increases expected returns from reserve storage increases placements. Larger quantities available for placement and/or larger participation will also increase placements.

Meyers et al. (1983b) chose a logistic function as the form to estimate the monthly coefficients. Equations (4.3) through (4.8) show the structure of their model and the estimated coefficients they obtained are given in (4.3).

$$(4.3)\quad PLACE_t = \frac{AVAIL_t}{1 + \exp[-(-7.75 - 1.95(CORPF_t) + 3.74(PPVMAX_t) - 1.30(PART_t)]}$$

$$(4.4)\quad AVAIL_t = (HARV_t - SLD_t)(PART_s)(CORPGR_s) - (1 - SLD_t)(BRS_{st} - BRS_{s1})$$

$$(4.4a)\quad PPVMAX = MAX(PPVDEF, PPVRED)$$

$$(4.5)\quad PPVDEF_t = CORRE_t + \sum_{j=1}^{T} \frac{SPMT_t - SCOST_t}{(1 + TBILL)^{j-1}}$$

$$(4.6)\quad PPVRED_t = PPVDEF + \left[\frac{.97(PEXP) - (1 + ICCC_t * YRINT_t)\ CORRE_t}{(1 + TBILL_s)^T}\right]$$

$$(4.7)\quad PEXP_t = 1.10 * (PRES_t)$$

$$(4.8)\quad CPLACE_t = CPLACE_{t-1} + CPLACE_t$$

where subscript t = month, subscript s = crop year, and superscript T = number of years the grain is held in the reserve.

Endogenous variables

CPLACE = cumulative placements,

PLACE = monthly placements in the reserve,

Exogenous variables

AVAIL = quantity available for reserve placement,

BRS = beginning reserve stock level,

CORPF = price received by farmers,

CORRE = reserve loan rate,

CORPGR = production for the crop year,

HARV = proportion of corn harvested by month t,

ICCC = CCC interest rate,

PART = reserve participation rate for the crop year,

PEXP = expected sales price,

PPVDEF = present value of defaulting on the loan,

PPVMAX = maximum present value of defaulting verses redeeming the reserve loan,

PPVRED = present value of redeeming the loan,

PRELS = reserve release price,

SCOST = storage cost per bushel,

SLD = proportion sold by month t,

SPMT = storage payment rate per bushel,

TBILL = three-year treasury bill rate,

YRINT = number of years interest is charged on reserve loans.

As mentioned earlier, the coefficients for Equation (4.3) were estimated for the direct entry periods. Direct entry was permitted in 1979, 1981, and 1982 when producers were allowed to participate in the reserve without first participating in the nine-month loan program. The signs on the estimated coefficients appear to be theoretically correct.

The identity for monthly quantities available for placement is shown in Equation (4.4). The first term in this equation measures the quantity of eligible grain harvested but not yet marketed at the beginning of month t in crop year s. The second term measures the quantity of grain removed from available supplies as a result of placements since the first month of the crop year. The following assumptions regarding available grain supplies for placement are made:

1) only set-aside participants are eligible for placements,

2) grain reserve placements reduce availability, but redemptions increase availability by substitution with new crop grain,

3) grain marketing reduces availability.

The present value variable in (4.4a) reflects producers' decisions to take the option with the highest return; either default on the loan or redeem it. Equations (4.5) and (4.6) show the computations for both options. The default option becomes attractive if the loan rate is too high relative to the expected sales price. The expected sales price is assumed to be 110 percent of the release price.

In Equation (4.6), shrinkage and quality deterioration are reflected by the 0.97; 3 percent of the corn is assumed to become unusable during the storage period. In this monthly model, Meyers et al. (1983b) have assumed two years as the maximum storage time.

We can now proceed to describe the method used to calculate the annual coefficients for Equation (4.1). The coefficients along with their elasticities are listed in Table 4.1.

Table 4.1. The coefficients for the cumulative placement function[a]

Variable	1979/80	1981/82	1982/83
CORPF	-581.00	-2550.84	-934.08
	[-3.97][b]	[-4.80]	[-1.74]
CORRE	133.44	3199.48	1242.32
	[.77]	[6.14]	[2.51]
PRELS	440.96	1289.64	4.40
	[3.14]	[3.06]	[.009]
ICCC	-1888.00	-7806.50	0
	[-.46]	[-.81]	[0]
TBILL	-800.00	-1433.00	-495.00
	[-.24]	[-.15]	[-.04]
CORPGR	.044	.1836	.1543
	[.95]	[1.13]	[.90]
CPART	1305.25	179.10	4967.15
	[.75]	[.13]	[.80]
SPMT	2460.80	11437.40	4652.10
	[1.77]	[2.28]	[.69]
INTERCEPT	112.90	-6303.80	-320.90

[a]See Appendix B for variable definitions.

[b]Elasticities are in brackets.

Using the described Meyers et al. (1983b) model, 12-month simulations were run for each crop year listed in Table 4.1. These simulations yielded "base values" for reserve cumulative placements for each crop year. These base values, by the way, were close to the actual cumulative placement values at each crop year's end as reported by the USDA.

Next, the variables in the monthly model were shocked to see how cumulative placements would be affected. Table 4.2 shows the actual or base value of each variable and the shock it was given. The values listed for CORPF, ICCC, and TBILL are the crop year averages. In the monthly data, these three variables change from month to month, but for illustration only the averages are shown in this table.

Table 4.2. Base values for the cumulative placement variables and the administered shocks[a]

	1979/80		1981/82		1982/83	
Variable	base	shock	base	shock	base	shock
CORPF[b]	2.52	±.25	2.50	±.25	2.68	±.25
CORRE	2.10	±.25	2.55	±.25	2.90	±.25
PRELS	2.63	±.25	3.15	±.25	3.25	±.25
ICCC[b]	0.09	±.02	0.139	±.02	0.094	±.02
TBILL[b]	0.110	±.02	0.139	±.02	0.102	±.02
CORPGR	7339.00	±200	8201.00	±200	8359.00	±200
CPART	.211	±.20	1.00	±.20	.23	±.20
SPMT	.265	±.10	.265	±.10	.265	±.10

[a]See Appendix B for variable definitions.

[b]12 month average.

Table 4.3. Changes in cumulative placements resulting from administered shocks[a]

	1979/80		1981/82		1982/83	
	+.25	-.25	+.25	-.25	+.25	-.25
$\frac{\partial CPLACE}{\partial CORPF}$	-121.87	168.63	-528.67	746.75	-252.60	214.43
$\frac{\partial CPLACE}{\partial CORRE}$	35.84	-30.67	1455.22	-144.52	365.06	-256.10
$\frac{\partial CPLACE}{\partial PRELS}$	123.88	-96.59	519.69	-124.63	2.20	0
	+.02	-.02	+.02	-.02	+.02	-.02
$\frac{\partial CPLACE}{\partial ICCC}$	-36.13	39.38	-108.60	203.65	0	0
$\frac{\partial CPLACE}{\partial TBILL}$	-15.25	16.65	-27.74	29.55	-9.78	10.01
	+200	-200	+200	-200	+200	-200
$\frac{\partial CPLACE}{\partial PROD}$	8.81	-8.81	36.72	-36.72	30.86	-30.86
	+.2	-.2	+.2	-.2	+.2	-.2
$\frac{\partial CPLACE}{\partial PART}$	194.56	-327.54	-71.33	-.3	877.77	-1109.09
	+.10	-.10	+.10	-.10	+.10	-.10
$\frac{\partial C\ PLACE}{\partial SPMT}$	266.27	-165.88	1575.47	-712.0	388.51	-541.90

[a]See Appendix B for variable definitions.

Dynamic simulations of the monthly model were run for each shock given to each variable for each of the three crop years. Table 4.3 shows the impacts on cumulative placements resulting from each shock over the 12 month periods. The sizes of the administered shocks reflect reasonable guesses of possible variations for each variable. The shock sizes, in fact, approximate the standard deviation for many of the variables listed. These ranges seem large enough to provide realistic spreads in which each variable's coefficient can be computed.

Equations (4.10) through (4.13) summarize the steps used to compute the annual coefficients in Table 4.1 for each year.

$$(4.10)\quad BV - IV_{+s} = CPV_{+s}$$

$$(4.11)\quad BV - IV_{-s} = CPV_{-s}$$

$$(4.12)\quad ((CPV_{+s} - CPV_{-s})/2) * 1/|s| = \beta_i$$

$$(4.13)\quad \alpha_0 = CPLACE_t - \sum_{i=1}^{8} \beta_i X_i$$

Where BV = base value simulation results for cumulative placements,

IV_{+s} = impact value of cumulative placements resulting from a positive shock to the variable,

IV_{-s} = impact value of cumulative placements resulting from a negative shock to the variable,

CPV_{+s} = change in cumulative placements from a positive shock,

CPV_{-s} = change in cumulative placements from a negative shock,

s = size of the shock given to each variable,

α_0 = intercept term,

β_i = computed coefficient,

X_i = independent variable,

CPLACE = actual quantity of cumulative placements at the end of the crop year.

The calculated coefficients in Table 4.1 are, perhaps, not as good as if they had been estimated simultaneously within the supply and demand model. However, due to the limited reserve observations available, the technique used in calculating them has yielded proxies for the estimated coefficients that allow the reserve placement equation to be used endogenously in the supply and demand simulation.

Note that the calculated coefficients in Table 4.1 vary among years. This is due to the nonlinear nature of the reserve placement function. The coefficients are generally larger in 1981 which may be the result of high eligible participation, since there was no set-aside program. The coefficient for CPART in 1981, however, is comparatively small. With the large eligible participation for that year, the marginal effect of additional participation becomes small. The large production coefficient (CORPGR) in 1981 may be the result of the producers gearing up for production. One might be wary of the large size of the SPMT coefficient for 1981.

In 1982, the coefficient for the CCC interest rate (ICCC) is 0 and the coefficient for the treasury bill (TBILL) is only -495. These relatively small sizes may be the result of the high loan rate for that year. The high loan rate caused the default option to be a dominate factor, which caused the interest rate effects to be vary small compared to other years. The release price coefficient (PRELS) in 1982 is also small. The release price in 1982 was set quite high resulting in additional effects on cumulative placements to be small.

Estimation and Validation

The parameters for the remaining behavioral equations can now be estimated. They are estimated using nonlinear two stage least squares to produce asymptotically unbiased estimates.

The following assumptions are made about the error term for the estimation procedure:

1) each equation has a random error with a normal distribution and an expected value of zero, $E(u) = 0$,

2) the error terms have 0 covariance, that is, their values are 0 between two observations,

3) the error terms are uncorrelated with the predetermined variables,

4) the contemporaneous covariance matrix of the error is nonsingular, $E(uu') \neq 0$.

The period of estimation, 1963-1982, is a long enough historical period to provide enough observations for the analysis. The short existence of the reserve presented a problem, which is why the parameters for the placement equation had to be calculated as described in the previous section of this chapter.

There are more predetermined variables than observations in this model, as a result, the principal component technique is applied in the first estimation stage. Fifteen principal components were arbitrarily chosen from all the exogenous variables to be used as instrumental variables.

The results of the simultaneous estimation procedure are presented in Table 4.4. The t-values are in parentheses and the elasticities evaluated at the means are in brackets below the estimated parameters. The R^2 and Durbin-Watsin statistics are listed on the right side of each equation. This model has two equations with lagged dependent variables, which renders the DW test less applicable. But, as Huyser (1983) points out, the DW test is still a powerful indicator of any serial correlation problems in these situations.

Acreage Response

The statistical properties of the corn acreage equation are quite good. The high R^2 indicates the equation explains almost all of the historical variation in corn acreage planted. All of the variables are significant at the 1 percent level except for the effective support/soybean price ratio (significant at the 10 percent level). The diversion policy variable is highly significant in influencing corn acreage planted. Acreage response is fairly inelastic with respect to the corn and soybean price as reflected by the net returns ratio.

Feed Demand

All of the variables in the feed demand equation are significant at the 10 percent level except for the wheat price and lagged feed demand. Instead of estimating this equation in the usual manner, it was turned around into the form

Table 4.4. Parameter estimates for structural equations[a,b]

	$\hat{\rho}$	R^2	D.W.
Acreage			
(1) $CORSA1 = 39.42 + 3.53\frac{CORNRE}{SNRE} + 14.87\frac{CORPE1}{SOYPF} + .428\ CORSA - 43.97\frac{CORPD1}{CORPF}$		0.962	1.83
(9.02) (2.61) (1.62) (5.84) (-11.85)			
[.05] [.06] [.44] [.07]			
Feed demand			
(2) $CORDF = -2566.43 - 884.46\frac{CORPF}{FPINDEX} + 4.55\frac{SOMPM}{FPINDEX} + 316.23\frac{WHEPF}{FPINDEX}$		0.978	2.90
(-.91) (-1.74) (2.43) (1.15)			
[-.35] [.13] [.17]			
$+ 53.38\ GCAUTST + 231.37\ LIVIF1 + .302\ CORDF_{-1}$			
(1.78) (1.55) (1.24)			
[1.36] [.10] [.30]			
Food demand			
(3) $CORDH = 211.97 - 39.56\frac{CORPF}{WHEIW1} + .350\ CEN1$	0.281	0.981	1.61
(4.64) (-1.24) (17.94)			
[-.10] [.62]			

[a]See Appendix B for variable definitions.

[b]The t-values are in parentheses and elasticities evaluated at the means are in brackets.

Table 4.4. (continued)

	R^2	D.W.

World Export demand

(4) $CORXTOT = 581.27 - 464.65\ CORSOYEU + 1313.77\ LIVPEUJ1 - .050\ COR9SRF$ — R^2 = 0.983, D.W. = 1.97

(1.41) (-2.25) (4.63) (-3.39)
[-.28] [1.41] [-.52]

$- 406.78\ SHIFT72 + 553.56\ SHIFT79$

(-4.60) (7.47)

Private stock demand

(5) $CORHCC1X = 1166.19 - 491.29\frac{CORPF}{WHEIW1} - .250\ (CORHPRRE + CORHHUN) - .053\ CORPGR1$ — R^2 = 0.818, D.W. = 3.00

(3.64) (-3.32) (-3.86) (-2.24)
[-1.26] [-.31] [-.69]

$+ .073\ CORPGR - .550\ NRL - 4.68\ IPCA$

(2.39) (-2.94) (-.30)
[.95] [-.37] [-.10]

Total Loans

(6) $CORTPSL = -818.91 + 1408.92\ CPRATW - 1198.28\frac{ICCC}{IPCA} + 1469.50\ CRISK + 0.107\ CORPGR$ — R^2 = 0.944, D.W. = 1.65

(-1.74) (4.09) (-3.09) (2.52) (2.11)
[2.01] [-1.34] [.16] [.98]

$+ 440.04\ CPART2 + 747.13\ WAIVE81 + 320.22\ RSHIFT$

(3.14) (4.13) (1.83)
[.31]

Nine-month redemptions

(7) $CORTRED = 10.48 - 7.39\frac{CORPL}{CORPF} - 9.57\ \frac{ICCC}{IPCA} + .0006\ CORPGR1$

(5.10) (-4.36) (-4.86) (4.31) — R^2 = 0.928, D.W. = 1.63
[-1.12] [-1.12] [.61]

$$P = P + Q - (\alpha_0 + \beta_1 P + \beta_i X_i)$$

to allow the model to solve for the equilibrium price.

