AN APPLICATION OF OPTIMAL CONTROL METHODS TO AGRICULTURAL POLICY ANALYSIS AND FORMULATION

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CHAPTER I

INTRODUCTION

The Problem

Consumers of agricultural commodities or products, agricultural producers and taxpayers view the United States agricultural sector from different perspectives and use different criterion or goal structures to gauge its performance. These goal structures tend to be conflicting. Consumer groups prefer low food costs. Farm groups want adequate levels of income from the products they produce. Taxpayers are, of course, a subset of both consumer and farm groups, but the vast majority of taxpayers are consumers. The preference of taxpayers are for low Federal outlays on Government farm programs. The agricultural policy decision maker must decide upon agricultural policy which considers the various, and, in general, conflicting goals of society.

Historically, agricultural policy makers have used three types of farm programs to attempt to alleviate the problem of low farm income and other problems facing agricultural producers. These farm programs are direct payments to farmers, price supports, and production or supply control. Direct payment programs are exemplified by the deficiency payment program of the 1977 Food and Agriculture Act which are based upon target prices. Direct payment programs can be very effective in raising farm income, but they can also be associated with high treasury costs or Federal outlays. Price support programs effectively set a minimum price which agricultural producers receive for their products. Prices are supported by the Federal Government by either non-recourse loans, which the farmer can turn his production over to the Federal Government as full payment for the loan, or through direct purchases of excess supplies. Either method can result in large stocks of agricultural commodities. Supply or production control programs may have relatively low treasury costs, yet may incur other social costs in the form of increased consumer food costs. These farm programs like price support programs reflect the use of the low price elasticity of demand of agricultural commodities in increasing farm income. A review of the success and failure of all these types of farm program may be found in Tweeten (1970).

Over the last decade, control theory has emerged from relative obscurity in agricultural economics to become a highly acclaimed theoretical construct which provides a conceptual framework for developing what could be called a general theory of policy formulation and analysis. Burt (1969) was one of the first agricultural economists to recognize the potential usefulness of control theory in developing temporal agricultural policy. The use of control theory as a comprehensive integrative device or framework for a general theory of policy development and analysis can be attributed to Rausser (1978).

However, one significant use of control theory has been largely ignored in past studies of policy formulation and analysis with control methods. This is the potential ability of control methods to facilitate the development of a concensus when the preferences or desires of policy makers vary.

Objectives

The general objective of this thesis was to demonstrate that control theory can be used to generate economic intelligence in regard to agricultural policy formulation and analysis. Specific objectives were 1) to develop a preformance measure which reflects alternative agricultural policy formulations which can occur as the preferences of agricultural policy decision makers vary for obtaining specified goals for annual net farm income and 2) to indicate the sets of agricultural policies that are consistent with the alternative preferences of decision makers for a given economic environment for agriculture. The objectives of this thesis were accomplished by adapting control theory methods to an economic model which simulates the United States agricultural sector. The economic model used was the National Agricultural Policy Simulator Simultaneous Version (POLYSIM).

Organization of the Remainder of Thesis

The remaining four chapters of this thesis are organized in the following fashion. The next chapter contains basic concepts of control methods and develops these concepts in relation to the United States agricultural sector. The third chapter contains a detailed description of the POLYSIM model which was used in this thesis. Chapter IV contains results for selected performance measures from which agricultural policy was formulated and analyzed. Summary and conclusions are presented in the last chapter.

CHAPTER II

METHODOLOGY

Optimal control methods can be classified in many ways. The most common categorizations of control methods are deterministic, stochastic and adaptive. The control method used in this study can be classified as deterministic. Stochastic and adaptive control methods have dealt primarily with gaining knowledge of and the summarization of stochastic elements which can enter the system or process being controlled. Information gained about the stochastic eleements of the system or process is used in a summary fashion to develop control policies. The summarization used is mathematical expectation. The successful application of stochastic and adaptive control methods requires the ability to mesh mathematical expectation and optimization techniques by which control policies are formulated. Existing stochastic and adaptive control methods require the ability to differentiate performance variables with respect to all control variables (performance variables and control variables are discussed in the following sections of this chapter). This requirement is not fullfilled for all performance variables of interest from the United States agricultural sector. Thus, the control method selected to be used in this thesis was of the deterministic type that allows for the formulation of control problems which do not meet the requirement of differentiability.

Some Basic Concepts of Control Methods

In general, the objective of control methods is to determine the levels of control variables that cause a particular system (or process) to satisfy a given set of boundary constraints and at the same time cause a given performance measure to be at a maximum (or minimum) (Jacobs, 1975; Kirk, 1970; Sage, 1968). The above definition not only defines the objective of control methods, but also suggests important issues a researcher must consider when applying control methods to policy formulation and analysis problems. These issues, which include the mathematical description of system or process to be controlled, performance measurement, and selection of the appropriate optimization method to determine the optimal control path, are discussed in the following sections of this chapter.

The System or Process to be Controlled

One of the basic issues a researcher must consider in a control situation is the mathematical description of the system or process to be controlled. In the case of economic systems, the system or process might be expressed as

$$Yit = fi(Yt, Yt-1, Ct, Xt) \quad (1)$$

where Yit is the ith element in the vector Yt which defines all endogenous or state variables in the system for time period t, Yt-1 is the vector Yt lagged one time period. Ct is the vector of control variables or policy instruments which can be controlled or manipulated by Government authorities. Control variables can be thought of as a subset of all exogenous variables defined in the system. The vector Xt defines the remaining exogenous variables in the system which are not subject to control. This representation of an economic system allows for simultaniety among endogenous variables and the consideration of lagged response. This formulation of economic system has been suggested and used in control studies by Chow (1976).

The breadth of the model of the economic system or process implicity determines the scope of the control problem that can be considered. As the model of the system becomes larger and considers more economic relationships, the more encompassing the control problem can be formulated. Past applications of control methods to agriculture policy analysis and formulation illustrate this point. Studies by Freebairn and Rausser (1974) and Rausser and Freebairn (1974) are examples of control problem formulations which used small economic models and had somewhat limited results since they considered only a specific agricultural commodity and did not consider interactions with other agricultural commodities. Arzac and Wilkinsons' (1977) study on the stabilization of the United States feed grain and livestock market represents a more comprehensive formulation of an agricultural control problem, yet precluded analysis of the effects of feed grain and livestock policy upon other agricultural commodities and also precluded the analysis of converse relationships. Richardsons' (1977) study was the first application of control methods to agricultural policy formulation and analysis which allowed for many interrelationships among agricultural commodities. Feed grain as well as food grain and fiber policies were determined which accounted for supply and demand interactions among major agricultural commodities.

The model of the system or process also implicitly defines the control variables or policy instruments by which policy can be determined. For a policy instrument to be used as a control variable in policy formulation and analysis with control methods, the policy instrument must be defined in the model. Garbade (1976) also suggested prerequisites for control variables selection from the set of policy instruments defined in the system. The first prerequisite relates to the ability of selected control variables to effect performance measures. If the performance of the system is to be measured by effecting the value of a particular endogenous variable and no control variables are included which affect this endogenous variable, then the ability of control methods to formulate policy will be nullified. The second requisite suggested by Garbade (1976) relates to the uniqueness of effect that a particular control variable has upon endogenous variables. The effects of control variables should be distinguishable. If the control problem has been formulated with redundant control variables, the problem should be reformulated to eliminate redundancies.

Performance Measurement

Another issue the researcher must consider in a control situation is the relationship which defines how the performance of the system is to be measured. The performance measure is usually termed the objective or criterion function and can be denoted as

$$W = f\ (Yp) \tag{2}$$

where Yp defines a vector which contains a subset of the variables defined in Y where Y is defined as

$$Y = (Y1,\ \ldots,\ YT) \tag{3}$$

and T represents the length of the control period or planning horizon. The elements defined in the vector Yp are usually termed the performance variables.

At least two other issues must be confronted in the development of an objective function given a particular mathematical form.[1] These are which endogenous or state variables defined in Y should be included in Yp and values to

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[1]An infinite number of different mathematical forms of an objective function can be constructed. However, as in the case of past control studies and this control study a particular mathematical form will be assummed. Emphasis in this study is placed on using the given or assummed mathematical form of the objective function in developing alternative control paths which reflect different decision maker preferences.

be assigned to parameters defined in the objective function which reflect the preferences of decision makers. The process of public policy decision making subscribed to here is as presented by Rothenberg (1961) and others. Decision making is viewed as bargaining process among centralized decision makers and other individuals such as special interest groups. Performance variables included in an objective function must relate to what decision makers view as relevant measures of the welfare of the individuals they represent.

Welfare measurements which have been proposed as performance variables in control studies include both direct measures of consumer and producer surplus and indirect measures such as interest rates, unemployment rates, and measures of either expenditures for or income accruing from commodities included in the economic system. The use of the area above the supply curve and below the demand curve as a performance variable in agricultural control studies was first proposed by Burt (1969). Along with the technical problems associated with using consumer and producer surplus as a measure of welfare, these types of welfare measures may be difficult to understand and relate to in the task of decision making (Richardson and Ray, 1980). Decision makers may be more interested in indirect performance variables. Examples of indirect performance variables which have been used in agricultural control studies are consumer food expenditures, farm income, and federal outlays on agriculculture (Richardson, 1978; Rausser and Freebairn, 1974).

In the context of centralized agricultural policy decision making, the main participants become the President and his cabinet, the legislative branch and possibly special interest groups. The selection of parameter values of an objective function, given the mathematical form, reflects the preferences of decision makers. In past control studies the most commonly used mathematical form of the objective function has expressed the objective or criterion function as a quadratic in the performance variables (Chow, 1975 and 1976, Holbrook, 1975; Rausser and Freebairn, 1975; Azzac and Wilkinson, 1977; and others). Two basic forms of the quadratic objective function, which have been used in past control studies are

$$W = \sum_{t=1}^{T} \sum_{i=1}^{P} Hit*((Yit-Ait)**2) \qquad (4)$$

and

$$W = \sum_{t=1}^{T} \sum_{i=1}^{P} kit*Yit- \sum_{t=1}^{T} \sum_{i=1}^{P} Kit*Yit**2 \qquad (5)$$

where Yit is as defined in (3) above and Ait, Hit, kit, and Kit are parameters or weights associated with performance variables in their respective equations. The parameters Ait have also been termed the target values of Yit (Chow, 1975).

As can be seen in (5) and especially (4), the parameters in these equations reflect the preferences of decision makers.[2] In the context of centralized decision making,

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[2]As an explanation consider the situation of P=2; that

Rausser and Freebairn (1974) have suggested that the objective function, or in their terminology the policy preference relation, should formalize preferences with assumptions about the marginal policy preference relation of the decision maker and the marginal rate of substitution between performance variables in the policy preference relation. To consider this formalization, let (5) represent the policy preference relation with the simplifying assumption that the control period is for only one year and the parameters of (5) do not vary over time. This objective function might then be rewritten as

$$W = \sum_{i=1}^{P} ki*Yi-Ki*Yi**2 \qquad (6)$$

First order conditions for the maximization of (6) require that

$$Wi = ki-2Ki*Yi= 0 \qquad (7)$$

or

$$Yi = ki/2Ki \qquad (8)$$

for all i, where Wi denotes the partial derivative of W with respect to Yi. Denote the optimum value of Yi as given by (8) as Ai. By substituting Ai into (6), the policy preference relation can be rewritten as

$$W = \sum_{i=1}^{P} ki**2/4Ki- \sum_{i=1}^{P} Ki*(Yi-Ai)**2. \qquad (9)$$

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is, two performance variables. If H1t is greater than H2t, the decision maker a higher desire to obtain the target value of Y1t than Y2t.

The utility maximizing value of (6) must also satisfy the fact that the marginal rate of substitution between any two performance variables must also equal the ratio of the marginal policy preference relation for the same two performance variables which are derived from (9) and defined as ratios of expressions such as

$$Wi = -2Ki*(Yi-Ai) \tag{10}$$

for all i. Rausser and Freebairn (1974) argue that for given values of the ratios of Wi and Wj as defined by (10), Ai, and base comparison points of Yi values for the parameters ki and Ki can be determined from (8) and (10).

This approach to developing an objective function is methodologically between an approach suggested by Bray (1974) and arbitrary weighting schemes. Bray (1974) suggests indepth interviewing of decision makers to determine parameter values objective functions which reflect intensity of preferences. Arbitrary weighting schemes occur when the researcher conducting the control study assumes values for parameters such as Hit, kit and Kit in the above discussion. The use of arbitrary weighting schemes in an objective function does not necessarily suggest poor methodology (Rausser and Freebairn, 1974). If the arbitrary weighting is made explicit, individuals and or decision makers with perhaps other desires may readily evaluate these assumptions. From this standpoint the decision maker(s) might conceptionalize what their policy prescriptions should be if their preferences differ from those assumed.

The consideration of possible ranges in preferences of decision makers suggests that a set of objective functions or policy preference relations. These different policy preference relations could reflect extreme viewpoints of decision makers as well as intermediate viewpoints. By indicating the policies developed by using different policy preference relations, a contribution to concensus public decision making might be obtained.

Optimization Approach and Choice of Optimization Technique

A third basic issue the researcher must consider in a control situation is that performance of the system can be altered or changed by movements in values of control or instrument variables. This issue or component a control situation is implied by the inclusion of the optimization statement in the earlier definition of the objective of control methods.

The approach to the optimization problem in a control situation and the choice of optimization technique to solve this problem is constrained by the mathematical and dynamic form of the objective function and the mathematical form of the system. If the objective function is of a form such that the multiperiod control problem is separable in time, then two basic approaches to the optimization problem can be used. These are dynamic programming and simultaneous optimization.

The use of dynamic programming allows an optimization problem to be solved by stages which will reduce the multi-period control optimization problem to a sequence of optimization problems (Chow, 1975). Dynamic programming has been used by many authors of optimal control studies such as Chow (1975) and (1976), Freebairn and Rausser (1975), Arzac and Wilkinson (1977).