The elasticity with respect to corn price at -0.35 is consistent with other studies, while the soymeal price is a little more inelastic at 0.13. The elasticity for grain consuming animal units is lower than the 1.46 obtained by the Center for National Food and Agricultural Policy at the University of Missouri-Columbia and a little higher than the 1.08 by Baumes and Meyers (1980).

Food Demand

In the food equation, price is left in because it has the right sign, even though it is statistically insignificant. The amount spent on nondurable goods and services is a very significant determinant of food demand for corn. This equation has been corrected for autocorrelation. The estimated value of ρ is listed to the right of the equation.

World Export Demand

The specification for the world export demand is similar to Westhoff and Meyers (1984). The equation explains the historical variation well as evidenced by the R^2 of 0.983. All of the variables are significant at the 1 percent level except for corn/soymeal ratio which is significant at the 5 percent level. It may be less than desirable to have the two dummy variables be as significant as they are, since they are used to reflect unexplained shifts in total world exports.

The corn/soymeal elasticity is slightly smaller than the -0.34 obtained by Westhoff and Meyers. The elasticity on the index of EEC and

Japanese poultry and hog production is a little larger than Westhoff and Meyers' 1.04 and Baumes and Meyers' 1.17. The results show Europe and Japan to be significant determinants of world export demand for corn.

Private Stock Demand

The private stock demand equation has the lowest R^2 of all the equations in the model, but it is still quite satisfactory. The low R^2 was not totally unexpected since stock equations have typically been harder to estimate. As mentioned in the previous chapter, this equation estimates free stocks excluding those under nine-month loan. Stocks under loan have become one of the regressors in the equation. All of the variables are significant at the 5 percent level except for the PCA interest rate. The PCA interest was left in because it had the correct sign and because its plausible to have some reflection of opportunity cost in a stock equation.

The price elasticity of -1.26 is consistent with the -1.209 obtained by Morton (1982) for feed grains and the -1.24 by the University of Missouri. It is slightly less than the -1.53 obtained by Baumes and Meyers. The coefficient on the government stocks, reserve plus CCC, is nearly the same as Morton's 0.259 for feedgrains and is also consistent with the coefficient Baumes and Womack (1980) obtained in their analysis on private stocks of corn. These results indicate that a one bushel increase in government stocks reduce private stocks by about 0.25 bushels, thus increasing total carryover by 0.75 bushels. The coefficient on nine-month loan carryover indicates an even larger displacement on free, no loan stocks. For every bushel increase in nine-month carryover stocks, nonloan free stocks are reduced by .55 bushels. There is a high level of substitution between these stocks, which is why nine-month stocks are considered to be part of free stocks, since they are redeemable upon demand.

The D.W. statistic for this equation is a little higher than desired, but it is still in the inconclusive region of the test at the 5 percent level.

Total Loans

The statistical results for the total loan equation are quite good. All of the variables are significant at the 5 percent level and the R^2 is high. The elasticity of total loans with respect to the loan/price ratio is lower than the 4.14 obtained by Miller, Meyers, and Lancaster (1978). Their definition of the ratio, however, did not include the farmer-owned reserve entry price. The elasticity for the interest rate ratio is more elastic than -0.84 obtained by Miller et al. The risk and production variables have similar elasticities in both analyses.

The significance of RSHIFT indicates the reserve program in general has had a significant effect on the demand for CCC Loans.

Nine-Month Loan Redemptions

All of the variables in the redemption equation are significant at the 5 percent level. Redemptions are fairly elastic with respect to the loan/price ratio and the interest rate ratio. A 10 percent increase in the price, <u>ceteris paribus</u>, would lead to an approximate 11.2 percent increase in redemptions. An increase in the market interest rate, *ceteris paribus*, would have the same effect according to the elasticity on the interest ratio.

The future price, as proxied by expected production, is a significant factor in redemptions. The elasticity indicates a 10 percent increase in expected production will cause redemptions to rise by a little over 6 percent.

Overall, the equations have satisfactory results. All the variables have the correct signs and the R^2's are quite high. In the next section, the historical simulation capabilities of the model will be examined.

Validation of the Model

In the validation run, the model is dynamically simulated over the 1963-1982 period. The dynamic simulation uses the solved values from the simulation to feed future lagged endogenous values. The simulation was done using Newton's method from the SIMNLIN procedure of SAS/ETS. There are several criterion used to evaluate the model's simulation performance. Pindyke and Rubinfeld (1981) can be checked for more indepth discussions.

One criterion used to evaluate dynamic simulations is the root mean square error. RM square error is a measure of the derivation of the simulated value from the actual value over the time period. It is computed as follows:

$$\text{RMSE} = \sqrt{\frac{1}{T}\sum_{t=1}^{T}(Y_t^s - Y_t^a)^2}$$

where Y_t^s = simulated value of Y_t,

Y_t^a = actual value,

T = number of periods in the simulation .

A more informative approach is to express RMSE in percentage terms. This allows comparisons between variables to be made. RM percent error is expressed as

$$\text{RM percent error} = \sqrt{\frac{1}{T} \sum_{t=1}^{T} \frac{Y_t^s - Y_t^a}{Y_t^a}} \quad .$$

A value of 0, or close to it, is desirable for the RM percent error.

Table 4.5 shows the RM square errors and RM percent errors for all the variables. Generally, RM percent errors of less than 0.2 are considered very good. If a variable is small in size, any small error in the simulation will produce a high proportional error. This is the case with the CRISK variable. All of the variables, except CRISK, have RM square errors of less than one, and a large majority (23 out of 32) are around 0.2 or below.

Another criterion used to evaluate a simulation is Theil's inequality coefficient defined as

$$U = \frac{\sqrt{\frac{1}{T} \sum_{t=1}^{T} (Y_t^s - Y_t^a)^2}}{\sqrt{\frac{1}{T} \sum_{t=1}^{T} (Y_t^s)^2} + \sqrt{\frac{1}{T} \sum_{t=1}^{T} (Y_t^a)^2}} \quad .$$

Table 4.5. Statistics of fit[a]

Variable	N	RMS error	RSM % error
CORPF	20	0.183	0.091
CORDF	20	162.329	0.043
CORDH	20	22.722	0.053
RCOPDPF	20	0.012	0.078
CORSA1	20	2.146	0.030
CORECPC	20	0.036	0.088
CORXTOT	20	82.323	0.084
CORSOYEU	20	0.045	0.064
CORPGR1	20	165.921	0.035
CORHCC1X	20	76.701	0.218
CORMX	20	82.323	0.102
CORNRE	20	16.449	0.241
RSCNRE	20	0.178	0.241
CORTPSL	20	137.255	0.554
CORTRED	20	92.159	0.521
Z	20	0.073	0.510
CORPFA	20	0.141	0.062
CRISK	20	0.054	18.134
CPRATW	20	0.077	0.088
CPRAT	20	0.076	0.088
NRL	20	114.533	0.609
CORPRES	20	73.238	0.101
CORHPRRE	20	49.547	0.045
CORHT	20	119.974	0.149
CPLACE	20	49.547	0.022
TSPMT	20	8.316	0.030
NMRED	20	117.911	0.786
NMLOAN	20	255.013	0.621
FORLOAN	20	204.474	0.079
NETNM	20	220.986	0.630
NETFOR	20	204.474	0.241
NETCOST	20	208.183	0.507

[a]See Appendix B for variable definitions.

Theil's inequality coefficient can be broken into three parts known as the proportions of inequality:

$$U^m = \frac{(\overline{Y}^s - \overline{Y}^a)^2}{(1/T) \; \Sigma \; (Y_t^s - Y_t^a)^2}$$

$$U^s = \frac{(\sigma_s - \sigma_a)2}{(1/T) \; \Sigma \; (Y_t^s - Y_t^a)^2}$$

$$U^c = \frac{2(1 - \rho) \; \sigma_s \; \sigma_a}{(1/T) \; \Sigma \; (Y_t^s - Y_t^a)^2}$$

where σ_a and σ_s are the standard deviations of the actual and simulated values.

U^m, called the bias proportion, indicates systematic error and is the difference between the means of the actual and simulated values. It is desirable to have a U^m of close to 0. U^s, called the variance or regression proportion, indicates the ability of the model to replicate the degree of variability of the actual data. It is also desirable to have the U^s be very small or 0, which means that the simulated model tracks the historical variation well. U^c, called the covariance proportion, measures the remaining error after deviations from average value and variabilities have been accounted for. The values of U^m, U^s, and U^c are weighted so that their sum is 1.0.

If the value of accuracy, U, is zero, the simulated values are equal to the actual values for all the periods. On the other hand, if U=1, or close to it, the simulated values vary significantly from the

Table 4.6. Theil's forecast error measures[a]

Variable	N	Relative Change (MSE)	Decomposition: Bias (UM)	Regress (US)	Disturb (UC)	Accuracy (U)
CORPF	20	0.0093	0.02	0.05	0.93	0.0483
CORDF	20	0.0019	0.01	0.00	0.99	0.0000
CORDH	20	0.0030	0.00	0.66	0.34	0.0001
RCOPDPF	20	0.0114	0.00	0.00	1.00	0.6699
CORSA1	20	0.0009	0.00	0.00	1.00	0.0004
CORECPC	20	0.0077	0.00	0.24	0.76	0.2789
CORXTOT	20	0.0077	0.00	0.08	0.92	0.0001
CORSOYEU	20	0.0051	0.01	0.01	0.97	0.0987
CORPGR1	20	0.0013	0.00	0.00	1.00	0.0000
CORHCC1X	20	0.0346	0.02	0.11	0.87	0.0004
CORMX	20	0.0120	0.00	0.03	0.97	0.0001
CORNRE	20	0.0576	0.00	0.07	0.93	0.0024
RSCNRE	20	0.0595	0.00	0.24	0.76	0.2374
CORTPSL	20	0.4250	0.03	0.09	0.88	0.0009
CORTRED	20	0.4957	0.05	0.21	0.74	0.0022
Z	20	0.0443	0.01	0.74	0.25	0.2429
CORPFA	20	0.0045	0.03	0.05	0.93	0.0350
CRISK	20	53.1216	0.15	0.72	0.13	57.2045
CPRATW	20	0.0085	0.02	0.01	0.98	0.1093
CPRAT	20	0.0085	0.02	0.01	0.97	0.1103
NRL	20	3.6863	0.07	0.06	0.88	0.0063
CORPRES	20	1.2501	0.25	0.71	0.04	0.0016
CORHPRRE	20	0.2423	0.24	0.70	0.06	0.0005
CORHT	20	0.0269	0.00	0.02	0.98	0.0001
CPLACE	20	0.0055	0.35	0.05	0.60	0.0000
TSPMT	20	0.0024	0.20	0.05	0.75	0.0003
NMRED	20	2.5233	0.02	0.02	0.97	0.0049
NMLOAN	20	0.5356	0.03	0.13	0.84	0.0011
FORLOAN	20	0.0613	0.01	0.00	0.98	0.0001
NETNM	20	4.2130	0.11	0.01	0.88	0.0049
NETFOR	20	0.2670	0.29	0.49	0.22	0.0004
NETCOST	20	3.9678	0.14	0.06	0.80	0.0018

[a]See Appendix B for variable definitions.

actual values.

Theil's forecast error measures are given in Table 4.6. Most all of the endogenous variables have a small bias or systematic error, which is desirable. A few of the variables, CORDH, Z, CRISK, CORHPRRE, CORPRES, NETFOR, have a larger variance proportion than desired. However, for Z and CRISK, the actual values are very small, so any small variation will create larger U^S values. Most of the variables have small accuracy values which is desirable.

Another important criterion for evaluating the historical performance of a model is to examine the turning points of simulated values of major endogenous variables verses their actual values. A turning point is a sudden change in the historical data, and it is desirable to have the simulation track those changes.

Figures 4.1 - 4.16 show the plots of the actual and simulated values for some of the key endogenous variables. Price seems to track well except for turning point errors in 1963 and 1976. The model captures the large increase in the actual price between 1971 and 1974.

The stock equations, total, reserve and private, non-loan carryover, are able to simulate the historical variation quite well. There are two turning point errors for private stocks in 1963 and 1965, but after that it follows the actual data closely. There are no turning point errors in the reserve stock predictions, however, keep in mind that 1977, 1978, and 1980 are exogenous for this variable. For total stocks, there is only one turning point error, in 1967, and the actual and simulated values are close to each other. Carryover under nine-month loan has the poorest

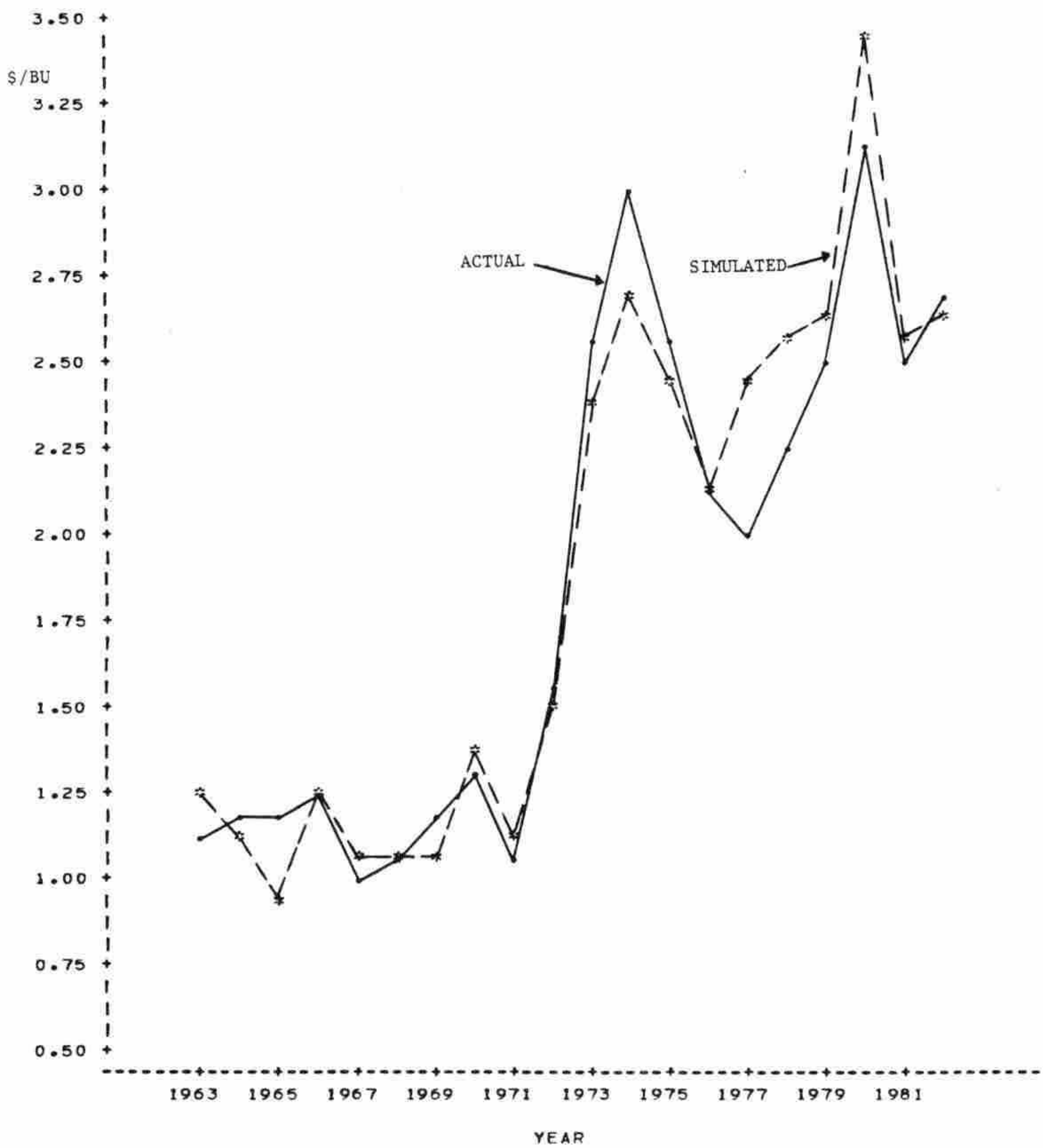

Figure 4.1. Plot of actual and simulated corn price (CORPF)

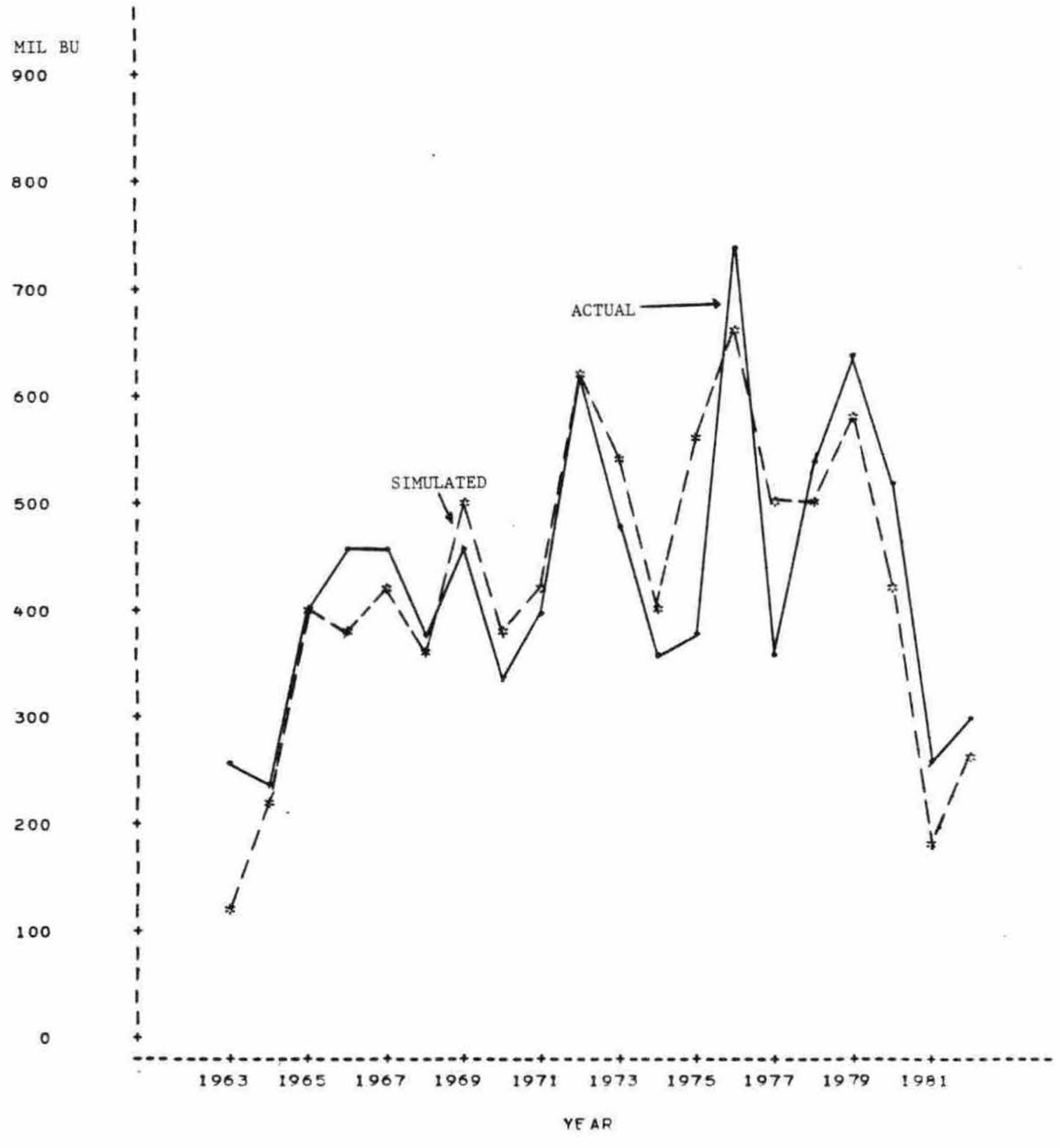

Figure 4.2. Plot of actual and simulated private carryover (CORHCCIX)

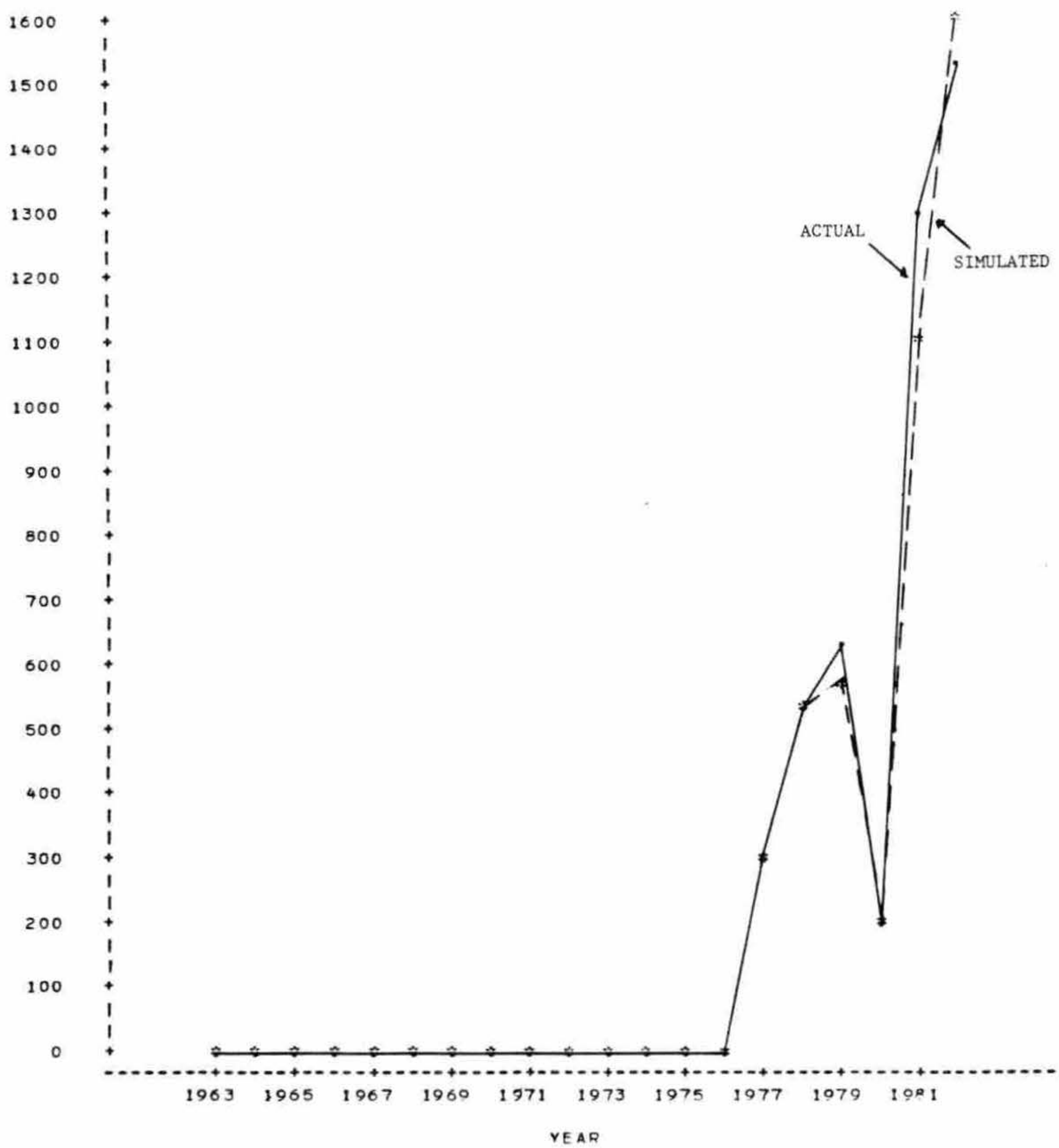

Figure 4.3. Plot of actual and simulated farmer-owned reserve carryover (CORHPRRE)

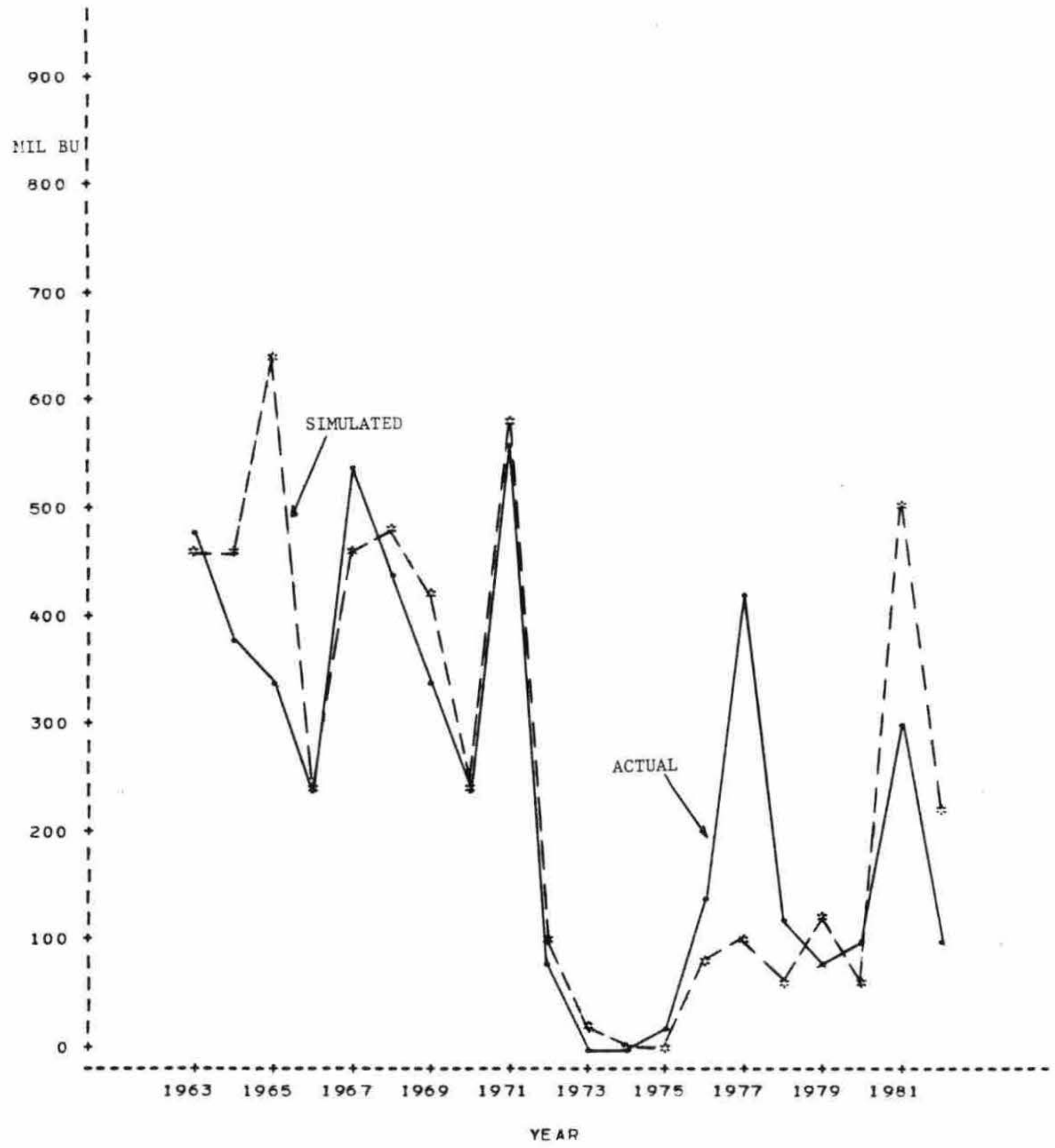

Figure 4.4. Plot of actual and simulated carryover under nine-month loan (NRL)