Simultaneous optimization approaches determine objecttive function optimizing values for all control variables for all time periods in the control period at once. Examples the use of this approach are Holbrook (1975) and Richardson (1978).

Two basic types of optimization techniques have been used in past control studies. These are gradient methods and direct search methods. The use of gradient methods require the ability to differentiate selected performance variables with respect to all control variables. This requisite, as mentioned earlier, is not guaranteed for the performance variables used in this thesis. Thus, a direct search method the Box Complex which does not require differentiability was used.

The Box Complex is a well documented and accepted direct search optimization technique (Swan, 1974). It was used for the purpose of the optimization problem in this control study as a simultaneous optimization approach. The computer programming of this optimization technique was based upon the work of Kuester and Mize (1973) and Richardson (1978). For a detailed description of the Box Complex procedure consult either Box (1965) or Richardson and Ray (1979). For more detailed information on types of optimization techniques which might be suitable to control optimization problems consult Farrell, McCall and Russell (1972) and Fair (1974).

A Development of Basic Concepts of Control Theory in Relation to the United States Agricultural Sector

As stated earlier one of the basic components of a control situation is the system or process to be controlled. The model of the system or process to be controlled in this control study was the National Agricultural Policy Simulator Simultaneous Version (POLYSIM). A detailed description of this economic model is presented in the next chapter.

Increases in net farm income can occur from two sources which are increases in market income from the sale of agricultural commodities and/or increases in Government payments. As a reflection of alternative preferences of decision makers, a set of control problems are formulated in this study that allow varying proportions of target net farm income increases to come from Government payments with the remainder coming from the market place. The specification of the objective function in each control problem or application would reflect different preferences as to the source of increase in net farm income. Two applications reflected extremums of preference: one where all the increase in net farm income came from the market place and one where all the increase in net farm income came from Government payments. The remaining applications reflect preferences that net farm income should come partly from Government payments and partly from the market place.

As stated above, the quadratic objective function of the form given by (4) was chosen for this study. Given this mathematical form and that performance variables are net farm income and the Government payments, the objective function can be formally expressed as

$$W = \sum_{t=1}^{T} (H1t*(Y1t-A1t)**2+H2t*(Y2t-A2t)**2) \qquad (11)$$

where Y1t represents net farm income, Y2t represents Government payments, A1t and A2t are the target values of Y1t and Y2t, respectively, and H1t and H2t are the weights associated with Y1t and Y2t, respectively.[3]

The values of the parameters H1t and H2t were chosen to be 1.0 and 50.0, respectively, for all control periods. The unit values for H1t were chosen to allow equal weighting in obtaining the target levels of net farm income for all control periods. The larger values of H2t were chosen to insure that the exact levels of Government payments were

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[3]By including Government payments and net farm income in the objective function, market income was implicitly included; that is, in achieving the target level of Government payments the target level of market income was also achieved since market income and Government payments sum to equal net farm income.

obtained. The target levels of net farm income along with the baseline levels of net farm income which were projected by the system to be controlled (POLYSIM) under conditions of no change in current farm policy for the control period (1980-1983), are given in Table I. The target levels of net farm income reflect the assumption of a 13 percentage point increase in the consumer price index for 1980 and a 9 percentage point increase in the consumer price index for 1981, 1982 1983. The different applications of (11) were conducted by changing the parameters A2t to allow differing target levels of Government payments. Thus, (11) was used as the objective function for this study with H1t, H2t, and A1t held constant over all applications and the level of Government payments (A2t) allowed to vary.

TABLE I

PROJECTED AND TARGET LEVELS OF
OF NET FARM INCOME, 1980-83

Year	Projected	Target
	..... billions of dollars	
1980	24.40	31.6
1981	23.10	32.9
1982	21.70	34.2
1983	19.40	35.4

Multiple applications of the same quadratic objective function can be viewed as tracing out a member of the family of curves that Rausser and Freebairn (1974) have termed the policy possibility frontiers. Ideally we would like to determine the set of policy instruments levels that will achieve the desired point on the policy frontier. But, to know the point one would have to know the tangency of the social (or policy) welfare function with the policy possibility frontier. An alternative is optimizing the system for several points on the policy possibility frontier and let the policy maker reveal his perception of the tangency of the welfare function by the solution and corresponding policy instruments he selects.

The policy possibility frontier implied by the minimization of the objective function in (11) for alternative values of A2t is conceptionalized graphically in Figure 1. The distance E-0 or A-0 when added to the projected level of net farm income will equal the target level of net farm income. The two extremes in policy formulation are represented by points A and E on Figure 1. Point A represents a policy formulation which generates all the increase in net farm income for a given control period from market sources of net farm income. The distance A-0 when added to the projected level of net farm income for the control period will yield the target level of net farm income. Point E represents the polar extreme. In this situation all the increase in net farm income must originate from Government

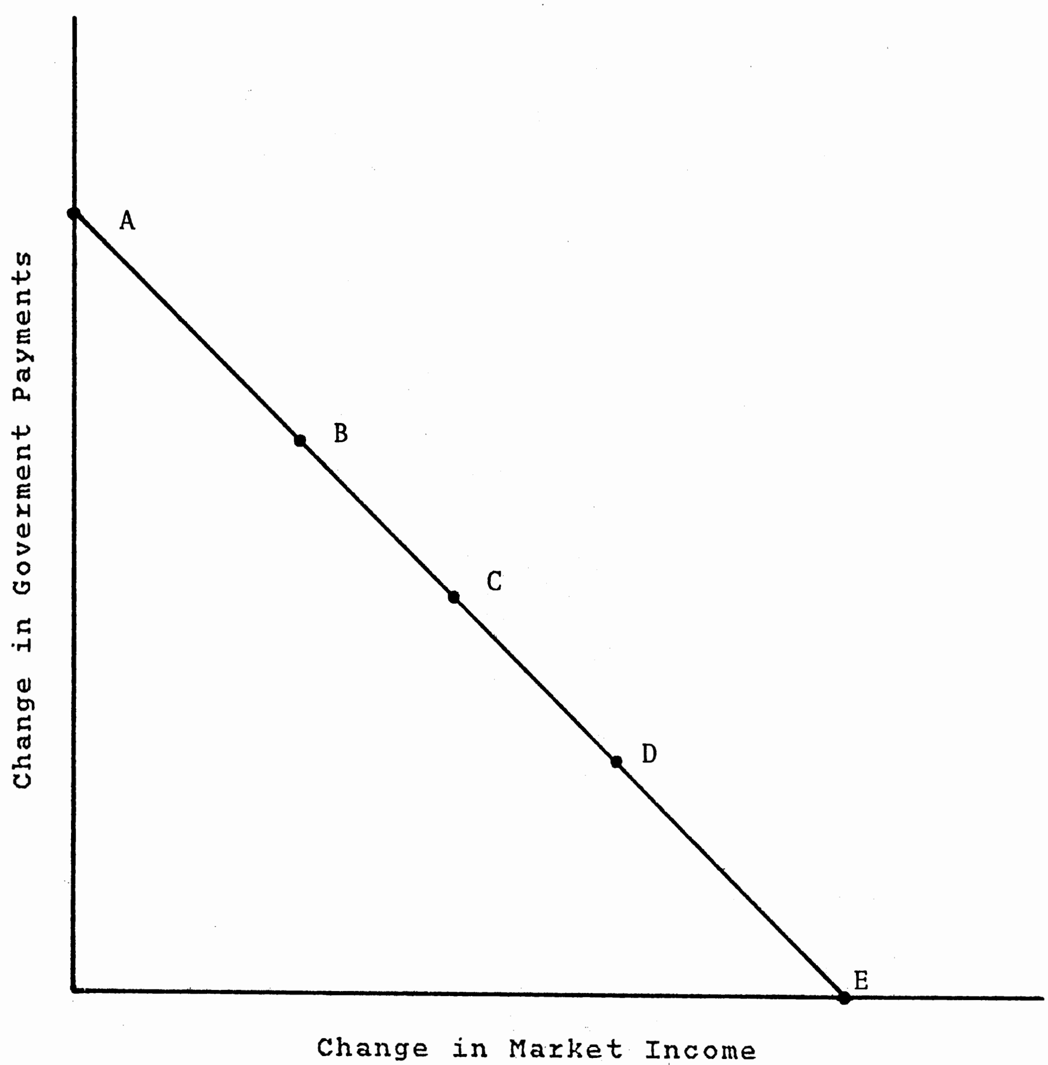

Figure 1. Policy Possibility Frontier

payments. Point C represents a policy formulation exactly between the extremums. In this application one-half the increase in net farm income would come from increases in market income and one half would come from Government payments. Point D represents the opposite of Point B, in this application of the objective function a larger proportion of the increase in net farm income must come from Government payments, yet some of the increase in net farm income must still originate from the market place. The exact percentages used in this thesis are 70 percent from Government payments and 30 percent from the market place.

In addition to the applications of the objective function described above, another application of the objective function allowed the selection of any combination of changes in market income and Government payments which obtains the target levels of net farm income. This application of the objective function in later sections of this thesis will be referred to as the free choice application. The results of of all six applications are presented in Chapter IV.

Control variable selections assumed continuation of present farm programs. It was assumed that a deficiency payment program based upon target prices was in effect for corn, grain sorghum, barley, wheat and cotton. Set-aside and stock programs were assumed for these crops with a stock program also available for oats and soybeans. For feed grains and wheat the farmer-held reserve program, as provided for in the 1977 Food and Agriculture Act was assumed.

For cotton and soybeans a Commodity Credit Corporation program which supports market price at loan rates was assumed. It was further assumed that if a set-aside program is in effect farmers must participate in the set-aside program to be eligible for income support (deficiency payment) and stock programs (farmer-held reserve and CCC).

The control variables or policy instruments used in this study were the target price, loan rate, and set-aside rate of corn, wheat and cotton. Changes in target prices in conjunction with a deficiency payment program reflect changes in income support payments to farmers. The formula by which deficiency payments are computed under the provisions of the 1977 Food and Agriculture Act is explained in detail in Chapter III. Table II contains the upper and lower boundary constraints of these control variables.

Loan rates have, historically, been used as price support levels for agricultural crops. Price supports have set minimums on prices which farmers receive for their crops via Commodity Credit Corporation non-recourse loan programs. Loan rates are also important in stock programs. These policy instruments are used to determine prices at which farmers can market grains in the farmer-held reserves and also the market prices at which Commodity Credit Corporation stocks can be marketed. Table III contains the upper and lower boundary constraints of these control variables.

Changes in set-aside rates reflect potential reduction or increases in crop production. Changes in set-aside rates

TABLE II

UPPER AND LOWER BOUNDARY CONSTRAINTS FOR TARGET PRICES OF CORN, WHEAT AND COTTON, 1980-83

Year	Corn Lower	Corn Upper	Wheat Lower	Wheat Upper	Cotton Lower	Cotton Upper
	....		$/bushel		....	
1980	2.10	3.97	3.00	5.72	.52	0.94
1981	2.10	4.46	3.00	6.37	.52	1.04
1982	2.10	4.92	3.00	7.11	.52	1.12
1983	2.10	5.26	3.00	7.57	.52	1.18

Source: Lower boundaries are from the 1977 Food and Agriculture Act. Upper boundaries represent 1980 parity prices of the respective crop adjusted by projected increases in variable cost of production.

TABLE III

UPPER AND LOWER BOUNDARY CONSTRAINTS FOR LOAN RATES OF CORN, WHEAT AND COTTON, 1980-83

Year	Corn Lower	Corn Upper	Wheat Lower	Wheat Upper	Cotton Lower	Cotton Upper
	....		$/bushel		....	
1980	1.75	3.57	2.00	4.04	0.37	0.81
1981	1.75	4.01	2.00	4.46	0.37	0.89
1982	1.75	4.43	2.00	4.98	0.37	0.96
1983	1.75	4.73	2.00	5.30	0.37	1.01

could reflect multiple policy goals, the one emphasized here is their effect upon the market prices of agricultural products through changes in production. Table IV contains the upper and lower boundary constraints of these control variables.

TABLE IV

UPPER AND LOWER BOUNDARY CONSTRAINTS FOR SET-ASIDE RATES OF CORN, WHEAT AND COTTON, 1980-83

	Corn		Wheat		Cotton	
Year	Lower	Upper	Lower	Upper	Lower	Upper
	...... percent of harvested acreage					
1980	0.0	70.0	0.0	70.0	0.0	70.0
1981	0.0	70.0	0.0	70.0	0.0	70.0
1982	0.0	70.0	0.0	70.0	0.0	70.0
1983	0.0	70.0	0.0	70.0	0.0	70.0

In addition to the control variables described above the target prices, loan rates, and set-aside rates for grain sorghum and barley and the loan rate for oats were computed based upon their historical relationship to corn variables. During the period 1977-1980, the target price of sorghum averaged 108.75 percent of corn target price and barley averaged 97.75 percent of corn target price. These percentages of corn target prices were used in computing sorghum and barley target prices. During the period 1977-1980 the loan rates of barley, grain sorghum, and oats were administratively set based upon the provisions of the 1977 Food and Agriculture Act. This legislation requires that the loan rate of barley, grain sorghum and oats be determined based upon thier feeding values in relation to corn. During this time period grain sorghum loan rate was set at exactly 95.0 percent of corn loan rate, barley loan rate was set at 81.5 percent of corn loan rate and oats loan rate was set at 51.5 percent. The same relationships were used in this thesis. The set-aside rates of barley and grain sorghum were also assumed to be equal to corn set-aside rate.

The National Agricultural Policy Simulator (POLYSIM) contains policy instruments other than those described above which were not subject to control in this study. These are national program acreages, administrative yields, release and call prices on grains in the farmer-held reserve and release prices for Government-owned stocks. The values of the policy instrument used for the control period of the study are given in Table V.

TABLE V

PREDETERMINED VALUES OF NATIONAL PROGRAM ACREAGE, ADMINISTRATIVE YIELDS, AND STOCK RELEASE PRICES, 1980-1983

Variable and Crop	Unit	1980	1981	1982	1983
National Program Acreage					
Corn	M. acres	70.5	27.0	74.0	5.0
Wheat	M. acres	65.0	66.5	65.8	65.4
Cotton	M. acres	10.3	10.0	10.0	10.0
Grain Sorghum	M. acres	13.5	14.1	14.0	14.4
Barley	M. acres	7.3	7.5	7.5	7.7
Administrative Yields					
Corn	bu./acre	101.1	100.0	99.0	98.0
Wheat	bu./acre	31.0	32.0	32.0	32.0
Cotton	bu./acre	480.0	480.0	480.0	480.0
Grain Sorghum	bu./acre	55.0	54.5	54.5	54.5
Barley	bu./acre	44.5	46.0	46.5	46.5
Farmer-held Reserve Release Price					
Corn	% of loan rate	125.0	125.0	125.0	125.0
Wheat	% of loan rate	150.0	150.0	150.0	150.0
Cotton	% of loan rate	125.0	125.0	125.0	125.0
Grain Sorghum	% of loan rate	125.0	125.0	125.0	125.0
Barley	% of loan rate	125.0	125.0	125.0	125.0
CCC Sales Price					
Corn	% of loan rate	150.0	150.0	150.0	150.0
Wheat	% of loan rate	190.0	190.0	190.0	190.0
Grain Sorghum	% of loan rate	150.0	150.0	150.0	150.0
Oats	% of loan rate	150.0	150.0	150.0	150.0
Barley	% of loan rate	150.0	150.0	150.0	150.0

Modifications Made to the National Agricultural Policy Simulator (POLYSIM)

Program Participation

For any farm program such as set-aside to be effective, farmers must participate. In the past some agricultural programs have had high farmer participation while others have had low farmer participation. To estimate farmer participation rates and to ensure that adequate renumeration would be given producers for participation, a breakeven producer decision model was developed. The model is based upon the work of Burnstein (1979).

When either the policy instruments values or in the context of this study the control variable values of a farm program such as set-aside are announced, a farmer has to decide whether or not to participate in that program. The decision process on whether or not to particpate can be analyzed by comparing the expected net revenue of the non-participant to that of the participant (Burnstein, 1979). The expected net revenue of the non-participant for the ith crop is total expected revenue for that crop less the expected cost of production. This can be expressed as

$$NVRi = PRODi*MPi - PRODi*ACYi \qquad (12)$$

where NVRi represents the expected net revenue of the ith crop, PRODi represents the expected production of the ith crop, MPi represents the expected market price of the ith crop, and ACYi represents the expected average variable cost per unit of the ith crop. If announced target price is greatter than expected market price, the expected net revenue for participants is assumed to be

$$NVRi = PRODi*MPi*(1-Si)+(TPi-MPi)*PAFi*AYi*NPAi +SPRi*Si*PRODi-PRODi*ACYi*(1-Si) \quad (13)$$

and if announced target price is less than expected market price

$$NVRi = PRODi*MPi*(1-Si)+SPRi*Si*PRODi -PRODi*ACYi*(1-Si) \quad (14)$$

where Si represents the announced set-aside rate of crop i, TPi represents the announced target price of crop i, PAFi represents the program allocation factor of crop i, AYi represents the administrative yield of crop i, NPAi represents the national program acreage of crop i, and SPRi represents the set-aside payment rate for crop i. As in past history it is assummed in this study that for a farmers to recieve deficiency payments based upon target price they must participate in the set-aside program.

By equating (12) to (13) and solving for SPRi and then equating (12) to (14) and solving for SPRi,the resulting expressions represent the breakeven set-aside payment rates. That is, if the announced target price is greater than market price of crop i

$$BSPRi = (Si*PRODi*(MPi-ACYi) -(TPi-MPi)*AYi*PAFi*NAPi)/Si*Prodi \quad (15)$$

and if announced target price is less than the expected market price of crop i

BSPRi = MPi - ACYi (16)

where BSPRi represents the breakeven set-aside payment rate of crop i.

Burnstein (1979) hypothesized that the participation rate of a set-aside program is the product of the breakeven participation rate (the participation rate if announced set-aside payment rate is equal to breakeven set-aside payment rate) and the ratio of announced to breakeven set-aside payment rate; that is,

APRi = BPRi*(ASPRi)/(BSPRi) (17)

when APRi represents actual program participation rate for crop i, BPRi represents the breakeven program participation rate for crop i, and ASPRi represents the announced set-aside payment rate for crop i. Burnstein (1979) assumed that the value of BPRi was greater than one-half. This reflects the hypotheses that production costs are normally distributed around a mean value that and other program benefits are not accounted for in this type of analysis. In this study, for feed grains the assumed breakeven participation rates were 0.6 and 0.8 for wheat and cotton. If (17) is solved for ASPRi; that is,

ASPRi =BSPRi*(APRi/BPRi) (18)

a level of announced set-aside payment rate could be computed which would maintain an actual or in this case desired set-aside program participation rate. The values of APRi used were 0.5 for feed grains, 0.6 for wheat, and 0.9 for cotton. These represent an attempt to increase feed grain set-aside program participation and keep wheat and and cotton set-aside program participation at or about their historical levels.

From this point, what might be called effective set-aside rates can be computed as

$$ESRi = Si*APRi \tag{19}$$

where ESRi represents the effective set-aside rate for crop i. Based upon effective set-aside rates, which account for program participation, the effects of announced set-aside rates can then be analyzed for their effect upon crop production and eventually the rest of the agricultural sector though crop harvested acreages. When applicable (where an announced target price was not large enough to insure adequate participation) participating producers were paid

$$SPi = Si*PRODi*ASPRi \tag{20}$$

where SPi represents the total set-aside payments paid on crop i.

In conducting this analysis for set-aside program participation, the POLYSIM model is structured such that simulated current time period values could be used for their expected values with the exception of crop market prices. One time period lagged market prices were used as the expected value of crop market prices. The announced values policy instruments -- target prices and set-aside rates -- were the value from the control paths the Box Complex procedure had generated.

Computer Programming

The National Agricultural Policy Simulator Simultaneous Version (POLYSIM) was written in FORTRAN IV computer language. The computer program consists of a main program and some 54 FORTRAN IV subroutines and real functions. To these members of POLYSIM eight other subroutines -- CONTR, CONS, CONSTT, CHECK, CENTR, EVALUT, FUNC, and OBJT -- were added which meshed Kuester and Mize's (1973) FORTRAN IV programming of the Box Complex procedure and POLYSIM together to accomplish this application of control theory. All original POLYSIM members as well as the added members were converted to extended precision.

Appendix A provides a listing of source code of the FORTRAN IV subroutines listed above plus the other members of POLYSIM -- GOVP, SETUP, and MAIN -- which were also modified. An entire listing of the source code of POLYSIM can be found in Parvin and Ray (1981).

Figure 2 provides a schematic flow of the computer program. The program begins, of course, in the MAIN. By the use of calls to subroutines INT1, INTIAL, INT2 the computer program reads data from direct access disc pack data sets (units 10 and 11) and from computer cards (unit 5). This process "sets-up" the program in relation to baseline data needs and user supplied farm program options (see Parvin and Ray, 1981 for a detailed description of the types of farm programs options included in POLYSIM).

The computer program then calls CONTR. CONTR provides

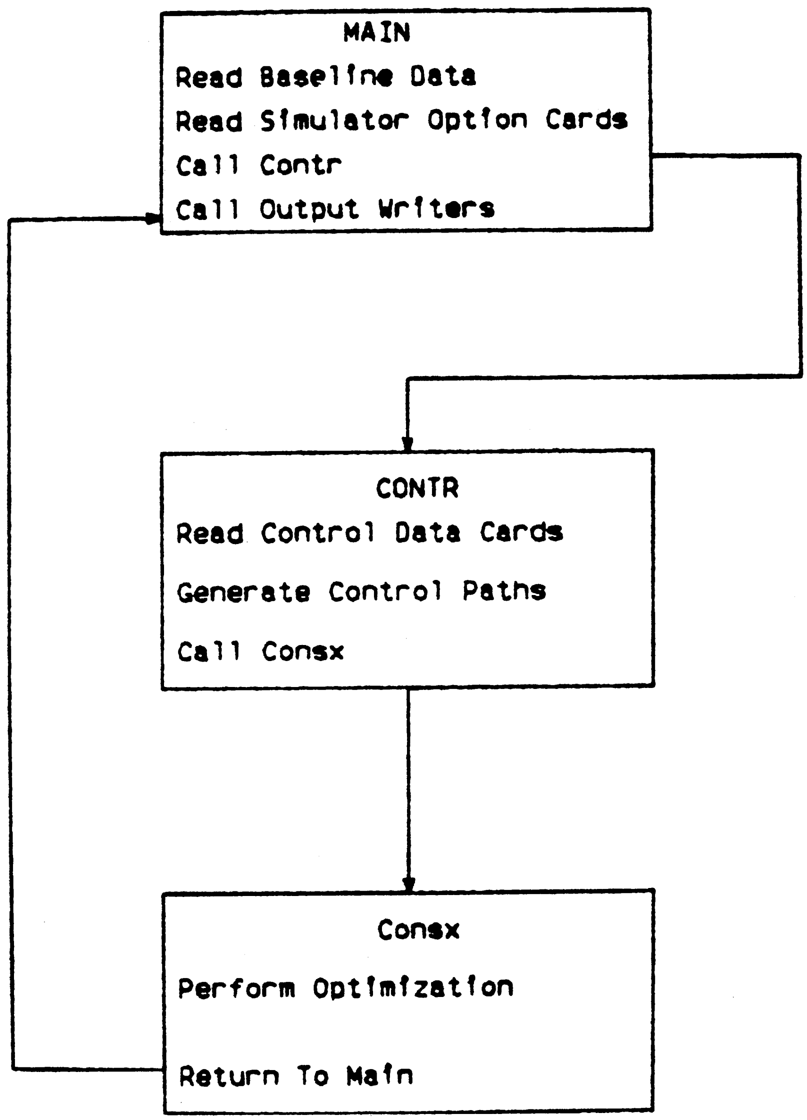

Figure 2. Flow of FORTRAN IV Computer Program for Control Application of POLYSIM

the main linkage between POLYSIM and the control algorithm. This subroutine reads data needs from computer cards (unit 9) which contain information on control variable codes, performance variables codes, objective function parameters and control variable upper and lower bounds. CONTR generates the initial control paths for the Box Complex procedure and then calls CONSX. Subroutine CONSX performs the actual optimization procedure. This subroutine calls POLYSIM members via subroutines OBJT and FUNC which evaluated a potential policy or control path in relation to minimization of the given objective function. This process continues until a solution is obtained. A solution was considered achieved when for five repeated interations the value of the objective function was within an interval of plus or minus 0.1 for all control paths. Upon obtaining a solution POLYSIM output writers print the optimal solution of both control variables and associated endogenous variables.

CHAPTER III

A DESCRIPTION OF THE NATIONAL AGRICULTURAL POLICY SIMULATOR (POLYSIM) SIMULTANEOUS VERSION[1]

Overview of the Model

POLYSIM SIMULTANEOUS VERSION is a dynamic simulator which analyzes the impacts of alternative Government farm programs and policy provisions or instruments upon ESCS, USDA baseline projections. Baseline projections represent the use of formal forecasting techniques and the tempering of these forecasts with the experience of the commodity analysts involved. The projections contain explicit assumptions concerning population, income, consumer preferences, technology and other demand and supply shifters and a specific set of Government farm programs and policy provisions. As will be seen in the following pages, POLYSIM makes full use of baseline projections.

In most short-run policy analysis, basic supply and demand shifters, such as those explicitly assumed in baseline projections, are assumed unchanged. Policy related

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[1]Reference to the word "POLYSIM" implies POLYSIM SIMULTANEOUS VERSION unless otherwise indicated.

shifts and indirect economic responses through the price mechanism are considered in the context of policy analysis. POLYSIM was developed to facilitate this need -- the assessment of the effect of changes in Government farm programs and specific changes in policy instruments associated with Government farm programs.

The agricultural sector of the United States economy is an interrelated system. When viewed from this standpoint, any model which attempts to analyze Government farm programs and policy provisions must consider not only major commodities which comprise the agricultural sector, but also the interrelationship among these commodities. To facilitate multicommodity Government farm program analysis, the crops included in POLYSIM are: barley, corn, cotton, grain sorghum, oats, wheat, soybeans, soybean meal and feed grains in aggregate. From the livestock sector: beef, chickens, dairy, eggs, sheep, pork and turkeys are included. The effects of Government farm programs and policy provisions upon the retail price of seven major animal products are also estimated. These animal products are: choice beef, pork, choice lamb, chicken fryers, turkey, grade A large eggs and fresh whole milk.

As stated above, the effects of changes in Government farm programs and policy provisions are not only associated with the commodity directly affected, but also other interrelated commodities. The basic equational form of POLYSIM reflects this concept through equational specifications and the use of direct and cross elasticities. Equation (1), which is the relationship used to estimate corn harvested acreage, reflects the basic equational specification of POLYSIM.

$$ASt m = ABt m*(1+ \sum_{j=1}^{7} Ejm*((PSsj-PBsj)/PBsj))) + (1-ADJm)*(ASsm-ABsm) \qquad (1)$$

where t denotes the current time period, s denotes the previous time period, m denotes corn, AStm represents simulated harvested acreage in time period t, ABtm represents the baseline value of AStm in time period t, PSsj represents the simulated price of the jth crop lagged one time period, PBsj is the baseline value of PSsj, Ejm is the elasticity of corn harvested acres with respect to the lagged price of the jth crop, and ADJm represents the long-run adjustment coefficient of mth the harvested acreage.