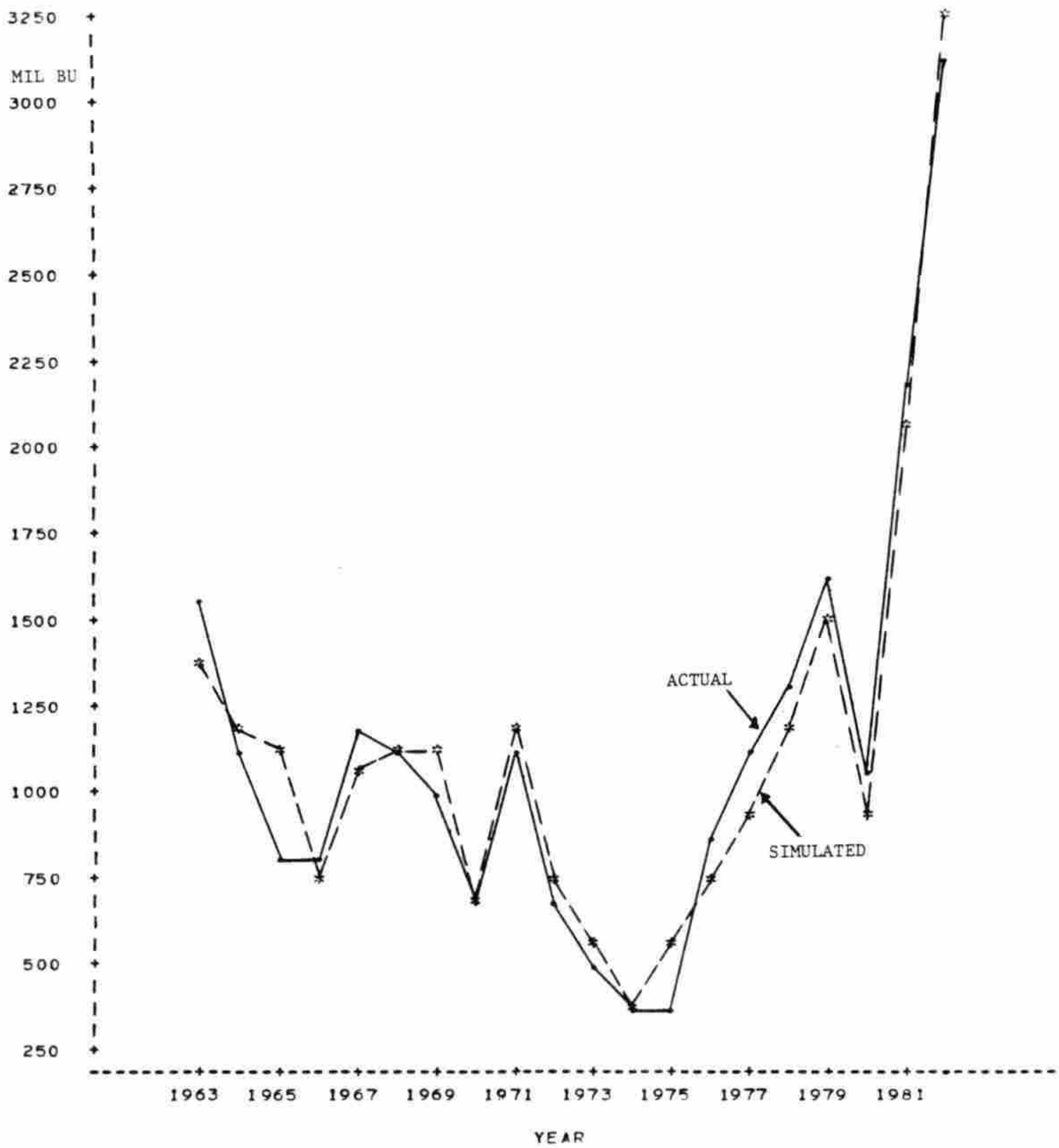

Figure 4.5. Plot of actual and simulated total stock carryover (CORHT)

Figure 4.6. Plot of actual and simulated world corn exports (CORXTOT)

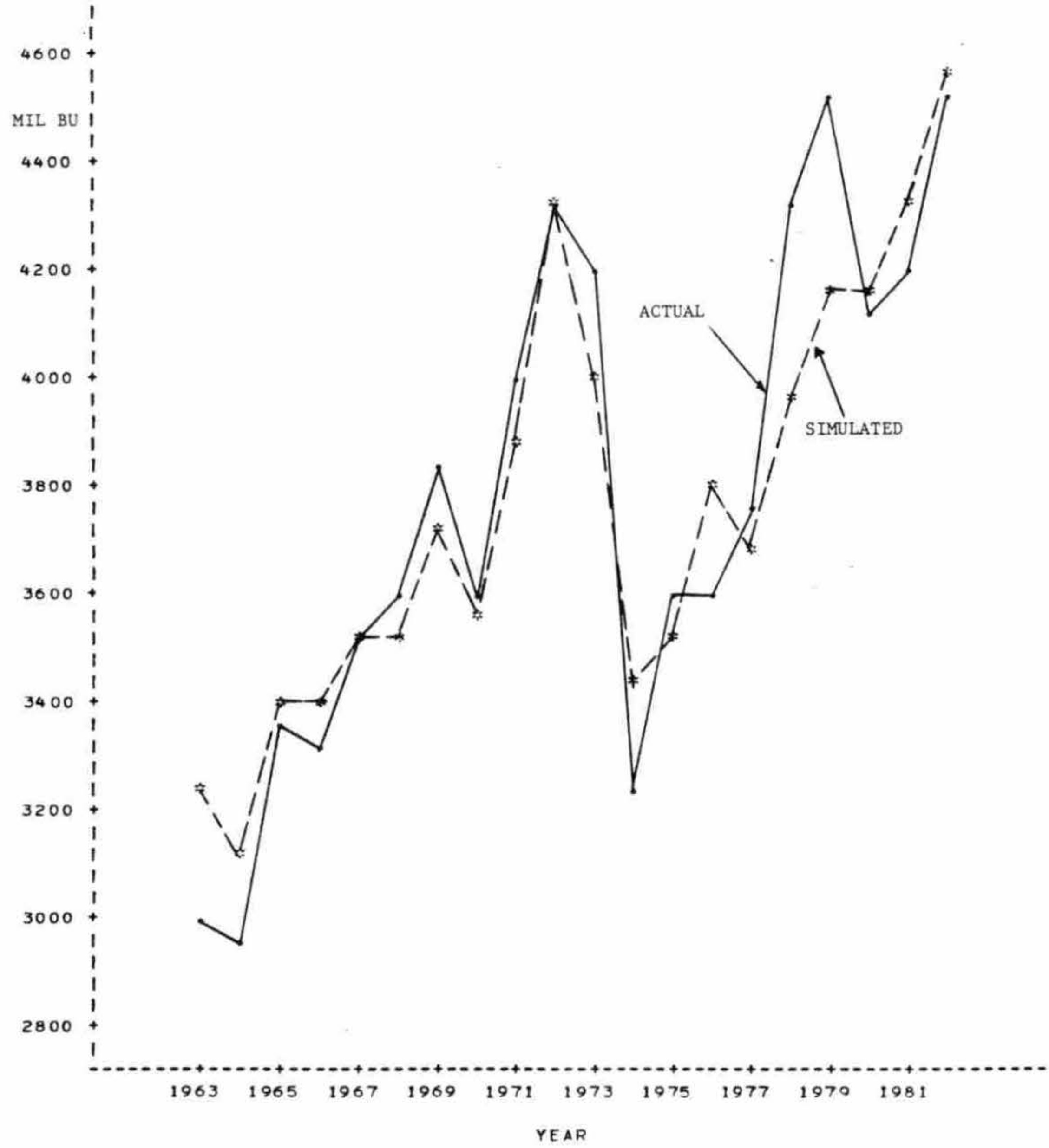

Figure 4.7. Plot of actual and simulated feed use (CORDF)

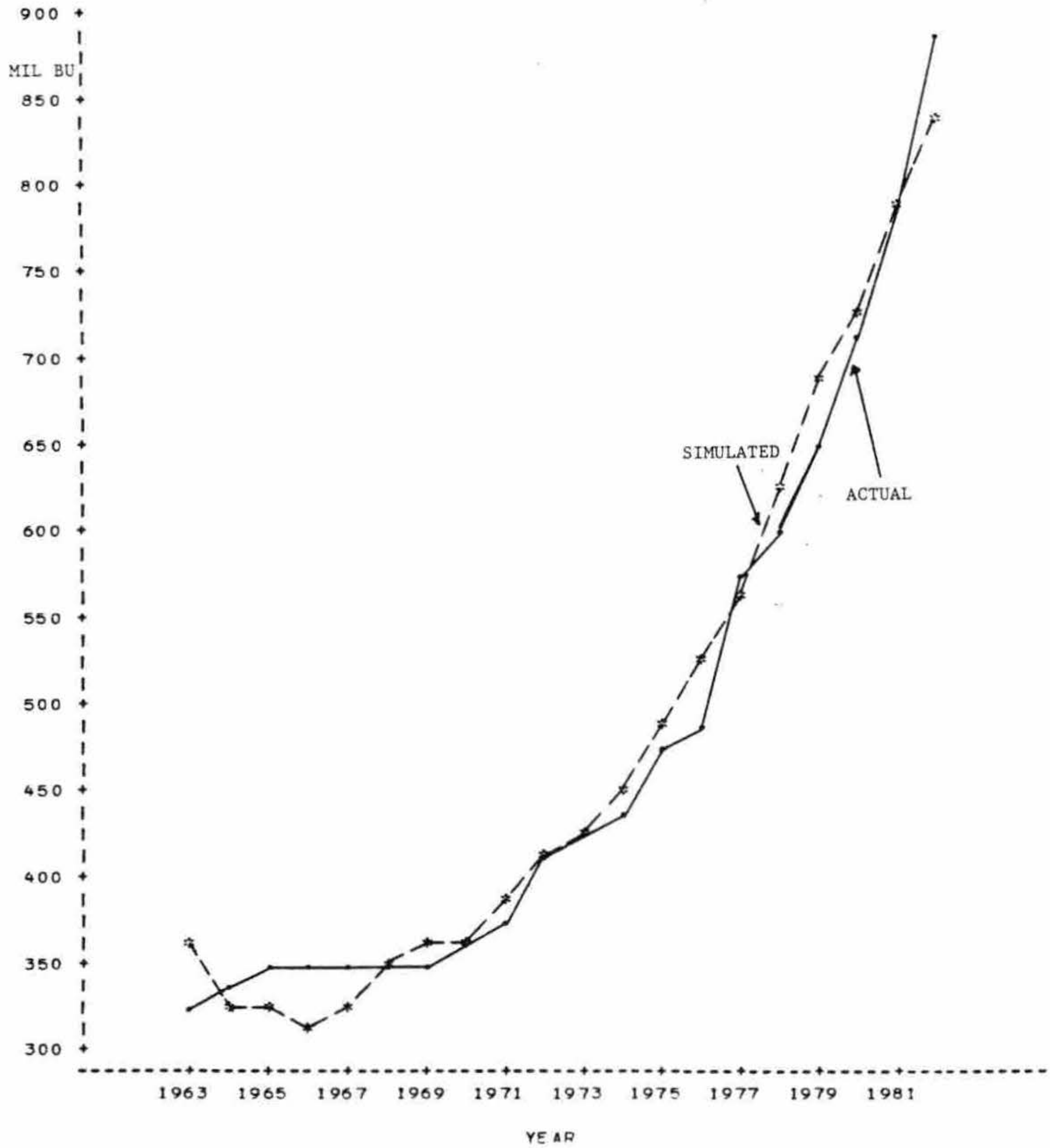

Figure 4.8. Plot of actual and simulated food use (CORDH)

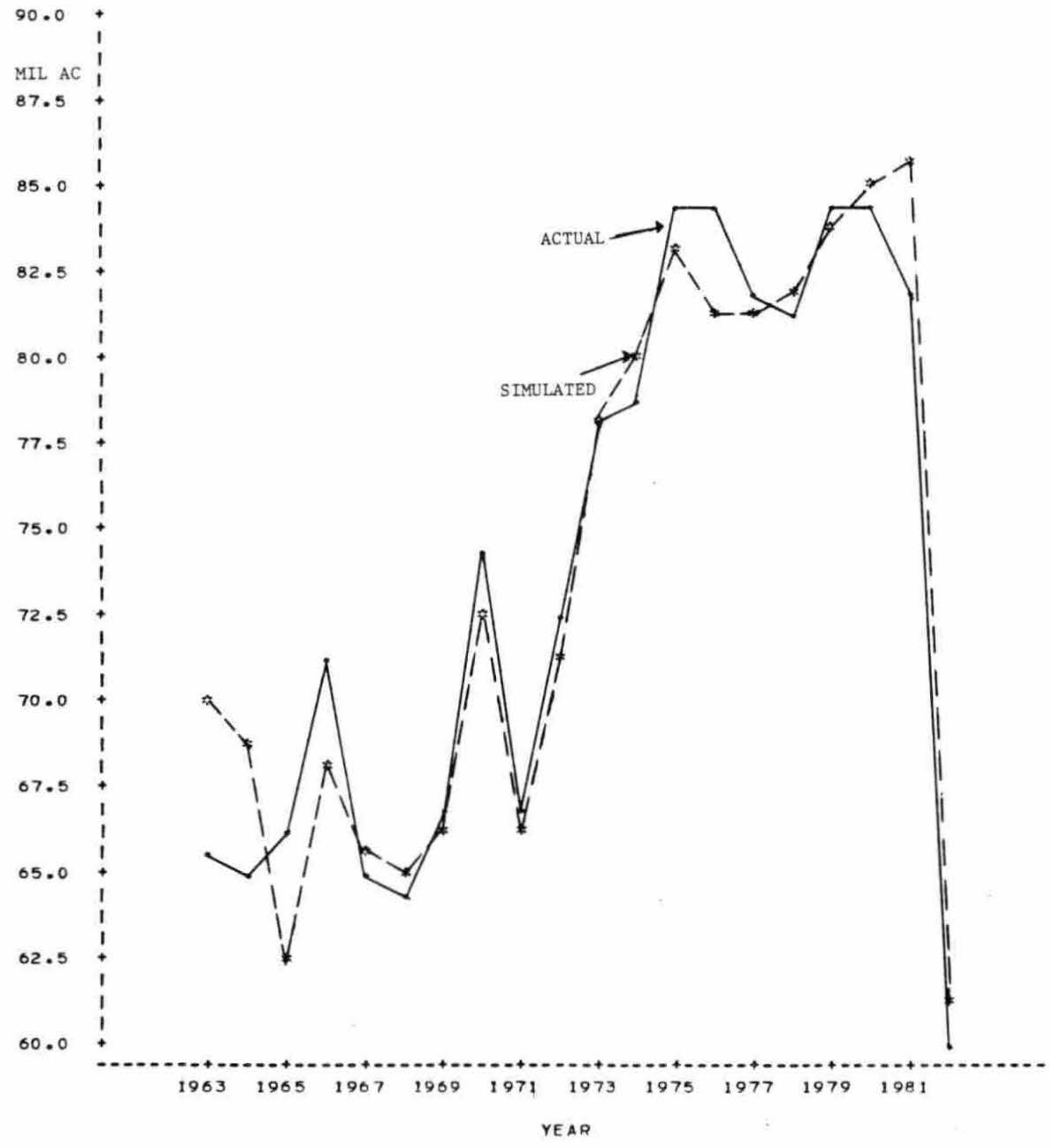

Figure 4.9. Plot of actual and simulated expected acreage planted (CORSA1)