The mechanics of this procedure are to first multiply the relevant direct and cross elasticities of a commodity series (say corn harvested acreage) by the percentage change between calculated and baseline estimates for the appropriate variable (say the previous year price of corn and other feed grains, wheat, soybeans and cotton). The results of these calculations are summed, added to one, and then multiplied times the baseline estimate for the commodity series (say corn harvested acreage). Since the long-run response of supply and demand to a sustained price change often differs from the short-run response, the basic equational form of POLYSIM allows for cumulative price response through an adjustment coefficient.

The derivation of the relationship defined in (1) is quite straight forward. A starting point for this derivation is with a functional statement of the variables which effect the commodity series being calculated or simulated. In relation to harvested acreage equations, such as (1), significant elements in determining harvested acreages are farmer expectations of crop prices. In harvested acreage studies such as Houck, et al. (1976) and Penn and Irwin (1971), lagged crop prices have been used as proxy measures of expected crop prices. Thus, the harvested acreage of, say, corn might be considered to be a function of lagged corn price and other lagged crop prices. Equation (2) states this functional relationship as

$$Atm = f(Ps1, \ldots, Ps7). \tag{2}$$

By taking the total differential of (2) with respect to all lagged prices

$$dAtm = \sum_{j=1}^{7} \partial f/\partial Psj * dPsj \tag{3}$$

substituting,

$$DAtm = ASst - ABst = dAtm$$

and

$$DPsj = PSsj - PBsj = dPsj$$

into (3), plus also multiplying both sides of (3) by the well chosen one

$$(ABtm)/(ABtm)*(PBs1/PSs1)*\ldots*(PSs7/PSs7)$$

(3) can be simplified to

$$DAtm = \sum_{j=1}^{7} \partial f/\partial Psj*DPsj*ABtm*(PBsj/PBsj) \qquad (4)$$

By the collection of terms in (4) and the substitution of

$$\partial f/\partial Psj *(PBsj/ABtm) = Ejm$$

for all j, (4) can be further simplified to

$$AStm = ABtm*(1+ \sum_{j=1}^{7} Ejm*((PSsj-PBsj)/PBsj)) \qquad (5)$$

By inclusion of a Nerlove adjustment procedure in (5), the resulting expression will be exactly identical to (1).

In POLYSIM the effects of changes in Government farm programs and/or changes in policy provisions does not end with the determination of harvested acreages. POLYSIM traces through the effects of Government farm program and/or policy provision changes upon production, price, demand and income for each of the fourteen farm commodities considered in the model and agriculture in general. Figure 3 presents the schematic flow of POLYSIM and also relates the behavioral relationships which Government farm programs and policy provisions can affect.

In the following pages the flow of POLYSIM will be described in three segments. The first segment will describe livestock production, consumption and price determination. The second segment describes crop production, supply, and demand and price determination. The last or concluding segment describes accounting and technical identities used in determining aggregate income and cost measures. Each

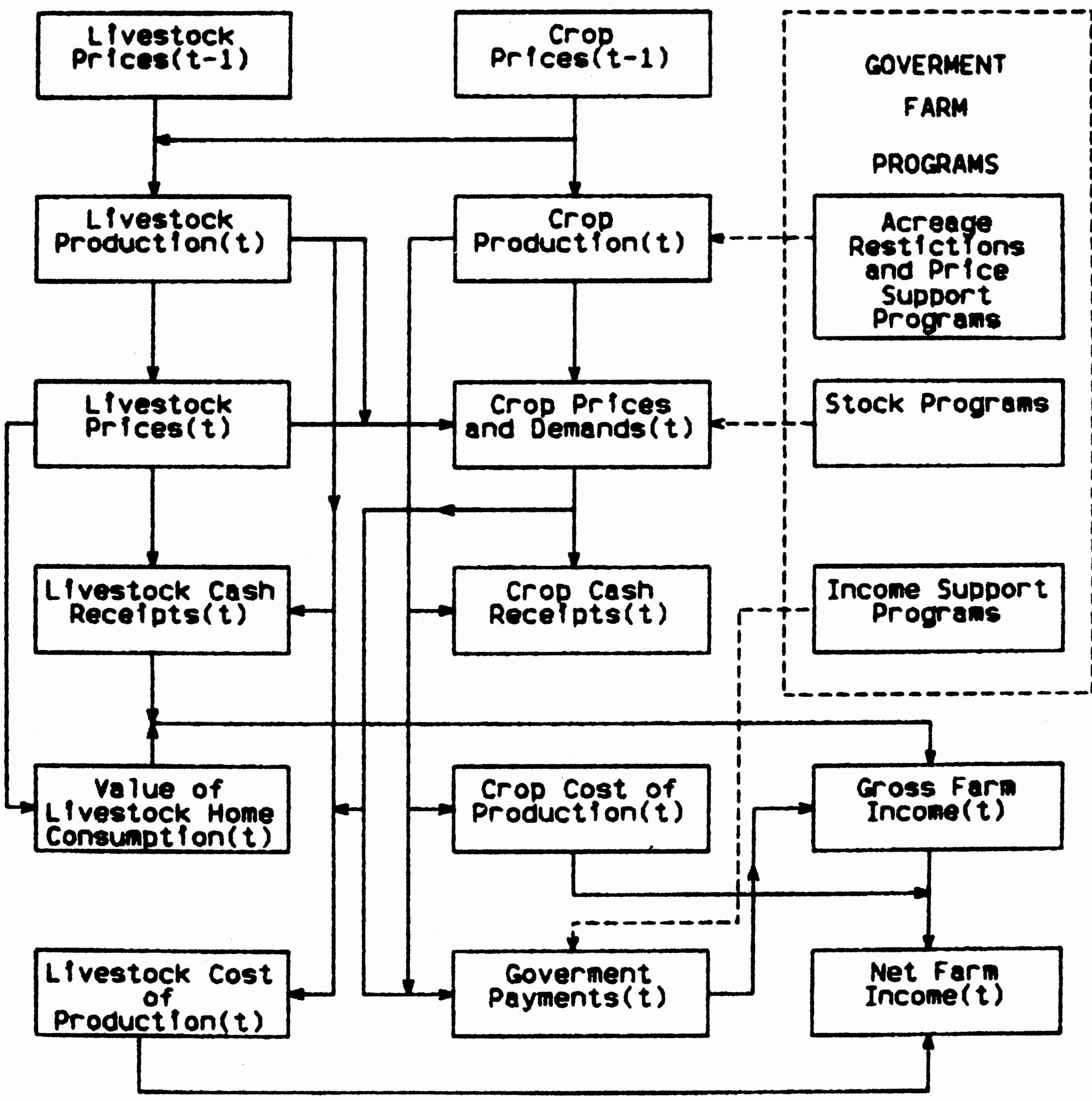

Figure 3. Flow of POLYSIM

segment contains a description of the equations used to estimate output variables and a discussion of the Government farm programs and policy provisions that could influence output variables.

Livestock Production, Consumption and Prices

Production, Consumption and Farm-Level Prices

POLYSIM SIMULTANEOUS VERSION can be viewed as a second generation model. The original version of POLYSIM developed by Ray and Richardson (1978) was a totally recursive model. The recursive formulation of the livestock sector developed by Ray and Richardson (1978) has been maintained in POLYSIM SIMULTANEOUS VERSION. In fact, the exact specification of the livestock sector and, hence, livestock elasticities and flexibilities of Ray and Richardson (1978) has been incorporated into POLYSIM SIMULTANEOUS VERSION.

The specification of the livestock sector could be explained as follows. Livestock production is determined by lagged livestock prices and lagged feed grain prices. The quantity of livestock available for domestic consumption is defined as production plus imports minus exports. A particular farm-level livestock price is considered to be not only a function of the quantity of that livestock commodity available for domestic consumption, but also the amount of other livestock commodities available for domestic consumption.

For a more detailed explanation of livestock production, consumption and farm-level price determination in POLYSIM consult either Ray and Richardson (1978) or Richardson (1978).

In considering the flow of POLYSIM defined in Figure 3, it should be noted that current period livestock production and farm-level livestock prices do affect current period crop demands and prices. Farm-level livestock prices also affect livestock market income or cash receipts and the value of livestock home consumption which ultimately effect aggregate farm income measures.

Retail Animal Product Prices

As stated earlier, a limited ability of analyzing the effect of Government farm programs and policy provisions upon the consumer sector has been incorporated into POLYSIM SIMULTANEOUS VERSION. Seven retail-level animal product prices are estimated. These are choice beef price, pork price, choice lamb price, chicken fryer price, turkey price, grade A large egg price and fresh whole milk price. These retail animal product prices are computed by using a price flexibility matrix and the computed percentage changes in quantities available for domestic consumption from their respective baseline values. Table VI contains the retail price flexibility matrix used by POLYSIM.

As an example of these calculations consider the calculation of choice beef price, which is shown algebraically

TABLE VI

RETAIL-LEVEL LIVESTOCK PRICE FLEXIBILITY MATRIX

Item	Beef Quantity(t)	Hog Quantity(t)	Sheep & Lamb Quantity(t)	Chickens Quantity(t)	Turkeys Quantity(t)	Eggs Quantity(t)	Milk Quantity(t)
Choice Beef Price(t)	-1.719	-.504	-.046	-.021	-.014	-.027	-.197
Pork Price(t)	-.458	-2.738	-.075	-.023	-.028	-.053	-.198
Choice Lamb Price(t)	-.595	-1.104	-.422	-.024	-.020	-.037	-.241
Chicken Fryer Price(t)	-.283	-.331	-.025	-.667	-.012	-.023	-.390
Turkey Price(t)	-.087	-.133	-.008	-.006	-3.153	-.283	-.033
Grade A Large Eggs Price(t)	-.047	-.062	-.004	-.004	-.099	-2.904	-.017
Fresh Whole Milk Price(t)	-.580	-.667	-.056	-.082	-.021	-.039	-1.426

Source: George and King (1971)

by equation (6).

$$PStm = PBtm*(1+ \sum_{j=1}^{7} Fjm*((QStj-QBtj)/QBtj)) \qquad (6)$$

where m denotes choice beef, t denotes the current time period, PStm represents simulated choice beef price in time period t, PBtm represents the baseline value of PStm, QStj represents the simulated amount of the jth animal product available for domestic consumption in time period t, QBtj represents the baseline value of QStj and Fjm represents the price flexibility of choice beef price with respect to the amount of the jth animal product available for domestic consumption.

In the computations defined in (6), the first row of the price flexibility matrix, defined in Table VI, is multiplied times the percentage change in quantity available for domestic consumption for the corresponding commodities. The seven multiplication products are summed, added to one, and the result is multiplied times the baseline choice beef price.

Aggregate Measures of the Livestock Sector

Along with individual livestock measures of prices and production, POLYSIM computes aggregate measures of livestock prices and production. The aggregate price measures are the index of prices received (1900-14=100) for meat animals, poultry and eggs, dairy products and livestock and livestock products. The measure of aggregate livestock production computed by POLYSIM is livestock production units (grain consuming animals).

Indices of prices received in POLYSIM are computed as an adjustment to baseline indices of prices for changes in component prices from their respective baseline values. These computations are conducted as shown in (7)

$$ISti = IBti+\sum_{j=1}^{m} Wij*(PStj-PBtj) \qquad (7)$$

where t denotes the current time period, i denotes the ith index of prices received, ISti is simulated values of ith index of prices received in time period t, IBit is the baseline value of ISit, Wij is the weight of jth price relative in the computation of ith index of prices received, PStj is the simulated value of jth price relative which comprises ISti or IBti, and PBtj is the baseline value of PStj .

Livestock production units is an index number series which relates the number of livestock and poultry feed on farms during a calendar year to the feeding requirement of each major livestock category, in terms of different grains, high protein feeds and roughages (USDA, 1970). The computation of this number is analogous to the procedure used to estimate indices of prices received. For a more detailed description of the computation of the livestock production units variable see Ray and Richardson (1978) or Richardson (1978).

Crop Production, Supply, Utilization and Prices

The crop production section of POLYSIM SIMULTANEOUS VERSION contains the same type of relationships included in the original version of POLYSIM. In this section of the simulator, harvested acreages, yield per harvested acre, variable production expense per harvested acre and total variable cost of production are computed for all model crops.

Harvested Acreage

The calculation of corn harvested acreage was used as an example (Equation (1)) in the earlier derivation and explanation of the basic equational form used by POLYSIM. Estimation of harvested acreages for other crops are conducted in a fashion exactly like corn, except the appropriate elasticities and adjustment coefficients are used.

In the calculation of the harvested acreage of a particular crop, the baseline harvested acreage of that crop is adjusted for farmer responses to changes in expected prices from their respective baseline values. Lagged crop prices are used as expected prices in the harvested acreage equations. Farmer responses to percentage change from baseline of expected prices are reflected in the elasticities used in the harvested acreage equations. These elasticities are listed in Table VII.

TABLE VII

DIRECT AND CROSS ACREAGE ELASTICITIES

Item	Soybeans Price (t-1)	Wheat Price (t-1)	Corn Price (t-1)	Grain Sorghum Price (t-1)	Oats Price (t-1)	Barley Price (t-1)	Cotton Price (t-1)
Soybean Harvested Acreage	.25 (.750)	-.02 (-.06)	-.15 (-.45)	-.03 (-.09)	0.0 (0.0)	0.0 (0.0)	-.03 (-.09)
Wheat Harvested Acreage	-.03 (-.06)	.20 (.40)	-.02 -.04	-.05 (-.10)	-.01 (-.02)	-.03 (-.06)	-.01 (-.02)
Corn Harvested Acreage	-.09 (-.27)	-.02 (-.06)	+.15 (.45)	-.03 (-.09)	0.0 (0.0)	0.0 0.0	-.01 (-.03)
Grain Sorghum Harvested Acreage	-.05 (-.15)	-.03 (-.09)	-.01 (-.03)	.09 (.27)	0.0 (0.0)	0.0 0.0	0.0 (0.0)
Oat Harvested Acreage	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	.24 (.72)	-.24 (-.72)	0.0 (0.0)
Barley Harvested Acreage	0.0 (0.0)	-.15 -.45	-.03 (-.09)	-.03 (-.09)	-.15 (-.45)	.36 (1.08)	0.0 (0.0)
Cotton Harvested Acreage	-.10 (-.20)	-.10 (-.02)	-.05 (-.10)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	.30 (.60)

Source: Appendix A, Section 3 of Ray and Richardson (1978).

Long-run elasticities are in parentheses.

When current period loan rate exceeds lagged crop price, current period loan rate serves as the expected price in the harvested acreage equations. As will be seen in later sections, loan rates also serve as expected prices, if greater than lagged prices for crop yield and per acre variable cost of production equations. The crop's loan rate becomes the marginal value of output for planting and input use decisions.

Acreage Restrictions

Acreage set-aside and/or acreage diversion programs can be simulated with POLYSIM. Under the 1977 Food and Agriculture Act participation in the set-aside program if in effect is required to participate in other Government farm programs such as the farmer-held reserve program and the income support program (deficiency payment). In some years farmers were encourage to further reduce their acreage by participating in the acreage diversion program. Acreage diversions are accompanied by payments for participation. Thus, set-aside and diversion programs can affect farm income through both higher prices for the reduced output and increased Government payments.

The procedure used to account for set-asides and diversions is different than the general equational approach used by POLYSIM. Baseline harvested acreage is modified so as to include the effects of user specified set-aside and diversion levels. The new acreage value becomes a "new" baseline acreage which is then used in equations such as (1). The exact computational procedure is shown in equation (8).

$$ASNtm = ABOtm+(1-Stm)*(SAUtm-SABtm) +(1-Stm)*(DAUtm-DABtm) \quad (8)$$

where t denotes the current time period, ASNtm represents the "new" baseline acreage for the mth crop in time period t, ABOtm represents "old" baseline acreage for the mth crop in time period t, Stm represents the slippage rate of the mth crop in time period t, SAUtm represents user supplied levels of acreage set-aside of the mth crop in time period t, SABtm represents baseline acreage set-aside for the mth crop in time period t, DAUtm represents user supplied acreage diversion for the mth crop in time period t, and DABtm represent baseline acreage diversion of the mth crop in time period t.

The slippage rate in equation (8) is included because not all acreage declared as set-aside or diversion would have been harvested even without acreage restriction programs. Some acreage in areas such as flood prone areas or unproductive hilltops are designated as set-aside and diversion areas.

From a behavioral standpoint, increases in acreage restrictions reduce a particular crop supply which given the level of demand will increase the crop price(s). The resulting crop price(s) increases affects market income, Government payments and in the case of feed grain prices increase the cost of producing a given level of livestock in the short-run and the level of livestock production in the following years.

Yield Per Harvested Acre

The simulated value of a particular crop yield is determined by adjusting the baseline yield up or down in response to the percentage change in expected own crop price from baseline and the percentage change from baseline of the prices paid for inputs. Lagged own crop price is used as expected own crop price, except when the current loan rate is greater than the lagged crop price. In this situation, the current loan rate is used as the expected price. The specification of the yield per harvested acre relationship is shown in equation (9)

$$YStm= YBtm*(1+Emp*((PSsm-PBsm)/PBsm) +Emc*CUt)+(1-AdJm)*(YSsm-YBsm) \quad (9)$$

where t denotes the current time period, s denotes the previous time period, m denotes the mth crop , YStm represents the simulated value of mth crop yield in time period t, PSsm and PBsm are as defined in (1), CUt represents the percentage change from baseline of input prices in time period t, Emp is the elasticity of the mth crop yield with respect to own lagged price, Emc is the elasticity of the mth crop yield with respect to the change from baseline of input prices and ADJm represents the adjustment coefficient for yield per harvested acre of the mth crop yield.

The rationale of this specification is that as an expected price increases (decreases), application of fertilizer and other inputs will increase (decrease) which will increase (decrease) yield per harvested acre. This specification also allows for an analysis of the effects of changes in input prices from baseline upon yield per harvested acre. Thus, the specification of the crop yield equations in POLYSIM allows expectation of crop prices to affect yields by changing input usage, and also allows the consideration of possible offsetting effects from increased input prices. Farmer response to these price changes are reflected by the elasticity of yield per harvested acre with respect to expected price and input prices as given in Table VIII. Crop yields are measured in bushels per harvested acre except for cotton and aggregate feed grains. Cotton yield is measured in pounds per harvested. Aggregate feed grains yield per harvested acre is measured in tons per acre (2000 lbs./ton).

Production and Supply

The production of a particular crop is simply the product of yield and the harvested acreage of that crop. The volume of production of all model crops, except cotton and feed grains in aggregate, is measured in million of bushels. Cotton production is measured in millions of net bales, while feed grain production in aggregate is measured in millions of tons (2000 lbs./ton). Total supply of a crop is defined as the summation of production, imports and

TABLE VIII

YIELD ELASTICITIES

Item	Soybean Price (t-1)	Wheat Price (t-1)	Corn Price (t-1)	Grain Sorghum Price (t-1)	Oat Price (t-1)	Barley Price (t-1)	Cotton Price (t-1)	Index of Prices Paid(t)
Soybean Yield(t)	.10 (.20)							.10 (.20)
Wheat Yield(t)		.10 (.20)						.10 (.20)
Corn Yield(t)			.15 (.30)					.10 (.20)
Grain Sorghum Yield(t)				.10 (.20)				.10 (.20)
Oat Yield(t)					.19 (.38)			.10 (.20)
Barley Yield(t)						.30 (.60)		.10 (.20)
Cotton Yield(t)							.15 (.60)	.10 (.40)

Sources: Appendix A, Section 3 of Ray and Richardson (1978)

Long-run elasticities are in parentheses.

carry-in stocks. Imports for each crop is considered as an exogenous variable in POLYSIM. Carry-in stocks for the current time period is carry-out or ending stocks from the previous time period. The unit of measure for the supply of a crop is the same as the unit of production.

Crop Variable Production Expense

The last set of computations conducted by POLYSIM in the crop production section is the computation of crop variable production cost per harvested acre and total variable crop cost of production. Microeconomic theory suggests that input usage is positively related to output price and negatively related to input price. As the expectation of price of the output from a productive process increases, the decision maker (which is the farmer in POLYSIM) is willing to use more of an input, all other things equal. Crop variable cost of production per acre is estimated with POLYSIM as follows

$$ACStm = ACBtm*(1+Emp*((PSsm-PBsm)/PBsm) + Emc*CUt)+(1-ADJm)*(ACSsm-ACBsm) \quad (10)$$

where t denotes the current time period, s denotes the previous time period, m represents the mth crop, ACStm is the simulated value of the variable cost of production per harvested acre of mth crop, ACBtm is the baseline value of ASCtm , Emp is the elasticity of variable cost of production of the mth crop with respect to its own lagged price, Emc is the elasticity of variable crop cost of production per harvested acre of mth crop with respect to the change from baseline of the prices of inputs, PSsm and PBsm are as defined in (1) and ADJm is the adjustment coefficient of average variable cost per harvested acre of the mth crop. Lagged crop prices are used as expected prices in equations such as (10). The only exception to this is the situation where loan rates exceed lagged prices, then loan rates are used as expected prices. As in the harvested acreage and yield equations elasticities reflect farmer response to the variables defined in (10). These elasticities are listed in Table IX.

Once the variable cost of production per acre for a particular crop and harvested acreage of that crop has been determined, total variable cost of production for the crop in question is determined. For all model crops total variable cost of production is computed as the product of variable cost of production per acre and the amount of harvested acreage. The units of measure of these costs are dollars per acre for per acre variable cost of production and millions of dollars for total variable production cost.

Crop Utilizations and Prices

Crop endogenous utilizations or demands and prices are determined simultaneously in POLYSIM. The Gauss-Seidel iterative technique is used to determine solutions for commodity series which involve simultaneity. A detailed description of the mechanics of the Gauss-Siedel iterative

TABLE IX

VARIABLE COST OF PRODUCTION ELASTICITIES

Elasticity of Variable Cost of Production Per Harvested Acre(t)	Soybean Price (t-1)	Wheat Price (t-1)	Corn Price (t-1)	Grain Sorghum (t-1)	Oat Price (t-1)	Barley Price (t-1)	Cotton Price (t-1)	Index of Prices Paid(t)
Soybean	.10 (.20)							1.0 (2.0)
Wheat		.10 (2.0)						1.0 (2.0)
Corn			.15 (.30)					1.0 (2.0)
Grain Sorghum				.10 (.20)				1.0 (2.0)
Oat					.19 (.38)			1.0 (2.0)
Barley						.30 (.60)		1.0 (2.0)
Cotton							.15 (.30)	1.0 (2.0)

Source: Appendix A, Section 3 of Ray and Richardson (1978)

Long-run elasticities are in parentheses.

technique is presented in Appendix B. The behavioral flow and specification of these sectors reflects the meshing of econometric studies such as Houck and Mann (1969), Womack (1976), Mienken (1953), Mo (1968) and Paulino (1966). The exact specification and the rationale of the specification of the crop demand and price relationships contained in POLYSIM are discussed following a presentation of the general structure of the demand and price equations contained in POLYSIM.

General Structure of Demand Equations

Following economic theory the specification of the demand equation of a particular commodity would include the price of that commodity, the prices of substitute commodities, consumer income and consumer tastes and preferences. The demand equations of POLYSIM follow this concept. However, some of the determinants of level of demand of crops included in POLYSIM are already included in ESCS baseline projections. Examples of these are consumer income, tastes and preferences and the price level of non-agricultural products. To fully utilize baseline projections POLYSIM crop demand equations were specified to consider only the price interrelationships among agricultural commodities. The general equational form of the demand equations in POLYSIM is the same as the basic equational form of other equations contained in POLYSIM. The equational form, formulated from a demand standpoint is

$$QDStm = QBtm*(1+Emp*((PStm-PBtm)/PBtm) + \sum_{i=1}^{n} Emi*((SSit-SBit)/SBit)) + (1-ADJm)*(QDSsm-QDBsm) \quad (11)$$

where t denotes the current time period, s denotes the previous time period, QDStm represents the simulated quantity demanded of mth crop in time period t, QDBtm represents the baseline quantity demanded in time period t, PStm represents the simulated price of mth commodity in time period t, PBtm represents the baseline value of the price of the mth commodity in time period t, SSit represents the simulated value of the ith shifter variable in time period t, SBit represents the baseline value of the ith shifter variable in time period t, Emp represents the own price elasticity of demand of the mth crop, Emi represents the cross demand elasticity of the mth crop with respect to the ith shifter variable and ADJm represents the adjustment coefficient.[2] Examples of shifter variables are other crop and livestock prices. All crop demands utilizations are measured in the same units as the respective production and supply of that crop.

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[2]The total demand or utilization of a crop in POLYSIM is defined as the summation of various demands, which include both endogenous and exogenous demands. Equations such as (10) in POLYSIM define endogenous crop demand either domestic or export. Thus, equation (10) could be viewed as actually defining the jth endogenous demand of the mth crop in POLYSIM. The various types of endogenous crop demands are discussed in the following pages.

<u>General Structure of the Price Equations</u>

Equation (12) reflects the typical crop prices equation used by POLYSIM.

$$PStm = PBtm*(1+Fm*(((QSStm-QSBtm) -(QDStm-QDBtm))/QSBtm))) \quad (12)$$

where t denotes the current time period, PStm is simulated price of the mth crop in time period t, PBtm is the baseline value of PStm, QSStm is the simulated supply of the mth crop in time period t, QSBtm is the baseline value of QSStm, QDStm is the simulated total demand or utilization of the mth crop in time period t, QDBtm is the baseline value of QDStm and Fm represents the price flexibility of the mth crop. In the above equation, if simulated crop supply is same as baseline crop supply simulated crop price will be the same as the baseline crop price assuming no shifts in demand. If on the other hand, estimated supply varies from baseline supply; that is, if there is a shift in supply the baseline price must be adjusted to reflect the new level of supply. The adjustment to the baseline price is computed as product of the percentage change in supply from the baseline level and the inverse of demand elasticity (or the price flexibility) of the crop. At the same time crop prices are determined, crop demands or utilizations are determined. To allow crop demands to affect crop prices, a set of terms is included in the crop price equations to account for changes in crop demands. Table X contains the price flexibilities of the crops included in POLYSIM.