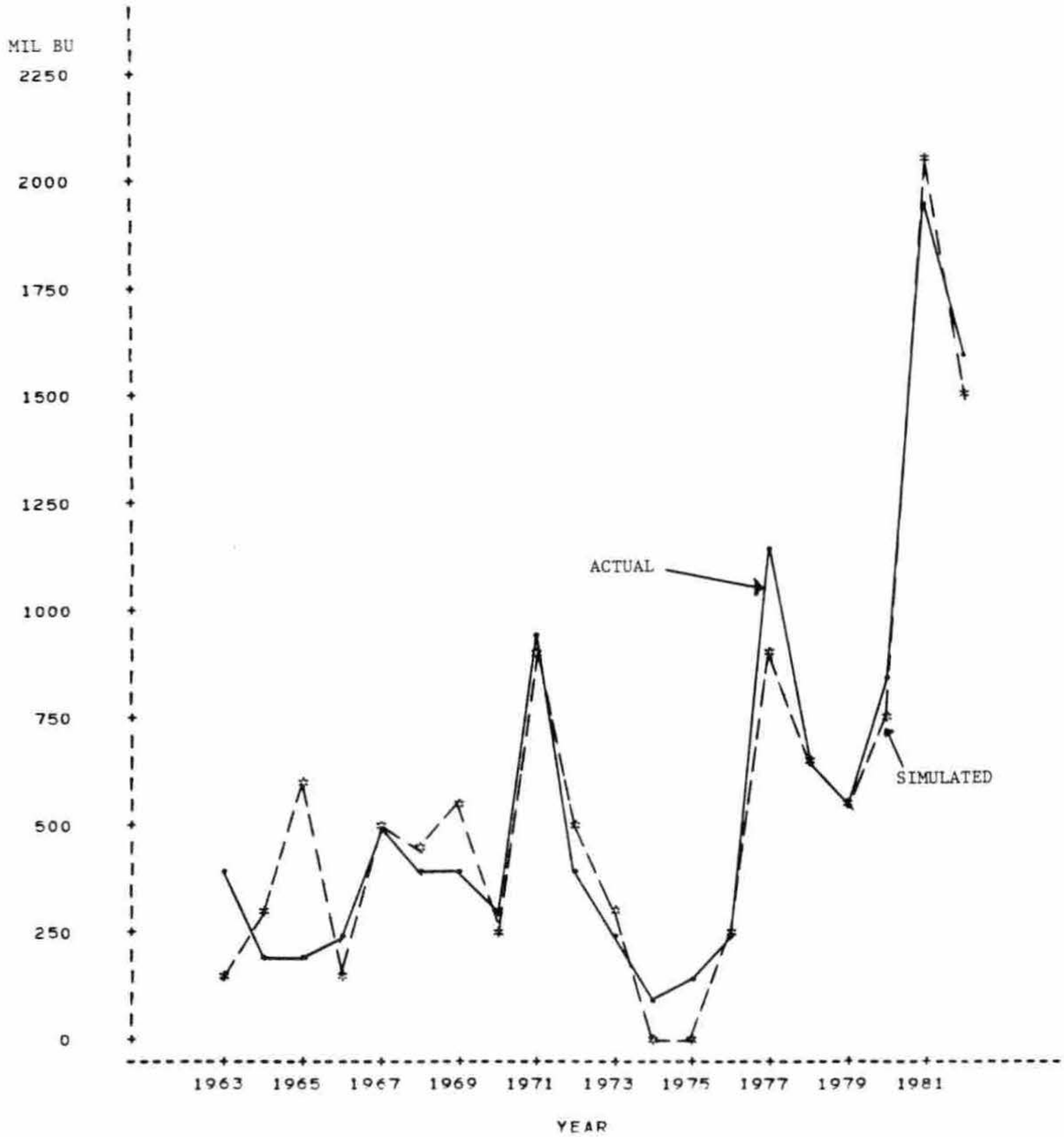

Figure 4.10. Plot of actual and simulated quantity placed under price support loan (CORTPSL)

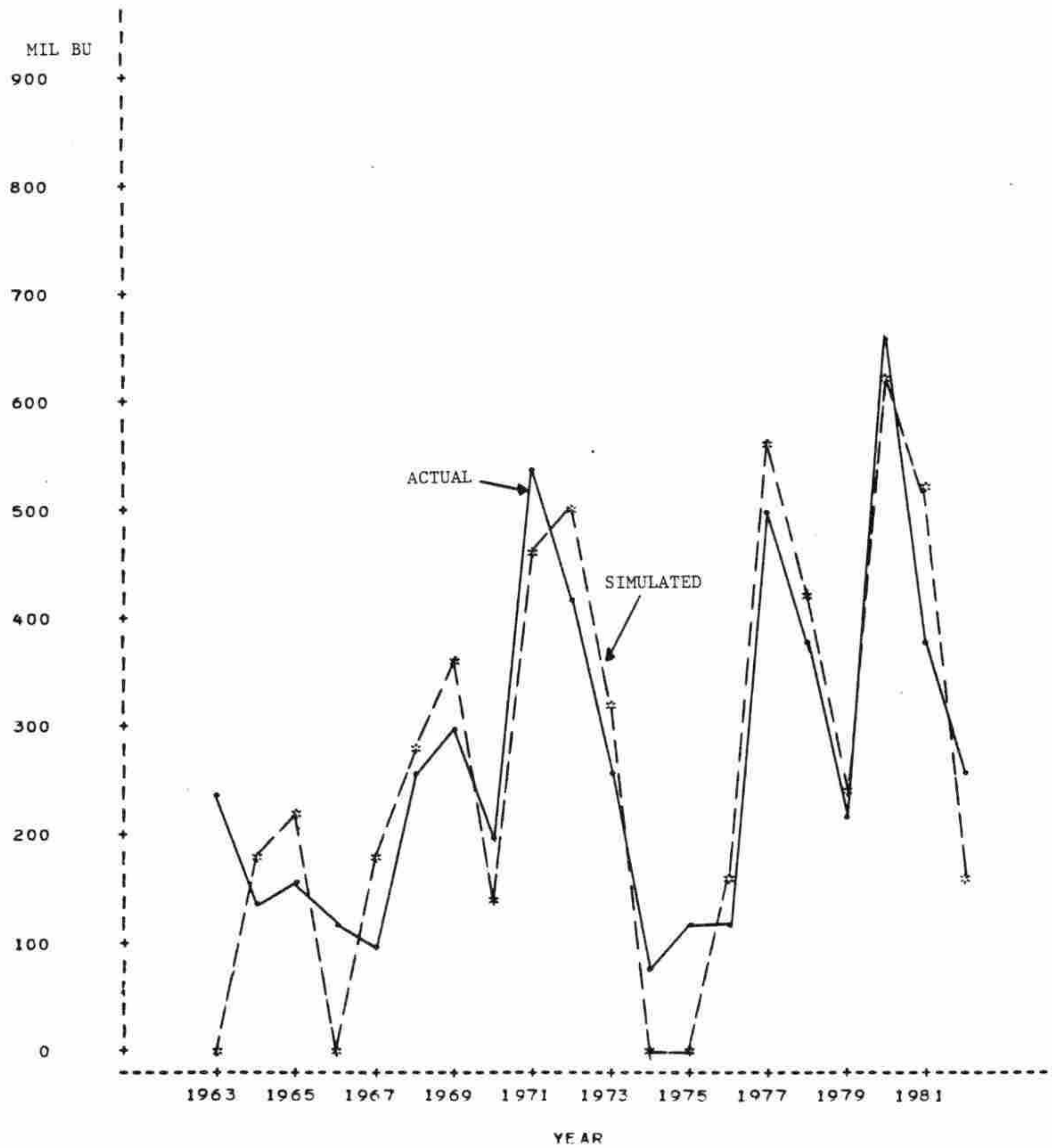

Figure 4.11. Plot of actual and simulated nine-month redemptions (CORTRED)

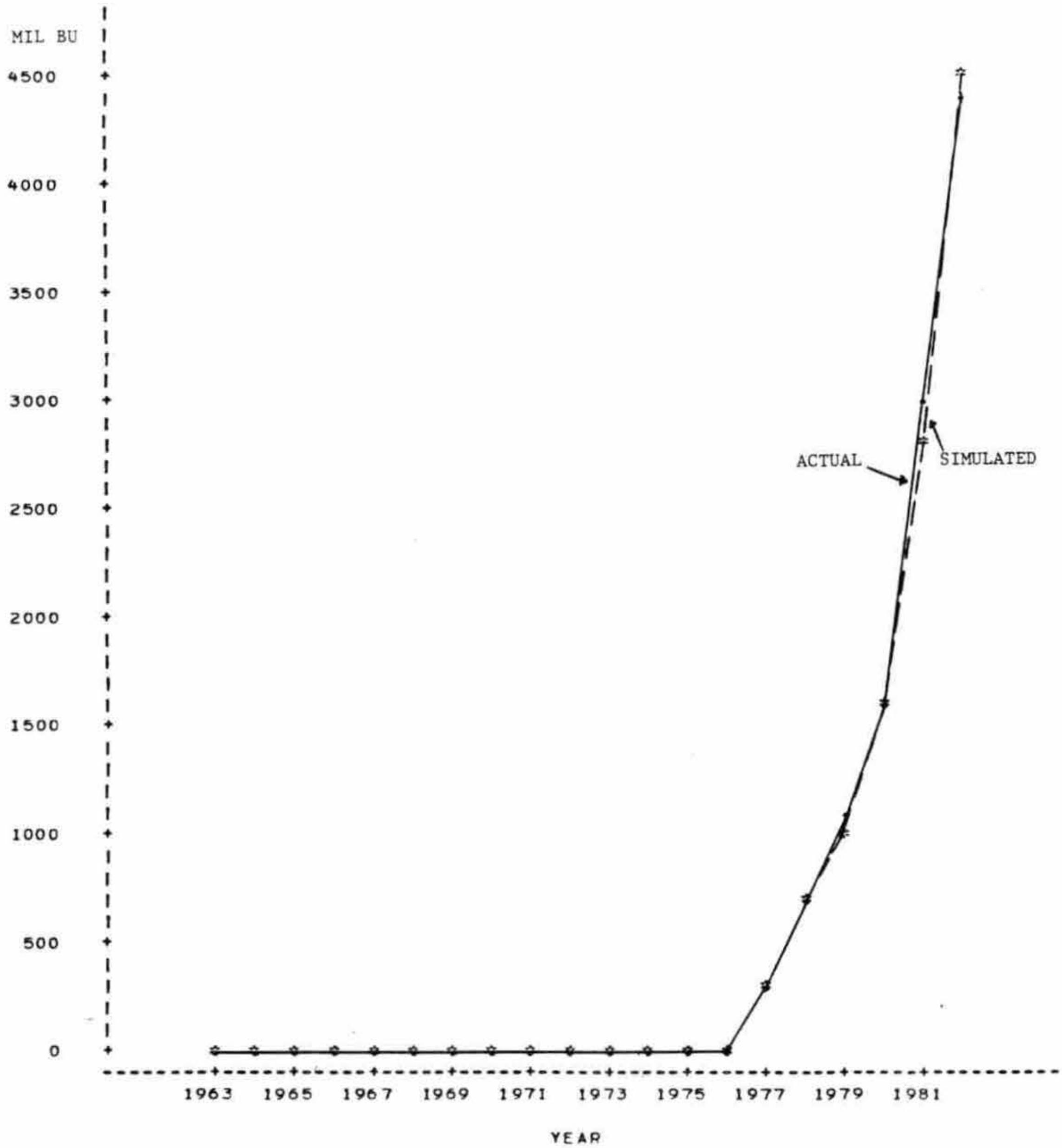

Figure 4.12. Plot of actual and simulated reserve cumulative placements (CPLACE)

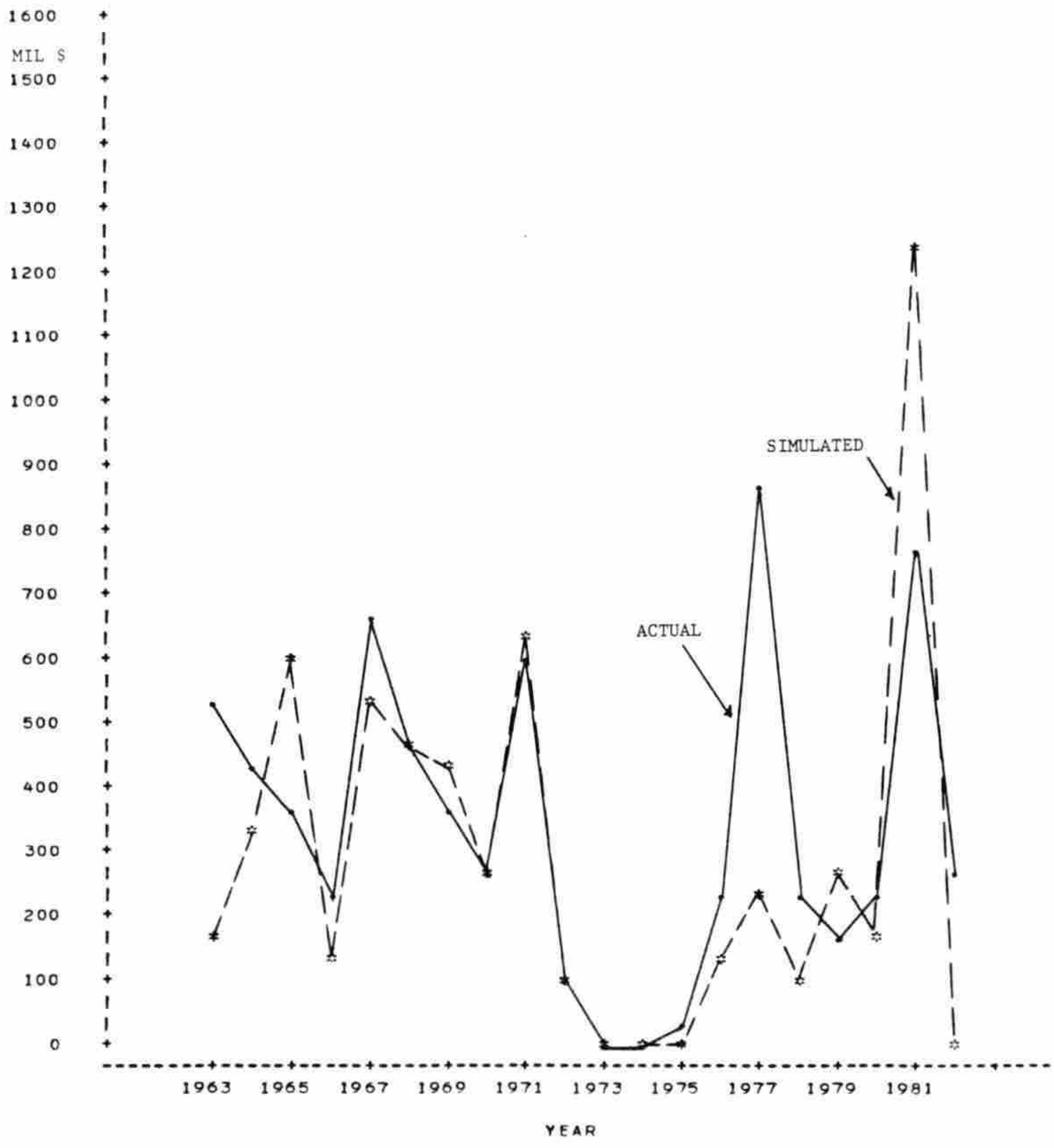

Figure 4.13. Plot of actual and simulated net cost for nine-month loans (NETNM)