TABLE X

OWN PRICE FLEXIBILITY SCHEDULES FOR FEED GRAINS, WHEAT, SOYBEANS AND COTTON

			Own Price Flexibility
	Corn		
	relative coverage[1]	< 0.05	-6.00
0.05 ≥	"	< 0.10	-4.00
0.10 ≥	"	< 0.15	-3.50
0.15 ≥	"	< 0.20	-2.75
0.20 ≥	"	< 0.30	-2.00
0.30 ≥	"		-1.00
	Grain Sorghum		
	relative coverage	< 0.05	-3.96
0.05 ≥	"	< 0.10	-2.64
0.10 ≥	"	< 0.15	-2.31
0.15 ≥	"	< 0.20	-1.82
0.20 ≥	"	< 0.30	-1.32
0.30 ≥	"		-1.00
	Oats		
	relative coverage	< 0.05	-3.00
0.05 ≥	"	< 0.10	-2.00
0.10 ≥	"	< 0.15	-1.75
0.15 ≥	"	< 0.20	-1.38
0.20 ≥	"		-1.00
	Barley		
	relative coverage	< 0.05	-2.16
0.05 ≥	"	< 0.10	-1.44
0.10 ≥	"	< 0.15	-1.26
0.15 ≥	"		-1.00
	Wheat		
	relative coverage	< 0.10	-6.00
0.10 ≥	"	< 0.15	-4.00
0.15 ≥	"	< 0.20	-3.00
0.20 ≥	"	< 0.30	-2.40
0.30 ≥	"	< 0.50	-2.00
0.50 ≥	"	< 0.60	-1.50
0.60 ≥	"		-1.00

TABLE X (Continued)

	Soybeans		
	relative coverage	< 0.033	-6.00
0.033 ≥	"	< 0.066	-4.00
0.066 ≥	"	< 0.100	-3.00
0.100 ≥	"	< 0.150	-2.50
0.150 ≥	"	< 0.200	-2.00
0.200 ≥	"		-1.75
	Soybean Meal		
	relative coverage	< 0.001	-4.00
0.001 ≥	"		-3.50
	Cotton		
	relative coverage	< 0.15	-5.00
0.15 ≥	"	< 0.20	-4.00
0.20 ≥	"	< 0.25	-3.00
0.25 ≥	"	< 0.35	-2.25
0.35 ≥	"	< 0.55	-1.75
0.55 ≥	"		-1.00

Source: Appendix A, Section 4 Ray and Richardson (1978)

[1]Relative coverage is the expected ending year carryover expressed as a percent of expected total demand. In POLYSIM Relative Coverage = Calculated supply(t) minus baseline demands(t) or expected demand(t) divided by baseline or expected demand(t). So as the fraction gets small the ending year carryover is small relative to demand and vice versa.

All crop prices except cotton and feed grains in aggregate are measured in dollars per bushel. Cotton price is measured in dollars per pound. The price of feed grains in aggregate is measured in dollars per ton (2000 lb./ton). This price is computed as the summation of corn, grain sorghum, oats, and barley cash receipts divided by the sales of these grains which determined the cash receipts.

Crop Demand and Price Sectors

Crop demands and prices in POLYSIM have been divided into three sectors. These sectors are: soybean and soybean meal, feed grains and wheat and cotton. These sectors can be viewed as individually simultaneous, yet block recursive in reference to the soybean and soybean meal sector being recursive to the feed grain and wheat sector. No sector is block recursive to the cotton sector and the cotton sector is not block recursive to any other demand and price sector. The specification of each demand and price sector is explained in the following pages.

Soybean and Soybean Meal. The schematic flows of soybean and soybean meal sector is shown in Figure 4. The elasticities associated with this flow are given in Table XI. Two endogenous demands are computed for soybeans, these are domestic crushing demand and export demand. Given the predetermined level of soybeans supply and exogenous demand, crushing demand, export demand, total utilization and seasonal average price are determined simultaneously along with

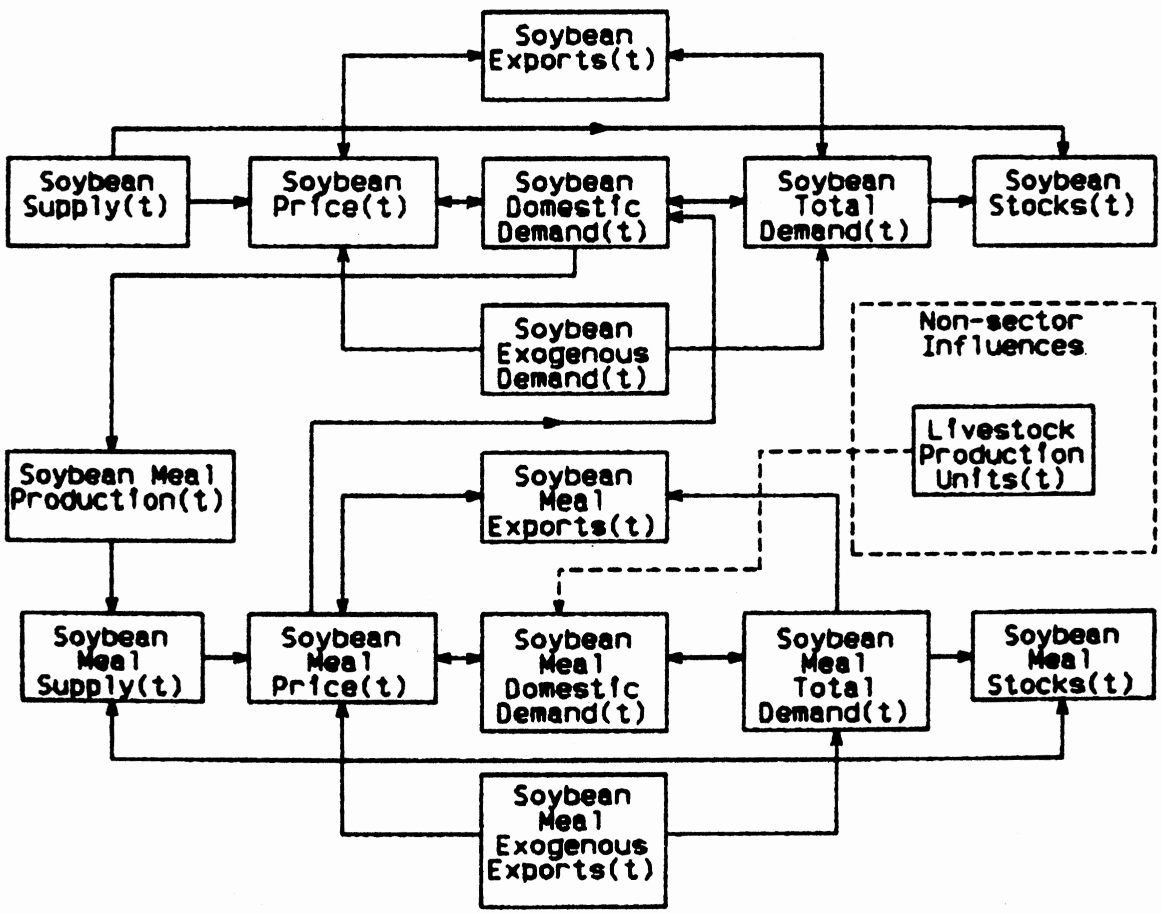

Figure 4. Flow of Soybean and Soybean Meal Sector

TABLE XI

SOYBEAN AND SOYBEAN MEAL DEMAND ELASTICITIES

Item	Soybean Price(t)	Soybean Meal Price(t)	Livestock Production Units(t)
Soybean Domestic Crushing Demand(t)	-.35 (1.03)	.10 (.30)	
Soybean Export Demand(t)	-.57 (-2.80)		
Soybean Meal Domestic Demand(t)		-.56 (-1.65)	1.00 (3.03)
Soybean Meal Export Demand(t)		-.57 (-2.90)	

Source: Appendix A, Section 4 of Ray and Richardson (1978)

Long-run elasticities are in parentheses.

soybean meal related variables. Soybean meal production is determined by soybean crushings, given baseline soybean meal yield per bushel of soybeans. Thus, soybean meal supply is estimated endogenously with soybean meal utilization and soybean meal price. Soybean meal endogenous demands are comprised of endogenous domestic demand and exports. The livestock sector is assumed to affect the soybean and soybean meal through soybean meal domestic demand specified as a function of livestock production units (Houck and Mann, 1968).

Feed Grain and Wheat. The individual feed grains and wheat have been grouped together in a demand and price sector because of interrelationships of feed demands. The demand for wheat as feed is determined by the price of corn as well as the price of wheat (Mienken, 1953). Corn is also the major substitute in determining grain sorghum, oats, and barley demands (Womack, 1976). This flow of effects, however, is not assumed to be symmetric; the feed demand of wheat, grain sorghum, oats, and barley are recursive to corn price determination. The schematic flow of effects of the feed grain and wheat demand price sector are shown in Figure 5. The elasticities associated with this flow are given in Table XII.

It should be noted that the only endogenous export demands in the feed grain and wheat sector are corn, wheat and grain sorghum. As noted by Womack (1976) and Bredahl (1975), corn and grain sorghum represent the majority of

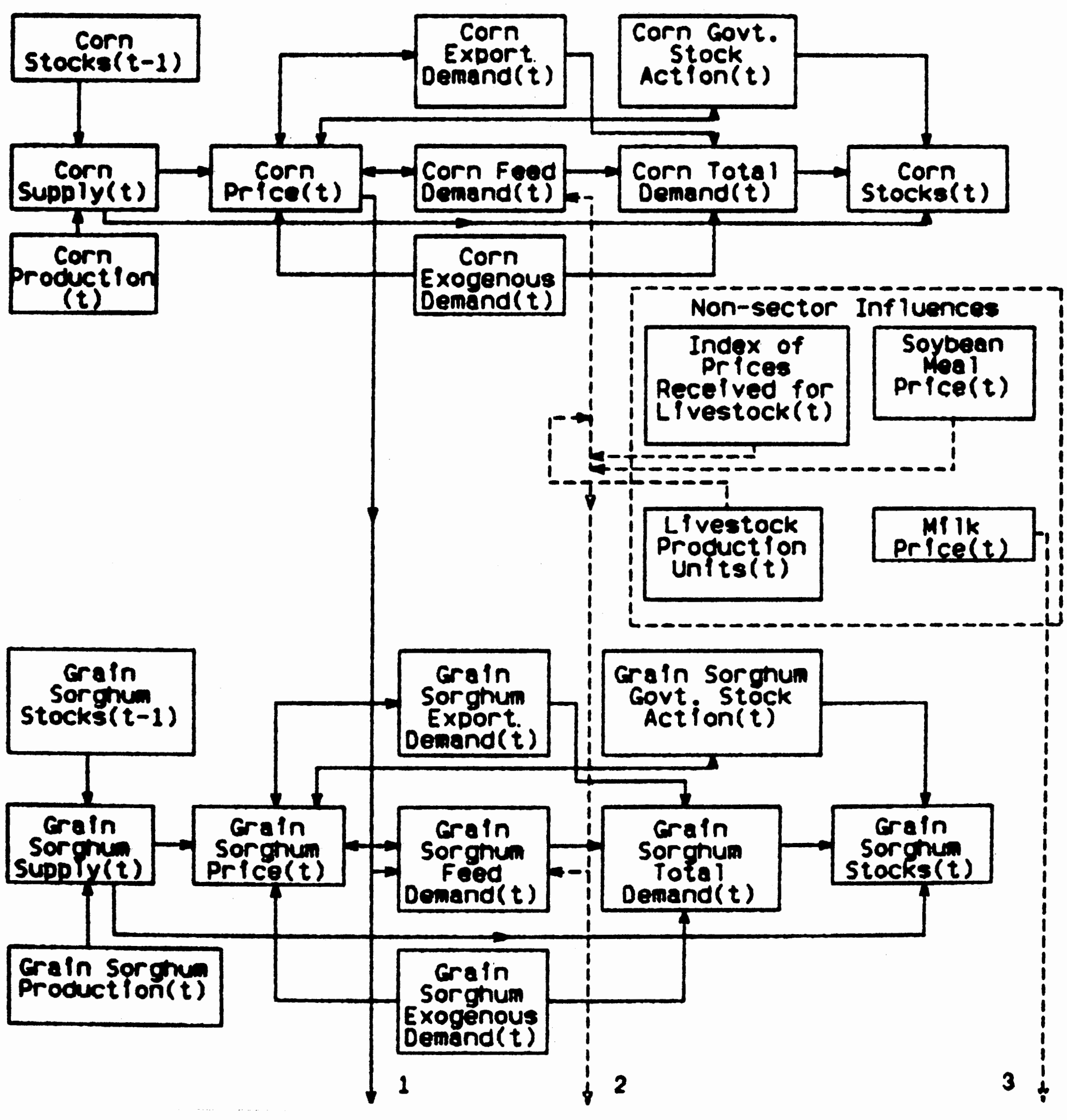

Figure 5. Flow of Feed Grain and Wheat Sector

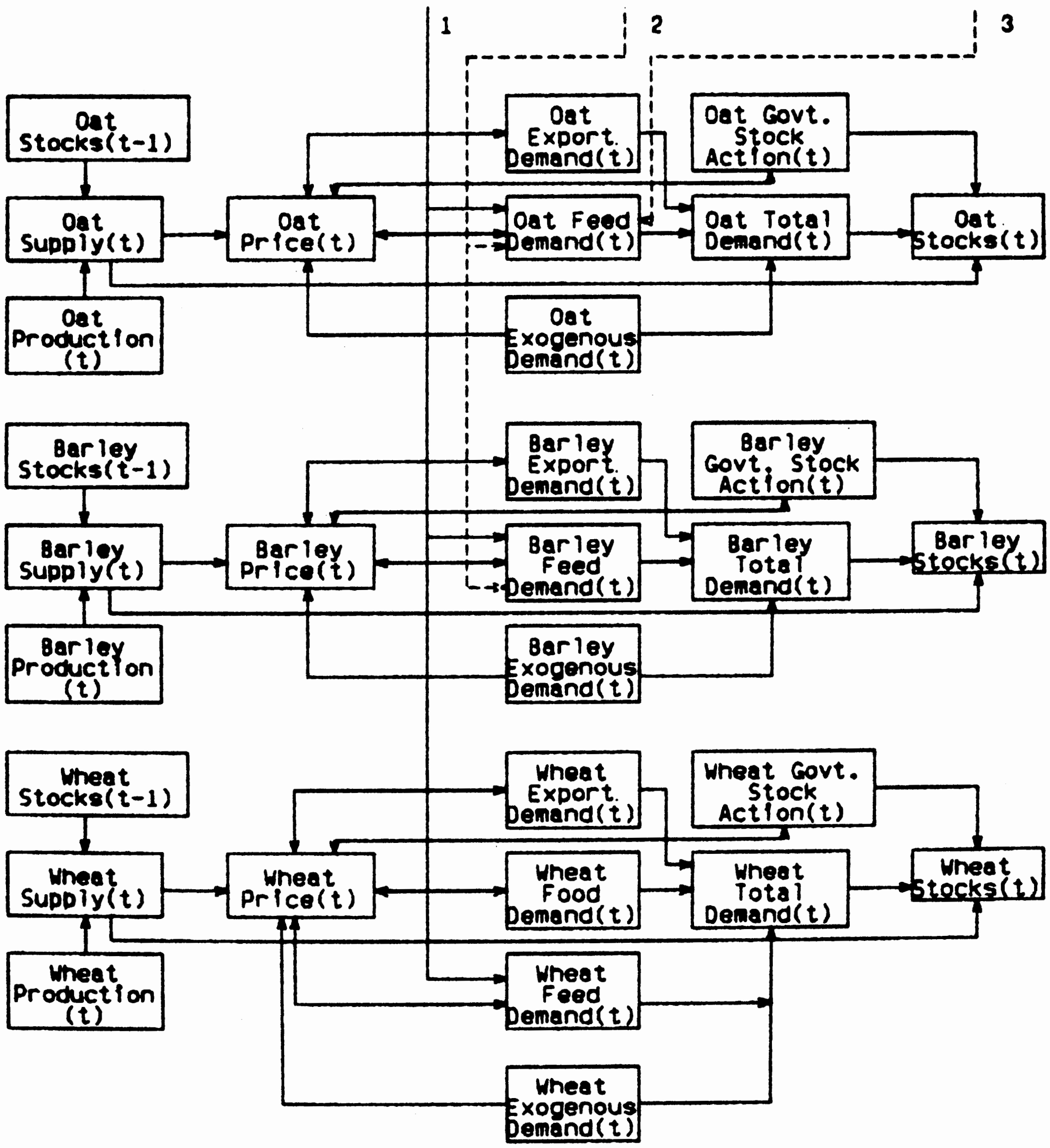

Figure 5. Continued

TABLE XII

FEED GRAINS AND WHEAT DEMAND ELASTICITIES

Item	Corn Price(t)	Grain Sorghum Price(t)	Oat Price(t)	Barley Price(t)	Wheat Price(t)	Livestock Production Units(t)	Index of Prices Received Livestock(t)	Milk Price(t)	Soybean Meal Price(t)
Corn Domestic Feed Demand(t)	-.42 (.84)					.50 (1.00)	.48 (.96)		.06 (.12)
Corn Export Demand(t)	-.50 (-2.50)								
Grain Sorghum Domestic Feed Demand(t)	.15 (.30)	-.59 (-1.18)				.50 (1.00)			
Grain Export Demand(t)		-.50 (-2.50)							
Oat Domestic Feed Demand(t)	.25 (.50)		-.79 (-1.58)			.50 (1.00)		.59 (1.18)	
Barley Domestic Feed Demand(t)	.30 (.60)			-1.08 (2.16)		.50 (1.00)			
Wheat Domestic Food Demand(t)					-.10 (-.20)				
Wheat Domestic Feed Demand(t)	.33 (.66)				-.30 (-.60)				
Wheat Export Demand(t)					-.50 (-2.50)				

Source: Appendix A, Section 4 of Ray and Richardson (1978)

Long-run elasticities are in parenthesis.

the exports of feed grains. The export demands of oats and barley are treated as exogenous demands in POLYSIM.

Cotton. The specification of the cotton demand and price sector has not been changed from the original specification developed by Ray and Richardson (1978). The only change has been a simultaneous interpretation of demand and price determinations. For a more detailed discussion of this sector see Ray and Richardson (1978) or Richardson (1978).

Government Stock Programs

POLYSIM has the ability to simulate two different stock programs. One is non-recourse Commodity Credit Corporation (CCC) loans. The other stock program is the farmer-held reserve program established by the 1977 Agriculture Act.

Farmer-held Reserve Program. The 1977 Food and Agriculture Act established the farmer-held or producer-held grain reserve program. This legislation required the creation of a wheat farmer-held reserve of 300-700 million bushels and authorized a feed grain farmer-held program, but set no volumes on feed grain reserves. Reasons cited for the creations of these grain reserves are to buffer sharp grain price movements which occur as production and demand vary and to provide grain to relieve human and/or livestock food and feed shortages as they occur worldwide (Stucker and Boehm, 1978).

Incentives for farmer participation in the reserve program are storage payments on the grains, low interest rates and loans which can be used for the construction of storage capacity. Eligibility for participation in the farmer-held reserve program is, in general, determined by participation in acreage restriction programs.

The operation of the farmer-held reserve is based upon three prices which are expressed in terms of loan rate values. These grain prices are the release price, call price, and the Commodity Credit Corporation (CCC) sales price. The release price defines the market price at which the farmer can market his grain reserve stocks without sustaining penalties from the Federal Government. If the producer were to market his reserve stocks when market price is below the release price, the Secretary of Agriculture is required to recover storage payments and may assess a penalty interest above the normal interest charge. The call price represents the market price at which the Secretary of Agriculture will encourage farmers to market their grain reserves. The Secretary of Agriculture can in this situation declare loans due and could collect interest on loans, backstorage payment and assess additional interest charges. When grain is in the farmer-held reserve, the CCC cannot market its stocks unless the market price of that grain is above the CCC sales price. The various prices (release, call and CCC sales for feed grains and wheat) are given in Table XIII as percentage of loan rates.

TABLE XIII

EXAMPLE FEED GRAIN AND WHEAT RELEASE, CALL AND CCC SALES PRICE

Crop	Release Price	Call Price	CCC Sales Price
	.... percent of loan rate		
Corn	125	145	185
Grain Sorghum	125	145	150
Oats	125	145	150
Barley	125	145	150
Wheat	150	180	190

Source: ASCS, USDA February, 1980

In POLYSIM the simulation of farmer-held reserve program is conducted in the following manner. Grain prices are computed, as described in the preceeding page, based upon prevailing supply and demand conditions. Two possible stock actions could occur based upon these solutions for grain prices: grain may either move into the farmer-held reserve of grain or may move out of the farmer-held reserve. When a computed grain price is below its loan rate, POLYSIM computes the quantity of grain that must be diverted from the market to raise its market price to the loan rate. The computation of the amount of grain to be diverted from the market is conducted by equations such as (13)

$$QDVtm = QSStm*((1-LRtm/PStm)/Fm) \tag{13}$$

where t denotes the current time period, QDVtm represents the quantity of the mth grain diverted from the market in time period t, QSStm represents the simulated supply of the mth grain in time period t, LRtm represents the loan rate of the mth grain in time period t, PStm represents the simulated price of the mth grain which would occur if there were no stock action and Fm represents the price flexibility of mth grain.

The terms in the inner parenthesis of (13) compute the percentage increase in the particular market grain price that is required to reach the loan rate. This percent increase (with algebraic sign changed) is then divided by the price flexibility of demand of that grain to compute the percent reduction in supply which would bring the market price to the level of loan rate. This computation is the same as multiplying the percent change in the price of the grain times the overall elasticity of demand of that grain. Thus, (13) determines the length of movement up the demand curve of equivalently the left ward shift in the perfectly inelastic supply curve that results in the market price being equal to the loan rate. The computed decrease in supply defines the amount of grain that must be diverted from the market and placed in the reserve. Once these computations are conducted for all appropriate situations (i.e., a market grain price below loan rate) a new solution for grain demands and prices is determined. If the new solutions for market prices, which reflect the volume of grains moving into the reserve, are greater than or equal to loan rates nothing is done; that is, the determination of movements of grains into farmer-held reserves is complete. However, if the solutions of market grain price(s) are still below loan rate(s), as second set of computations, when appropriate, as defined by (13) are conducted. This process is continued until market grain prices are increased to at least thier respective loan rate.

When market price goes above call price, POLYSIM releases reserve stocks until either the market grain price is below call price or a user supplied minimum level of farmer-held reserve stock is met. This computation is conducted by equations such as

QRtm = QSStm*((1-CPtm/PStm)/Fm) (14)

where QRtm represents the quantity of the mth grain released from the farmer-held reserve in time period t, CPtm represents the call price of the mth grain in time period t and QSStm, PStm and Fm are as in (13). This equation computes the amount of farmer-held reserves to release to bring market prices to the level of call prices.[3]

When grains are in the farmer-held reserve, the CCC can only release Government-owned stocks if market grain prices are above 150 percent of the respective grains loan rate (190 percent for wheat). When prevailing demand and supply conditions generate market grain prices above the CCC sales price, POLYSIM releases CCC stocks before farmer-held reserves. CCC stock releases are conducted until either the market grain price is brought to the CCC sales price or CCC stocks are completely exhausted. CCC stock releases are computed by equations analogous to (14).

Non-resourse CCC Loans. Non-recourse Commodity Credit Corporation loans have been a part of farm program legislaion for many years. The simulation of this farm program is analogous to the simulation of the farmer-held reserves program. This loan program, however, includes cotton and soybeans as well as feed grain and wheat. This Government program assumes that crop prices will be supported by com-

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[3]In actuality grains may move out of farmer-held reserve when market prices exist between release price and call price. These movements are not accounted for in POLYSIM.

modity purchases at loan rate. Quantities of commodities diverted from the market are computed by equation such as (13). Existing CCC stocks can be released at market prices above 115.0 percent of loan rate unless the farmer-held reserve is in effect.

Indices of Crop Prices Received

Several aggregate measures of crop prices are computed by POLYSIM. These include the index of prices received (1910-14=100) for food grains, feed grains and hay, cotton, oil crops and all crops. Crop indices of prices recieved are computed in exactly the same as the indices of prices recieved of the livestock sector (Equation (7)). Based upon the price relatives used in the computation of the indices of both the crop and livestock sector, the index of prices received (1910-14=100) for all farm products is computed.

Feed Grains in Aggregates

Aggregate measures of feed grains (corn, grain sorghum, barley and oats) such as production, demand, price, market income, production expense and policy provisions are also computed by POLYSIM. These measures reflect the combination of solutions for the individual feed grains. Thus, all feed grains in aggregate computations in POLYSIM occur after the individual feed grain computations.

Measures of Farm Income and Production Expenses

POLYSIM computes several measures of farm income and production costs or expenses. These measures include not only income and expenses for individual crops and livestock categories, but also aggregate income and production costs for the entire agricultural sector. Farm income originates from two sources: market income from the sale of crops and livestock and non-market income such as government payments. Production costs computed by POLYSIM also originate from two basic sources which are costs incurred in livestock and crop production. Table XIV presents the income and expense computations of POLYSIM in an accounting income and expense statement form. A description of these computations is presented in the following pages.

Measures of Farm Income

As stated above and shown in Table XIV POLYSIM computes several measures of farm income. The most aggregate measures of farm income computed are realized gross farm income and realized net farm income (Table XIV). Realized net farm income is computed as realized gross farm income less total farm production expenses. Realized gross farm income is comprised of market income or cash receipts from crop and livestock sales, realized non-money income and Government farm payments.

TABLE XIV

AN ACCOUNTING INCOME AND EXPENSE STATEMENT TYPE FORMAT OF FARM INCOME AND EXPENSES COMPUTED BY POLYSIM

	MEASURES OF FARM INCOME
	CROP CASH RECEIPTS
(1)	Barley
(2)	Corn
(3)	Cotton
(4)	Grain Sorghum
(5)	Oats
(6)	Soybeans
(7)	Wheat
(8)	Non-Model Crop Cash Receipts[1]
(9)	Total Crop Cash Receipts (1 + 2 3 + 4 + 5 + 6 + 7 + 8)
	LIVESTOCK CASH RECEIPTS
(10)	Beef
(11)	Chicken
(12)	Dairy
(13)	Eggs
(14)	Pork
(15)	Sheep
(16)	Turkey
(17)	Non-Model Livestock Cash Receipts[1]
(18)	Total Livestock Cash Receipts (+ 11 + 12 + 13 + 14 + 15 + 16 + 17)
(19)	Total Cash Receipts (9 + 18)
	REALIZED NON-MONEY INCOME
(20)	Beef Value of Home Consumption
(21)	Chicken " " " "
(22)	Dairy " " " "
(23)	Eggs
(24)	Pork
(25)	Sheep
(26)	Non-Livestock Perquisites[1]
(27)	Total Realized Non-Money Income (20 + 21 + 22 + 23 + 24 + 25 + 26)
	GOVERNMENT PAYMENTS
(28)	Barley Deficiency, Diversion, Storage
(29)	Corn " "
(30)	Grain Sorghum
(31)	Oats " "
(32)	Wheat " "
(33)	Cotton Deficiency, Diversion
(34)	Soybean Diversion
(35)	Non-Model Government Payments[1]

TABLE XIV (Continued)

(36)	Total Government Payments (28 29 + 30 + 31 + 32 + 33 + 34 + 35 + 36)
(37)	Total Realized Gross Farm(19 + 27 + 36)
MEASURES OF PRODUCTION EXPENSES	
	CROP PRODUCTION EXPENSES
(38)	Barley
(39)	Corn
(40)	Cotton
(41)	Grain Sorghum
(42)	Oats
(43)	Soybeans
(44)	Wheat
(45)	Total Model Variable Crop Production Expense (38 + 39 + 40 + 41 + 42 + 43 + 44)
	LIVESTOCK PRODUCTION EXPENSES
(46)	Protien Feed Cost
(47)	Feed Grain Feed Cost
(48)	Roughage Feed Cost
(49)	Wheat Feed Cost
(50)	Non-Feed Cost of Production
(51)	Total Variable Livestock Cost of Production (46 + 47 + 48 + 49 + 50)
	DOUBLE ACCOUNTING ADJUSTMENTS
(52)	Barley
(53)	Corn
(54)	Grain Sorghum
(55)	Oats
(56)	Soybeans
(57)	Wheat
(58)	Total Double Accounting Adjustment (52 + 53 + 54 + 55 + 56 + 57)
(59)	Total Variable Livestock and Crop Cost of Production (45 + 51 + -58)
(60)	Non-Model Livestock and Crop Cost of Production and Model Crop and Livestock Fixed Production Cost[1]
(61)	Total Farm Cost of Production (59 + 60)
(62)	Realized Net Farm Income(37 - 61)

[1]Exogenous variable.