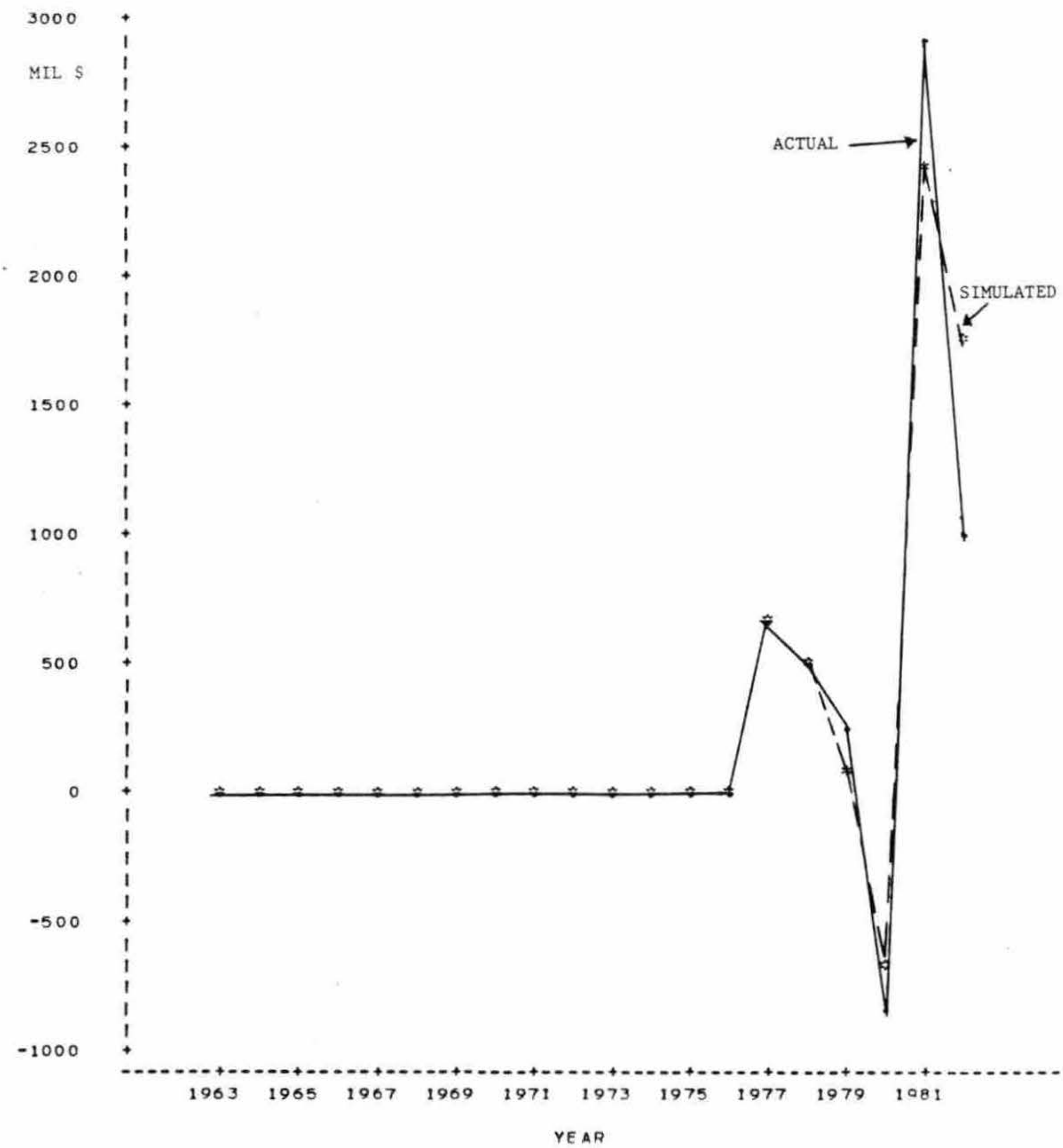

Figure 4.14. Plot of actual and simulated net cost for farmer-owned reserve loans (NETFOR)

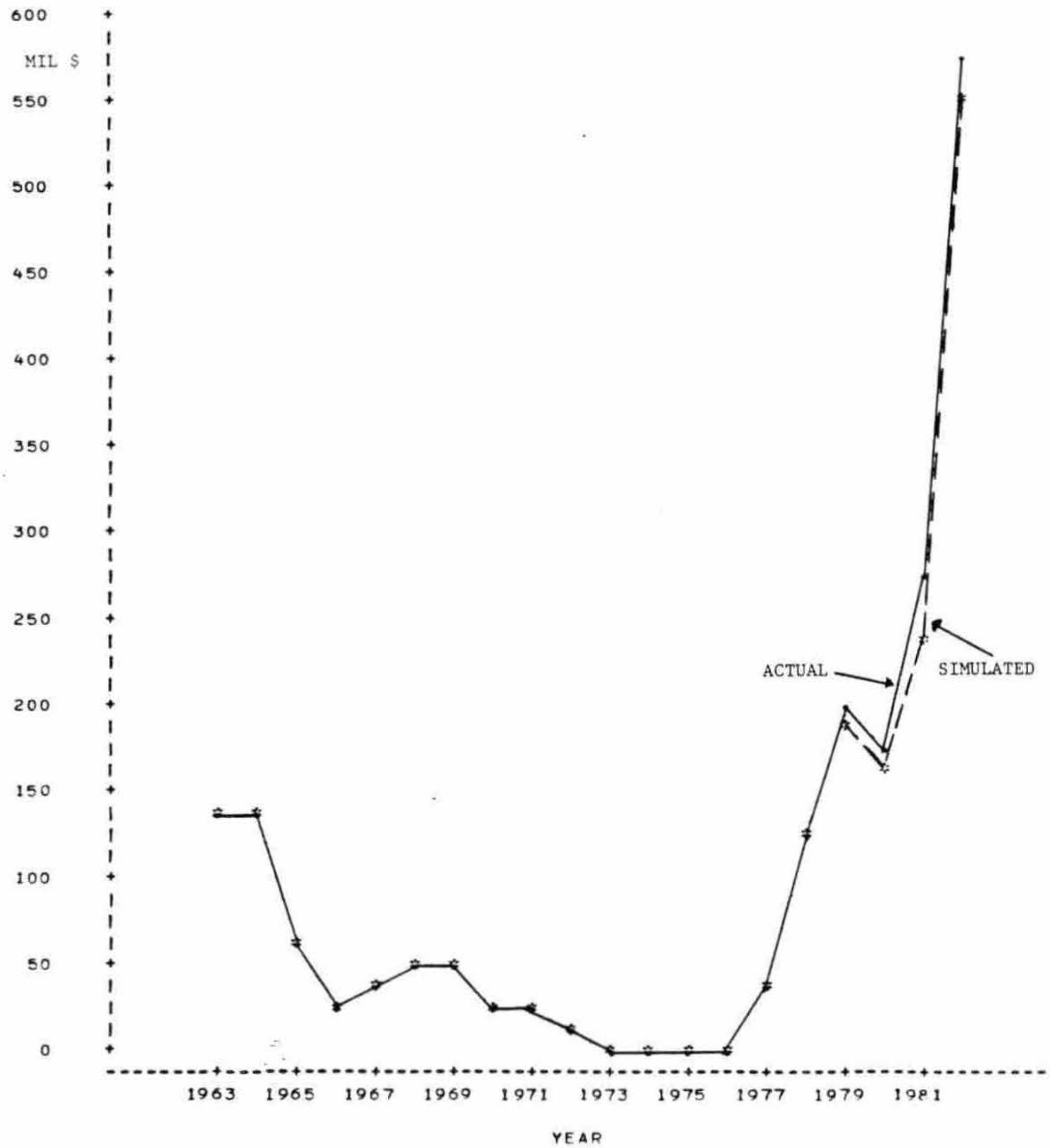

Figure 4.15. Plot of actual and simulated total storage costs (TSPMT)

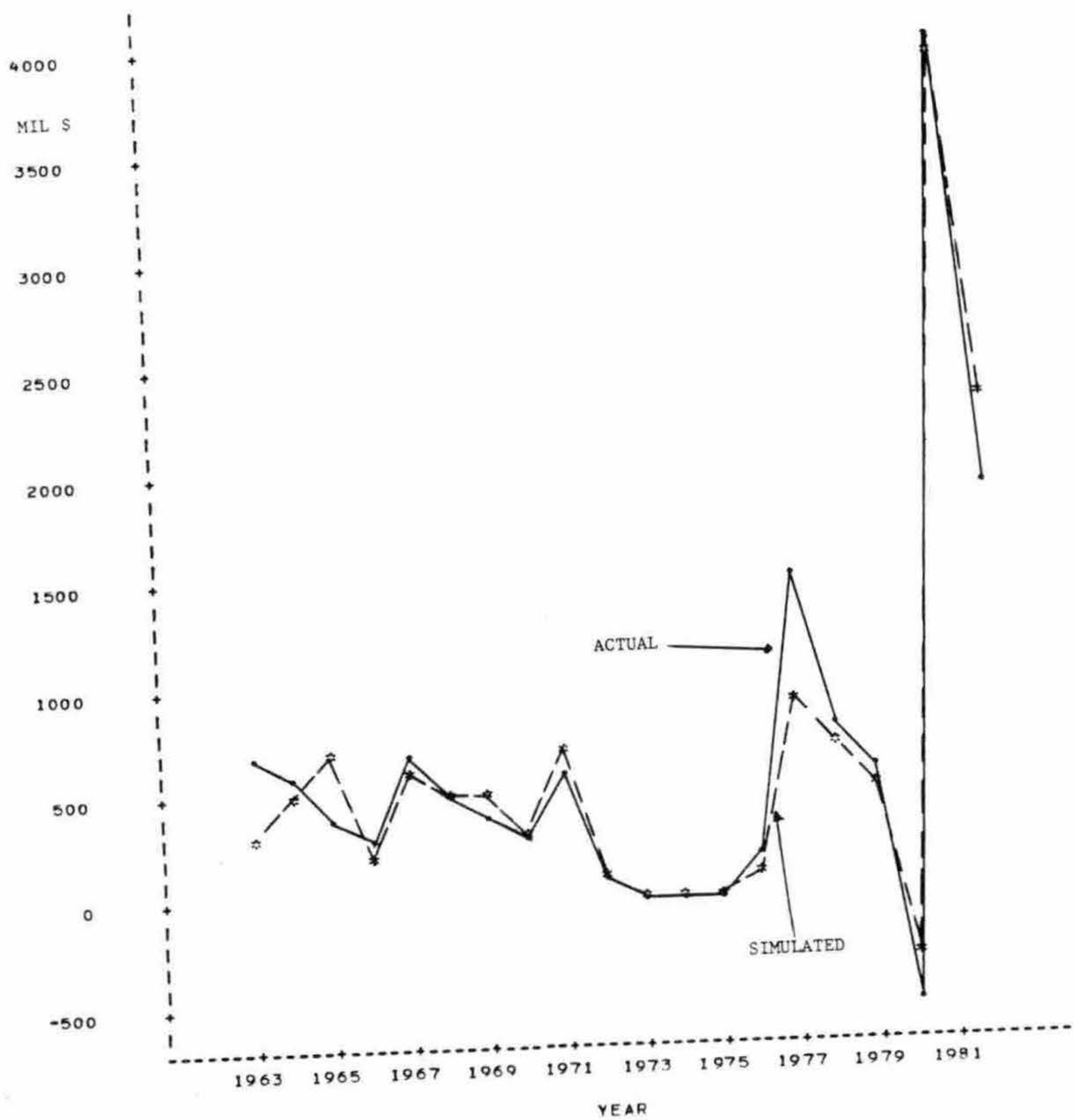

Figure 4.16. Plot of actual and simulated net storage program costs (NETCOST), excluding deficiency payments

performance of the stock equations even though there are only three turning point errors. The difference between the actual and simulated values are fairly large for 1964, 1977, and 1981.

The remaining demand side simulations are in Figures 4.6-4.8. Total exports has only two turning point errors--in 1966 and 1981. Feed has one error, but the difference between the actual and simulated values become relatively pronounced between 1978 and 1980. Some of that difference may be a result of turning this equation around to solve for price. After 1968, simulated food values remain close to the actual.

For corn acres planted, the simulated and actual values are close, particularly after 1966. The large drop in 1982 is due to the payment-in-kind program which included a large land diversion. The model tracked the acreage drop well. There are turning point errors in 1964, 1977, and 1980 for acreage planted.

The total loan, redemption, and cumulative placement equations also do all right in tracking the actual variation. After the first four years, total loans and nine-month redemptions do a fine job of tracking historical values.

The government cost simulations respond in almost the same manner as the variables they are associated with. The net nine-month loan outlays variable appears to have the largest discrepancy between actual and simulated values.

Overall, the simulated series tend to reproduce the actual series, except for a few short-run fluctuations. The incidence of turning point errors with respect to the total number of turning points is low.

A final criterion used in this analysis is the stability test. Stability is tested by administering an exogenous shock to the model, rerunning the simulation, and then checking to see if the endogenous variables return to their base simulation values over time. The faster they return to equilibrium, the more stable the model is considered to be. The shock in this analysis was administered to expected yield in 1975. Expected yield was lowered from 88 bushels per acre to 84 bushels per acre harvested. Since the shock is on expected yield, the major effects will not be noted until 1976. Table 4.7 shows the base simulation values along with the change and percent change in those values as a result of the shock.

The immediate effect of an expected yield decrease is seen in 1975 in expected production, which decreases by 276 million bushels, or by over 4 percent. Effect of the shock on production decreases and reaches 0 percent by 1982. The level of expected production for 1975 becomes the current production level for 1976. The 1976 price rises by almost 11 percent and then quickly diminishes to a 0 percent change in 1980.

The immediate effect on the stock levels is to decrease them. Theory would imply that a price increase causes stock levels to decline as producers become more inclined to sell them off. The lower production level itself would result in the use of more stocks for feeding operations. The effects of the shock on stocks diminish to nearly 0 percent by 1982.

The effects on total loan demand and nine-month redemptions are large. Both decrease by 68 percent and 63 percent respectively in 1976,

Table 4.7. Dynamic impact of a one year decrease in expected corn yield[a,b]

		Year:
Expected production (mil.bu.)	Base	
	Change	
	Percent change	
Corn price ($/bu.)	Base	
	Change	
	Percent change	
Private stocks excluding loan carryover (mil.bu.)	Base	
	Change	
	Percent change	
Total stocks (mil.bu.)	Base	
	Change	
	Percent change	
Carryover under loan (mil.bu.)	Base	
	Change	
	Percent change	
Reserve stocks (mil.bu.)	Base	
	Change	
	Percent change	
Feed (mil.bu.)	Base	
	Change	
	Percent change	
Food (mil.bu.)	Base	
	Change	
	Percent change	
U.S. exports (mil.bu.)	Base	
	Change	
	Percent change	
Total loans (mil.bu.)	Base	
	Change	
	Percent change	
Nine-month redemptions (mil.bu.)	Base	
	Change	
	Percent change	
Cumulative reserve placements (mil.bu.)	Base	
	Change	
	Percent change	

[a]* signifies less than 1.

[b]Expected yield in 1975 was reduced by 5 percent (87.bu./ac. to 84 bu./ac.)

1975	1976	1977	1978	1979	1980	1981	1982
6313	6383	7059	7736	6579	8066	8487	4304
-276	35	17	-8	-3	-1	-*	*
-4.38	.55	.25	-.10	-.05	-.01	.00	.01
	2.20	2.52	2.66	2.68	3.59	2.59	2.70
	.23	.03	-.03	.00	.00	.00	.00
	10.65	1.21	-1.05	-.07	.00	.00	.00
	647	500	486	575	413	176	270
	-48	1	7	*	-1	-1	-*
	-7.41	.19	1.48	.03	-.29	-.34	-.08
	725	906	1170	1478	894	2045	3182
	-108	-11	8	*	-1	-*	-*
	-14.92	-1.19	.66	.01	-.07	-.02	-.01
	77.22	77.96	42.96	115.48	57.26	516.79	198.87
	-60	-12	*	-1	1	1	*
	-77.90	-14.97	1.00	-.67	.97	.29	.21
				531.26		1051.21	1547.82
				1		-1	-*
				.13		-.13	-.02
	3833	3700	3997	4217	4188	4350	4590
	-136	-59	-4	-*	-2	-1	-*
	-3.55	-1.58	-.09	-.01	-.05	-.02	-.01
	528	567	622	683	726	782	837
	-5	-1	*	*	-*	-*	*
	-.90	-.10	.08	.01	.01	.00	.00
	1750	1918	2158	2508	2230	1764	1908
	-17	-3	2	*	-*	-*	-*
	-.95	-.15	.10	.01	-.01	.00	.00
	244	863	602	525	777	2080	1542
	-165	-42	-32	-3	10	3	2
	-67.69	-4.81	-5.27	-.66	1.30	.12	.13
	167	548	413	261	637	602	186
	-105	-30	-32	-3	10	2	1
	-62.97	-5.43	-7.79	-1.31	1.50	.40	.31
				264		1069	1691
				1		-1	-*
				.27		-.13	-.02

but the shock effect diminishes quickly thereafter.

The yield decline causes the other demand components to decline, due mainly to the higher market price. The effects of the shock for these components, too, diminish rapidly.

All of the variables seem to move back to their equilibrium values after the expected yield variable has been shocked, hence, we can say the model is stable.

In summary, the model appears to do a satisfactory job of simulating historical behavior. In the next chapter, a further analysis will be presented using the dynamic simulation of this model.

CHAPTER 5. DYNAMIC SIMULATION ANALYSIS

The model developed in this study is used in this chapter to evaluate the effects of exogenous shocks on major endogenous variables. The simulation is run to obtain impact values which are compared to the values from the base simulation. Tables 5.1 through 5.3 list the actual values and impacts in actual and percentage terms that result from changes in the selected exogenous variables. A brief discussion of the three scenarios follows.

Scenario 1: Lower Reserve Loan Rate and Release Price for 1982

The reserve loan rate in 1981 was set by taking the 1980 reserve loan rate level plus $.15. This scenario examines what would have happened had the policymakers used that same kind of decision to determine the 1982 reserve loan rate level. In this scenario the reserve loan rate is set at a level that is $.15 greater than the previous year's loan rate. Instead of the actual $2.90 per bushel, the reserve loan rate becomes only $2.70 per bushel. The release price for this scenario is 115 percent of the reserve loan rate, or only $3.10 per bushel instead of the actual $3.25 per bushel.

The results indicate a resulting decline in reserve loans and reserve ending stocks. The decline in reserve stocks is larger than the increases in the other stock categories, causing total stocks to decline by more than 50 million bushels. Lower stock accumulation causes the market price to decline by $.10 per bushel. The lower price causes the other demand components, food use, feed use, and exports to increase.

The lower reserve loan rate causes the demand for total loans to decline, but carryover under nine-month loan increases by over 100 million bushels. Nine-month redemptions increase as the quantity of nine-month loans available for redemption increase, due to the lower reserve placements.

With a target price of $2.70 per bushel in 1982, the lower market price results in a larger deficiency payment to producers. The payment jumps by $178 million; almost 80%. The higher deficiency payment, however, is offset by declines of 448 million in the other loan outlay categories to yield a decrease in total net outlays of $270 million.

Scenario 2: Equating the Farmer-owned Reserve and Nine-month Loan Rates

Table 5.2 gives the results of setting the reserve loan rate equal to the nine-month loan rate. The reserve loan rate was lowered from $2.55 to $2.40 in 1981 and from $2.90 to $2.55 in 1982. The release price was set at 115 percent of the loan rates.

The lower loan rates cause reserve placements and reserve stocks to decline by 516 million bushels in 1981 and by 323 million bushels in 1982. The large drawdown in reserve stock levels results in lower total stock levels, as a result, the price also declines in both years. Lower carryin supplies for 1982 cause the price to fall by less than it did in 1981.

There is a split effect on carryover under nine-month loan. In 1981, these stocks experience a large increase which appears to displace nonloan private stocks, while in 1982 carryover under loan decreases. Total loan demand increases in 1981 and decreases in 1982.

Table 5.1. Impact of a lower reserve loan rate and release price in 1982[a]

		1982
Corn price ($/bushel)	Actual	2.68
	Change	-.10
	Percent change	-3.7
Total stocks (mil. bu.)	Actual	3120
	Change	-52
	Percent change	-1.7
Private stocks excluding those under loan (mil. bus.)	Actual	293
	Change	5
	Percent change	1.7
Reserve stocks (mil. bus.)	Actual	1550
	Change	-158
	Percent change	-10.2
Carryover under nine-month loan (mil. bu.)	Actual	110
	Change	101
	Percent change	91.8
Food use (mil. bu.)	Actual	883
	Change	1
	Percent change	.11
Feed use (mil. bu.)	Actual	4522
	Change	42
	Percent change	.93
U.S. exports (mil. bu.)	Actual	1501
	Change	9
	Percent change	.60
Expected production (mil. bu.)	Actual	4121
	Change	-100
	Percent change	-2.4
Total loans (mil. bu.)	Actual	1576
	Change	-40
	Percent change	-2.5

[a]1982 reserve loan was lowered from $2.90 per bushel to $2.70 per bushel. The release price was lowered from $3.25 per bushel to $3.10 per bushel.

Table 5.1. (continued)

Reserve placements (mil. bu.)	Actual	1435
	Change	-158
	Percent change	-11.0
Nine-month redemptions (mil. bu.)	Actual	266
	Change	17
	Percent change	6.4
Deficiency payments (mil. $)	Actual	226
	Change	178
	Percent change	78.8
Net outlays (mil. $)	Actual	2114
	Change	-270
	Percent change	-12.8

Table 5.2. Impact of equating the reserve loan rate to the nine-month loan rate[a]

		1981	1982
Corn price ($/bushel)	Actual	2.50	2.68
	Change	-.19	-.13
	Percent change	-7.6	-4.8
Total stocks (mil. bu.)	Actual	2174	3120
	Change	-98	-261
	Percent change	-4.5	-8.4
Private stocks excluding those under loan (mil. bus.)	Actual	263	293
	Change	-147	158
	Percent change	-55.9	53.9
Reserve stocks (mil. bus.)	Actual	1310	1550
	Change	-516	-323
	Percent change	-39.4	-20.8
Carryover under nine-month loan (mil. bu.)	Actual	299	110
	Change	566	-97
	Percent change	189.3	-88.2
Food use (mil. bu.)	Actual	792	883
	Change	3	2
	Percent change	.39	.23
Feed use (mil. bu.)	Actual	4201	4522
	Change	79	81
	Percent change	1.9	1.8
U.S. exports (mil. bu.)	Actual	1640	1501
	Change	17	12
	Percent change	1.0	.80
Expected production (mil. bu.)	Actual	8235	4121
	Change	-69	-157
	Percent change	-.84	-3.8
Total loans (mil. bu.)	Actual	1969	1576
	Change	138	-28
	Percent change	7.0	-1.8

[a]For 1981, the reserve loan rate was lowered from $2.55 per bushel to $2.40 per bushel. For 1982, the reserve loan rate was lowered from $2.90 per bushel to $2.55. For both years, the release price is 115 percent of the loan rates.

Table 5.2. (continued)

Reserve placements (mil. bu.)	Actual	1328	1435
	Change	-516	-323
	Percent change	-38.9	-22.5
Nine-month redemptions (mil. bu.)	Actual	381	266
	Change	88	-125
	Percent change	23.1	-47.0
Deficiency payments (mil. $)	Actual	--	226
	Change	--	97
	Percent change	--	42.9
Net program outlays (mil. $)	Actual	3952	2114
	Change	-99	-161
	Percent change	-2.5	-7.6

Table 5.3. Impact of a yield reduction[a]

		1981	1982
Corn price ($/bushel)	Actual	2.50	2.68
	Change	.14	.36
	Percent change	5.6	13.4
Total stocks (mil. bu.)	Actual	2174	3120
	Change	-300	-482
	Percent change	-13.8	-15.4
Private stocks excluding those under loan (mil. bus.)	Actual	263	293
	Change	21	93
	Percent change	8.0	31.7
Reserve stocks (mil. bus.)	Actual	1310	1550
	Change	-418	-402
	Percent change	-31.9	-25.9
Carryover under nine-month loan (mil. bu.)	Actual	299	110
	Change	97	-172
	Percent change	32.4	-156.4
Food use (mil. bu.)	Actual	792	883
	Change	-2	-5
	Percent change	-.25	-.57
Feed use (mil. bu.)	Actual	4201	4522
	Change	-62	-177
	Percent change	-1.47	-3.91
U.S. exports (mil. bu.)	Actual	1640	1501
	Change	-12	-32
	Percent change	-.73	-2.13
Current production (mil. bu.)	Actual	8119	8235
	Change	-395	-396
	Percent change	-4.9	-4.8
Total loans (mil. bu.)	Actual	1969	1576
	Change	-142	-274
	Percent change	-7.2	-17.4

[a]Yield was reduced by 5 percent in 1981 and 1982 (from 109.9 bu./ac. to 104 and from 114.5 bu./ac. to 108.8 for 1981 and 1982, respectively).

Table 5.3. (continued)

Reserve placements (mil. bu.)	Actual	1328	1435
	Change	-418	-402
	Percent change	-31.5	-28.0
Nine-month redemptions (mil. bu.)	Actual	381	266
	Change	178	-117
	Percent change	46.7	-44.0
Deficiency payments (mil. $)	Actual	--	226
	Change	--	-198
	Percent change	--	-87.6
Net outlays (mil. $)	Actual	3952	2114
	Change	-888	-701
	Percent change	-22.5	-33.2

In 1981, there was no opportunity for producers to receive deficiency payments as the target price was set equal to the nine-month loan rate. The lower price for 1982, however, leads to higher deficiency payments of $97 million. The higher deficiency payment is again offset by declines of $258 million in the other loan categories to yield a decrease in total net outlays of $161 million.

Both scenarios 1 and 2 indicate that reserve loan rates are important in determining the quantity of reserve placements.

Scenario 3: 5 Percent Yield Reduction in 1981 and 1982

One of the reasons reserve stocks began swelling in 1981 and especially 1982 was because of the good harvests during those years. In this scenario, we examine the effects of lowering the yield by 5 percent per acre for 1981 and 1982. Yield in 1981 was lowered from 109.9 bushels per acre to 104 bushels per acre and in 1982 from 114.5 to 108.8 bushels per acre.

The lower production levels cause price to rise by $.14 in 1981 and by $.36 in 1982. Placements into the reserve and total loans decline for both years. Carryover under loan increases in 1981 then decreases in 1982. The other demand components, food use, feed use, and export demand respond to the higher market prices by declining only slightly. The market price ends up being above the target price in 1982, hence, producers receive no deficiency payments loan program outlays decline substantially by $888 million in 1981 and $701 million in 1982.

Note that the other demand components, particularly exports, do not change very much. Their consistency and stability indicate that the government's stock programs help keep the United States as a reliable supplier of corn to importing countries. Supply shocks are absorbed by the stock programs instead of being drastically transmitted through to these other demand components.

It appears the good harvests were largely responsible for the reserve stock accumulation and large program outlays in 1981 and 1982.

CHAPTER 6. SUMMARY

The general concern of this study was to examine the relationships that exist between the stock categories and how these relationships affect the cost and effectiveness of the government's subsidized storage programs. The specific objective was to endogenize models of the government's loan programs into a U.S. corn supply and demand model. In so doing, direct loan policy analysis is possible. Also, other types of analyses, like altering yield, permit the effects on the programs and costs to be directly examined. Chapter 5 presented examples of these kinds of analyses. Those results indicate that price and stock levels are fairly responsive to changes in the reserve loan rate and yield levels.

The general model used in this study was specified similarly to the U.S. corn model developed by Baumes and Meyers (1980). The major difference was the specification of the ending stock equation. The stock equation in this model was designed to separate the stock categories that are subsidized by the government from the privately owned stocks. In so doing, carryover under nine-month loan became one of the regressors in the stock equation. By following the method of Miller, Meyers, and Lancaster (1978), a total loan demand equation was developed to include the reserve loan rate. This equation along with a behavioral equation for nine-month loan redemptions, permitted the carryover under nine-month loan category to be an endogenous variable in the stock equation. To make the reserve loan program endogenous, the coefficients for the placement equation had to be calculated from simulation runs of a monthly reserve placement model developed by Meyers, Jolly, and Smyth (1983a,b). The results provided proxies for the annual coefficients and yielded price elasticities based on annual placements that ranged from -1.74 in 1982/83 to -4.8 in 1981/82. The differing participation rates in the program was a major reason for the spread in the elasticities.

The remaining coefficients in the model were estimated using nonlinear two-stage least squares with principal components. The overall estimation results were satisfactory and generally consistent with results from other studies. The model was validated through the use of a historical simulation and was found to track the actual data well for most of the endogenous variables. The model converged to equilibrium after it was shocked for the stability check.

The simulations in Chapter 5 covered three scenarios. The first two examined the effects of changing the reserve loan rate and release price. The third scenario looked at what would have happened if the yields in 1981 and 1982 had been 5 percent less.

The results of the estimation and simulations yield the following conclusions about the storage programs and the reserve in particular.

1) The price elasticities obtained for reserve placements are larger than the price elasticities for the other demand components. Other studies of the reserve have also yielded large price elasticities -- even larger than obtained here.

2) The reserve program appears to stabilize price and make total stocks more responsive to production shortfalls as shown in Table 6.1

below.

Table 6.1. Change in price and total stocks per 100 million bushel change in production

Year	Price Change	Total Stock Change
1976 (no reserve)	$.08	39 million bushels
1981 (with reserve)	$.04	76 million bushels

The data in Table 6.1 were computed from the results listed in Tables 4.7 and 5.3. In 1976, when there was no reserve program, the change in price per 100 million bushel change in production was $.08. In 1981, when the reserve program was in existence, the price change was only $.04, or half of the 1976 price change. The change in total stocks more than doubled from 39 million bushels in 1976 to 76 million bushels per 100 million bushel change in production in 1981. These results indicate that the reserve acts as an additional buffer against production changes to maintain a more stable price.

3) Government and subsidized stocks do displace private stocks. The coefficient of -.25 for reserve plus CCC stocks in the ending stock equation indicates that private stocks decline by one-fourth bushel for every bushel put in the reserve. For increases in the carryover under nin-month loan, the ending stocks not under loan decline by just over half a bushel for each bushel under loan.

4) The subsidized storage programs keep the other demand components more stable during production shortfalls. The U.S. benefits

because it helps maintain our status as a reliable supplier of grain for export. Livestock producers also benefit, as their price and supply of feed is more stable.

5) The additional subsidy that reserve participants receive in the form of higher loan rates appears to be important in determining the quantity of grain placed into the reserve. Scenarios 1 and 2 illustrated how placements responded to loan rate changes.

6) In 1981 and 1982, the high yields appear to be a significant cause of the large buildup in reserve stocks and the high loan outlays that resulted. The good harvests may have been more significant than the high participation incentives offered by the program.

There are, no doubt, improvements that can be made to this model. The fact that the reserve program was endogenous only for three years placed some restrictions on the simulation analysis. This model would be enhanced if annual equations for both cumulative placements and cumulative redemptions could be developed. The difficulty, however, lies in the limited number of observations that are available, especially for redemptions.

Another enhancing possibility would be to link the participation rate in the reserve program to acreage response equation. The acreage response equation does not contain a participation rate variable, which is in the loan program equations. If this link were made, analyses could be done to compare supply side programs with demand side programs via the subsidized storage programs.

BIBLIOGRAPHY

Baumes, Harry S., Jr., and William H. Meyers. "The Crops Model: Structural Equations, Definitions, and Selected Impact Multipliers." NED Staff Report. USDA, ESCS, Washington D.C., March 1980.

Baumes, Harry S., Jr., and Abner W. Womack. "The Demand Structure of Field Crops and Policy Implications." Paper presented at Southern Agricultural Economics Association Meetings, Hot Springs, Arkansas, Feb. 1980.

Brennan, Michael J. "The Supply of Storage." The American Economic Review 48 (March 1958):50-72.

Burnstein, Harlan. "An Evaluation of the U.S. Reserves Management Program." NED Working Paper. USDA, ESCS, Washington, D.C., Dec. 1980.

Burnstein, Harlan. "Total price support loans and year end private government stocks of corn 1965/66-80/81." Typewritten data. NED, ESCS, Washington, D.C., 1982.

Chambers, Robert G., and William E. Foster. "Participation in the Farmer-Owned Reserve Program: A Discrete Choice Model." American Journal of Agricultural Economics 65 (Feb. 1983):120-124.

Golden, Michael, and Leonard Burman. "An Econometric Model of Farmers' Demand for Commodity Credit Corporation Loans." Southern Journal of Agricultural Economics 12 (Dec. 1979):47-55.

Huyser, Wipada S. " A regional analysis of trade policies affecting the soybean and soymeal market." Unpublished Ph.D. Dissertation. Iowa State University, Ames, Iowa, 1983.

Langley, James. "Reserve Loan Activity." Typewritten data. Food and Agricultural Policy Branch, NED, ERS, Washington, D.C., 1984a.

Langley, James. "U.S. Ending Stocks, 1950-1983." Typewritten data. Food and Agricultural Policy Branch, NED, ERS, 1984b.

Martin, Marshall A. "The Agriculture and Food Act of 1981: Implications for Indiana Farmers." Purdue Farm Management Report. Cooperative Extension Service, Purdue University, West Lafayette, Indiana, Feb. 1982.

Meyers, William H., and Robert W. Jolly. "Price Implications of Farmers' Response to the Farmer-Owned Reserve Program." Presented at American Agricultural Economics Association Meetings, Urbana, Illinois, July 1980.

Meyers, William H., Robert W. Jolly,, and D. Craig Smyth. "Forecasting Farmers' Response to the Farmer-Owned Reserve Program." Presented at the Applied Commodity Analysis and Forecasting Conference, Iowa State University, April 1983.

Meyers, William H., Robert W. Jolly, and D. Craig Smyth. "On Estimating Parameters for Farmer-Owned Reserves." NC-169 Regional Workshop. West Lafayette, Indiana, August 1983.

Meyers, William H., and D. Craig Smyth. "An Evaluation of Corn Reserve Placements: The Impacts of Program Provisions and Market Conditions." Presented at AAEA Meetings, Cornell University, Aug. 1984.

Miller, Ronald R., William H. Meyers, and Michael A. Lancaster. "Farmers' Response to the Commodity Credit Corporation's Loan Program." Southern Journal of Agricultural Economics 11 (Dec. 1978):157-164.

Morton, Andrew Scott. "Potential price variability in the U.S. grain and livestock sector in the 1980s under alternative policy scenarios: An econometric approach." Unpublished Ph.D. Dissertation. Iowa State University, Ames, Iowa, 1982.

Peck, Anne E. "Implications of Private Storage of Grains for Buffer Stock Schemes to Stabilize Prices," Food Research Institute Studies 15, No. 3 (1977):125-140.

Pindyck, R., and D. Rubinfeld. Econometric Models and Economic Forecasts. Second ed. New York, McGraw-Hill, 1981.

SAS. SAS/ETS User's Guide. SAS Institute, Inc., Cary, North Carolina, 1982.

Sharples, Jerry A., and Forrest D. Holland. "Impact of the Farmer-Owned Reserve on Privately Owned Wheat Stocks." American Journal of Agricultural Economics 63 (August 1981):538-543.

Spitze, R. G. F., and Marshall A. Martin. Analysis of Food and Agricultural Policies for the Eighties. North Central Regional Research Publication, No. 271, Illinois Bulletin 764. University of Illinois at Urbana-Champaign, Nov. 1980.

USDA. Agricultural Statistics. Various issues. United States Government Printing Office, Washington, D.C.

USDA. "USDA Reports Price Support Loan Activity." Various issues. ASCS, Washington, D.C.

Westhoff, Patrick, and William H. Meyers. "Alternative Single Equation Models of World Export Demand for Corn, Soybeans, Soymeal, Wheat, and Soyoil." Unpublished paper. Economics Dept., Iowa State University, Ames, Iowa, June 1984.

APPENDIX A. REDUCED FORM DERIVATIONS

Reduced form for P_t (Equation 2.6): Substitute (2.3), (2.4) into (2.2), then substitute (2.1), (2.2), (2.3) into (2.5) and solve for P_t.

(A.1) $$P_t = \frac{a_1 + a_2 + a_3(1-d_2) - e_2a_4 + (c_2-1)QP_t + C_3(1-d_2)Z_t + (1-f_2)CCC_t}{b_1 + b_2 + e_2b_4 + b_3(1-d_2)} - \frac{(STK_{t-1} + R_{t-1} + CCC_{t-1})}{b_1 + b_2 + e_2b_4 + b_3(1-d_2)}$$

where

$\alpha_0 = a_1 + a_2 + a_3(1-d_2) - e_2a_4$

$\alpha_1 = c_2 - 1$ $\qquad \alpha_1 < 0$

$\alpha_2 = c_3(1-d_2)$ $\qquad \alpha_2 > 0$

$\alpha_3 = 1-f_2$ $\qquad \alpha_3 > 0$

$\gamma_0 = STK_{t-1} + R_{t-1} + CCC_{t-1}$ $\qquad \gamma_0 > 0$

$\beta = b_1 + b_2 + e_2b_4 + b_3(1-d_2)$ $\qquad \beta > 0$

Reduced form for R_t (Equation 2.7): Substitute (2.6) into (2.3).

Reduced form for QP_{t+1} (Equation 2.9): Substitute (2.6) into (2.4).

Reduced form for STK_t (Equation 2.8): Substitute (2.6), (2.7), (2.9) into (2.2).

(A.2) $$STK_t = a_2 - d_2a_3 - e_2a_4 + \frac{\alpha_0}{\beta}(d_2b_3-b_2) + e_2b_4\alpha_0 + \left[\frac{\alpha_1}{\beta}(b_2 + e_2b_4 - d_2b_3) + c_2\right]QP_t - \left[\frac{\alpha_2}{\beta}(b_2 + e_2b_4 - d_2b_3) + d_2c_3\right]Z_t$$

$$-\left[\frac{\alpha_3}{\beta}(b_2 + e_2b_4 - d_2b_3) + f_2\right] CCC_t + \left[\frac{1}{\beta}(b_2 + e_2b_4 - d_2b_3)\right]\gamma_0$$

where $\lambda_0 = a_2 - d_2a_3 - e_2a_4 + \frac{\alpha_0}{\beta}(d_2b_3 - b_2) + e_2b_4\alpha_0$ in (2.8).

Note that in (2.8), $b_2 + e_2b_4 - d_2b_3 = \beta - b_1 - b_3$ and that

$$1 - \frac{b_1 + b_3}{\beta} = 1 - \frac{b_1 + b_3}{b_1 + b_2 + e_2b_4 + b_3(1-d_2)} > 0 \quad .$$

APPENDIX B. DEFINITION OF VARIABLES

Endogenous variables:

CORDF: Corn feed demand, million bushels.
CORDH: Corn food demand, million bushels.
CORHT: Corn, total ending stocks, million bushels
CORECPC: Corn, proportion of world exports to EEC, million bushels.
CORHCC1: Corn, ending commercial stocks less carryover under loan, million bushels.
CORHPRRE: Corn, ending farmer-owned reserve stocks, million bushels.
CORMX: Corn, total U.S. exports, million bushels.
CORNRE: Net returns from corn, $/acre.
CORNTRED: Corn, nine-month loan redemptions, million bushels.
CORPF: Corn price received by farmers, $/bushel.
CORPGR1: Corn, production for next year, million bushels.
CORPRES: Corn, net crop year placements in the reserve, million bushels.
CORSA: Corn acreage planted, million acres.
CORSA1: Corn, expected acreage planted, million acres.
CORSOYEU: Weighted corn/soymeal price ratio of EEC threshold and U.S. market price, $/bushel.
CORTPSL: Corn, total price support loans, million bushels.
CORXTOT: Corn, world export demand, million bushels.
CPLACE: Corn, cumulative reserve placements, million bushels.
CPRATW: Weighted price ratio, government loan rate/market price of corn.
CRISK: Corn, risk variable.
DEFPAY: Corn, deficiency payment when market price is below target price, $.
FORLOAN: Farmer-owned reserve loan outlays, $.
FORRED: Value of reserve loan redemptions, $.
NETCOST: Net outlays for the loan programs, $.
NETFOR: Net reserve loan outlays, $.
NETNM: Net nine-month loan outlays, $.
NMLOAN: Nine-month loan outlays, $.
NRL: Corn, carryover under nine-month loan, million bushels.
TSPMT: Total reserve and CCC stock storage costs, $.
Z: Proportion of total loans placed under nine-month loan.

Exogenous variables:

CEN1: Personal consumption expenditures, nondurable goods and services, billion $.
CORDS: Corn, seed demand, million bushels.
COREXTL: Corn placed under extended loan during crop year, million bushels.
CORFCCC: Corn, nine-month loans forfeited to CCC, million bushels.
CORHHUN: Corn, ending CCC (uncommitted) stocks, million bushels.
CORMESR: Corn, Soviet Union net imports from non-U.S. sources, 1000 metric tons.
CORMG: Corn, total U.S. PL480 and AID exports, million bushels.
CORMI: Corn, total U.S. imports, million bushels.
CORMXCC: Corn, exports of South Africa, Argentina, Thailand, 1000 metric tons.
CORMXSPR: Corn, total U.S. exports to Soviet Union and PRC, million bushels.
CORPA: EEC threshold price, UOA/MT.
CORPD1: Corn, effective diversion payment, $/bushel.
CORPE1: Corn, expected effective price support, $/bushel.
CORPL: Corn, nine-month loan rate, $/bushel.
CORPT: Corn, target price, $/bushel.
CORRE: Corn, reserve loan rate, $/bushel.
CORSYGR1: Corn, yield for next year, bushel/acre.
CORVC: Corn, variable cost of production, $/acre.
COR9SRF: Available supply of corn for feed in EEC and rice feed in Japan, 1000 metric tons.
COSMNEA: World exports to EEC, million bushels.
CPART: Program participation rate, %.
CUMFOR: Corn, cumulative reserve forfeitures, million bushels.
CUMRED: Corn, cumulative reserve redemptions, million bushels.
CYRED: Corn, crop year reserve loan redemptions, million bushels.
EXTCARRY: Corn carried over under extended loan, million bushels.
FPINDEX: Farm price index, 1967 = 1.
GCAUTST: Grain consuming animal units, cal. year.
ICCC: CCC interest rate on loans, %.
IPCA: PCA interest rate on loans, %.
LIVIF1: Livestock price index, 1953-57 farm prices, 1966 = 1.
LIVPEUJ1: Index of EEC Japanese poultry and hog production, 1967 = 1.
PRES: Corn, reserve release price, $/bushel.
RSHIFT: Dummy variable, 1 for 1977-1982, otherwise 0.
SDROCT: U.S. dollars per SDR, October basis, $/SDR.
SHIFT72: Dummy variable, 1 for years prior to 1973, otherwise 0.
SHIFT79: Dummy variable, 1 for 1979 and 1980, otherwise 0.
SNRE1: Soybeans, net returns per acre, $/acre.
SOMPM: Soybean price received by farmers, $/bushel.
SPMT: Storage payment, $/bushel.
TBILL: Three-year treasury bill rate, %.
WAIVE81: Dummy variable, 1 for 1981, otherwise 0.
WHEIW1: Wholesale price index, 1967 = 1.
WHEPF: Wheat, average price received by farmers, J-J, $/bushel.