Crop Cash Receipts

Crop cash receipts are computed with equations such as (15)

$$CCRSti = (PSti/PBti)*(CPSti/CPBti)*CCRBti*Mi*Wi + (PSsi/PBsi)*(CPSsi/CPSsi)*CCRBti*(1-Wi)*Mi \qquad (15)$$

where t denotes the current time period, s denotes the previous time period i denotes the ith crop, CCRSti represents the simulated value of the cash receipts of the ith crop in time period t, CCRBit is the baseline value or CCRSti, PSti is the simulated price of the ith crop in time period t, PBti is the baseline value of PSti, CPSti is simulated production of the ith crop in time period t, CPBti is baseline value of CPSti, Mi is proportion of the production of the ith crop marketed and Wi represents the weight to convert crop year cash receipts to calendar years. Equations such as (15) reflect the fact that crop cash receipts are not generally equal to value of production (price times quantity). Farmers which produce both livestock and grains feed part or possibly all their grain production to livestock. Thus, equations in POLYSIM which compute cash receipts contain marketing proportions (Mi) which are accounted for in this relationship. These marketing proportions and the weights which convert crop year cash receipts to calendar year (Wi) for all model crops are given in Table XV.

As can be seen from (15), the simulated value of crop cash receipts reflect the adjustment of baseline cash

TABLE XV

MARKETING PROPORTIONS AND CROP YEAR CONVERSION WEIGHTS USED BY POLYSIM

Crop	Marketing Proportions (Mi)[1]	Crop Year Conversions Wieghts (Wi)[2]
Barley	.70	.45
Corn	.60	.45
Cotton	1.00	.70
Grain Sorghum	.76	.45
Oats	.32	.40
Soybeans	.98	.50
Wheat	.96	.70

[1]Marketing proportions reflect the amount of production sold.

[2]Crop year conversion weights reflect factors to convert crop year sales to a calendar year basis.

receipts by the ratio of simulated production and prices to their respective baseline values. If there are no changes from baseline in both crop production and prices, then baseline and simulated cash receipts will be equal.

The total of crop cash receipts in POLYSIM is the summation of model individual crop cash receipts (barley, corn, cotton, grain sorghum, soybeans and wheat) and non-model crop cash receipts. Non-model crop cash receipts is an exogenous data series in POLYSIM.

Livestock Cash Receipts

For a livestock category, simulated cash receipts are computed by adjusting that each livestock category's baseline cash receipts by the ratio of simulated production and price to their respective baseline values. The following equation shows the computation of livestock cash receipts

$$LCRSti=LCRBti*(PDSti/PDBti)*(PSti/PBti) \qquad (16)$$

where t denotes the current time period, where i represents the ith livestock category, LCRSti represents the simulated cash receipts of the ith livestock category in time period t, LCRBti represents the baseline value of LCRSti, PDSti represents simulated production of ith livestock category in time period t, PDBti represents the baseline value of PDSti, PSti is the simulated price of the ith livestock category in time period t and PBti is the baseline value of PSti. Since livestock production and prices are computed on a calendar year basis, no marketing year conversions are necessary in computations such as (16).

Total livestock cash receipts is the summation of the seven individual livestock category cash receipt (beef, pork, sheep, chicken, turkey, eggs and dairy) and exogenous non-model livestock cash receipts. Non-model livestock cash receipts are assigned baseline values unless otherwise supplied by the user.

Total cash receipts in POLYSIM is defined as the sum of total livestock cash receipts and total crop cash receipts. All cash receipts, both individual crops or livestock categories and the aggregate total, are measured in millions of dollars on a calendar year basis.

Realized Non-Money Income

Realized non-money income in POLYSIM originates from two sources. These are value of home livestock consumption and prerequisites other than livestock consumed on-farm (rental values of building, crops, off-farm income, etc). A typical equation used to compute a particular livestock category value of home consumption is

$$VSti = VBti*(PSti/PBti) \qquad (17)$$

where t denotes the current time period, i represents the ith livestock category, VSti represents the simulated value of home consumption of the ith livestock category in time period t, VBti is the baseline value of VSti and PSti and PBti are as defined in (16). It is implicitly assumed that the quantity of particular livestock category consumed on-farm is highly inelastic and exhibits little variation. Hence, the baseline value of home consumption is adjusted by the ratio of simulated and baseline farm-level livestock prices.

The other component of non-money realized farm income, prerequisites other than livestock consumed on-farm, is an exogenous variable. Livestock value of home consumption for all livestock categories are added to other prerequisities to form total realized non-money income. The unit of measure of non-money income is millions of dollars.

Government Farm Payments

POLYSIM computes three types of Government farm payments: diversion payments, deficiency payments and storage payments on farmer-held reserves. All Government farm payments are measured in millions of dollars.

Diversion Payments. Diversion payments for each crop is computed as the product of the acreage diverted of that crop times the diversion payment rate per acre for that crop. The unit of measure for diversion payments for all crops is millions of dollars.

Deficiency Payments. Deficiency payments are computed as in the 1977 Food and Agriculture Act. Deficiency payments are made only when a crop's market price is less than its target price. Deficiency payments are computed in POLYSIM based on the values of five variables which are either policy provisions or are based upon policy provisions.

DSti= DPRti*NPAti*AYti*PAFti*PRti (18)

where t denotes the current time period, i represents the ith crop, Dsti represents the simulated deficiency payments of the ith crop in time period t, DPRti represents the simulated deficiency payment rate of the ith crop in time period t, NPAti represents the simulated national program acreage of the ith crop in time period t, AYti represents the simulated administrative yield of the ith crop in time period t, PAFti represents the simulated program allocation factor of the ith crop in time period t and PRti represents the program participation rate of the ith crop in time period t. The deficiency payment rate for a crop is the minimum of the difference between target price and average market price and the difference between target price and loan rate.[4]

Storage Payments. With the creation of the farmer-held reserves in the 1977 Food and Agriculture Act, farmers participating in the reserve program are paid storage payments on their reserve stocks. These payments are computed as the product of per bushel storage payment rate and the volume of the reserve in bushels.

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[4]In actuality deficiency payments are based upon the average crop price for the first five months of the marketing year. In computing deficiency payments POLYSIM uses the average price based upon the entire marketing year.

Government farm payments are aggregated in two fashions in POLYSIM, by individual crops and by total payments to all crops. For each crop, diversion, deficiency and storage payments when applicable are summed to compute total model Government payments for that crop. These summary measures along with exogenous non-model Government farm payments are summed to compute total Government farm payments. Exogenous non-model Government farm payments are comprised of any Government farm payments not computed for crops included in POLYSIM and Government farm payments occurring to agricultural products not included in POLYSIM.

Measures of Farm Production Expenses

In POLYSIM the cost of producing the output is viewed as having two components. These are variable production costs and fixed production costs. Variable production costs are the endogenously computed production expenses in POLYSIM.

Total variable livestock cost of production is computed as the sum of both feed and non-feed variable costs of production. Variable feed costs are disaggregated into the following types: protein, feed grain, wheat and roughages. Protein cost is computed as the product of simulated by-product feed demand and the price of soybean meal.[5] This

[5]By-product feed demand is computed in POLYSIM SIMULTANEOUS VERSION in the same manner as in the original version of POLYSIM. See either Ray and Richardson (1978) or Richardson (1978) for a detailed explanation of the

computation reflects costing out or pricing all by-products fed in terms of soybean equivalents at the price of soybean meal.

The feed grain feed cost of livestock production is computed as the sum of corn, grain sorghum, oats and barley feed costs. These computations are conducted with equations such as (19)

$$FCSti= Wi*(FDSti*Mi*PSti+FDSti*(1-Mi)*(ACSti/YSti)) \quad (19)$$
$$+(1-Wi)*(FDSsi*Mi*PSsi+FDSsi*(1-Mi)*(ACSsi/YSsi))$$

t denotes the current year, s denotes the previous year, i represents the ith feed grain, FCSti represents the simulated value of livestock feed cost associated for the ith feed grain in time period t, FDSti represents the simulated value of the feed demand of the ith feed grain in time period t, Mi represents the proportion of grain i marketed, Wi represent weights to convert crop year feed costs to calendar year feed cost and ACSti and YSti are as defined above. The terms in the inside parentheses in (19) express that a portion Mi of feed demand of grain i is costed out at the price of i, while a portion 1-Mi of the feed demand of grain i is costed out at the cost of producing grain i. The weights Wi are included in equation (19) to convert marketing years to calendar years.

Wheat feed cost for livestock production is computed by an equation similar to (19). However, it is assumed that

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computation of by-product feed demand.

all wheat fed to livestock is purchased in the market place. Thus the equation which computes wheat feed cost to livestock, costs out or prices all wheat fed to livestock at the market price of wheat. Roughage cost is computed in an analogous manner to feed grain feed costs. The computation of roughage feed costs is based upon the amount of roughage fed to livestock, the price of hay, the cost of production of hay and the portion of roughage bought in the market place. In the computation of roughage cost of production, the portion of roughage bought is costed out at the price of hay, while the portion raised on-farm are priced at cost of roughage production per unit.

Total non-feed cost of livestock production is the summation of the sum of seven livestock production levels times the respective non-feed cost per unit of production. The non-feed costs of production include farmer expenditures for salt, mineral supplements and veterinarian expenses. For a more detailed description of these computations of non-feed livestock and roughage costs of production see either Ray and Richardson (1978) or Richardson (1978).

Total variable cost of production in POLYSIM is defined as the sum of the variable production costs of the seven crops and total variable cost of production of the livestock sector (feed and non-feed), less double accounting adjustments. Double accounting adjustments in POLYSIM compute the portion of crop production expense already counted as feed expense in livestock production. These measures are computed as

$$DASti = (1-Mi)*Wi*(ACSti/YSti)*FDSti + (1-Mi)*(1-Wi)*(ACSsi/YSsi)*FDSsi \quad (20)$$

where t denotes the current time period, s denotes the previous time period, i represents the ith crop, DASti represents the simulated double accounting adjustment of the ith crop in time period t, Wi, ACSti and FDSti are as defined in (19). Total variable production expense for the individual model crops were discussed in an earlier section.

The total cost of agricultural production is then defined as total variable cost of production plus non-model variable and fixed production costs and model fixed production costs. Non-model variable and fixed production costs and model fixed production costs are an exogenous data series in POLYSIM.

CHAPTER IV

RESULTS OF APPLICATIONS OF DIFFERENT PARAMETERIZATIONS OF THE QUADRATIC OBJECTIVE FUNCTION TO AGRICULTURAL POLICY ANALYSIS AND FORMULATION

In this chapter the results of six applications of a quadratic objective function to agricultural policy analysis and formulation are presented. In the first application the control algorithm was free to choose any combination of Government payments and market income in the selection of an optimal control path that achieved the target levels of net farm income. This solution will be referred to as the free choice application. The target levels of net farm income were 31.6 billion dollars, 32.9 billion dollars, 34.2 billion dollars, and 35.4 billion dollars for 1980-83, respectively. The remaining five applications had the same overall objective as the free choice application which was obtain the specified net farm income targets. The differences in these applications were the amounts of increase in net farm income which could originate from Government payments. These applications reflect decision maker preferences for 0, 30, 50, 70, and 100 percent of the increase in net farm income to originate from Government farm payments.

As stated above, each of these applications were conducted for the control period 1980-83. The four year control period length was selected because farm program legislation is usually written to cover a four year time period and computer cost considerations.

The same farm program policy instruments were available for all applications of the objective function except the 0 percent increase in Government payments. As described in Chapter II, the overall farm program allows a set-aside program for corn, barley, grain sorghum, wheat and cotton, a deficiency payment program based upon target prices, a set-aside payment program, a farmer-held reserve program for all feed grains and wheat, and a Commodity Credit Corporation stock program for cotton and soybeans.

For the 0 percent increase in Government payments application, a somewhat different farm program was assumed. The set-aside program and stock program were assumed to be in force, but participation was mandatory. This approach was developed to simulate a mandatory production control program or marketing quota program thus, no Government payments were assumed.

Data Requirements

POLYSIM requires a baseline of forecasted data. Baseline data includes projections of supply, utilization and prices of agricultural commodities as well as associated income and expense measures. ESCS commodity specialists develop baseline projections used by POLYSIM. The projections reflect the use of formal and informal forecasting tempered with experience and judgments of commodity analysts. The baseline data used in this control study is a modification of the July 1979 baseline to reflect more recent developments in agricultural commodity prices, supplies, uses, incomes and production expenses. These data were developed assuming continuation of the 1977 Food and Agriculture Act.

Additional data were supplied to POLYSIM by the Box Complex optimization procedure. These were the policy instruments selected as control variables including the target prices, loan rates, and set-aside rates for corn, wheat, and cotton. As described in Chapter II the target prices and set-aside rate of grain sorghum and barley were based upon the corresponding corn policy instruments. Also the loan rates of grain sorghum, barley and oats were determined based on corn loan rate.

Considerations of Agricultural Policy Analysis and Formulation with Control Methods

In obtaining an optimal solution for a particular application of the objective function, the Box Complex optimization technique must consider the static and dynamic aspects of the United States agricultural sector as represented in POLYSIM. Many of the control variables or policy instruments used in this control study have both static (current period) and dynamic (future period) effects.

The deficiency payment program based upon target prices is an example of a control variable which exhibits a somewhat static effect. Under the provisions of the 1977 Food and Agriculture Act, deficiency payments are paid crop producers only if crop market price is less than target price. As was described in Chapter III, the relative price difference between target and market price defines a factor which in part determines deficiency payments. When the optimization technique chooses a control path which generates a POLYSIM solution which increase relative price differences, deficiency payments will increase. This facilitates the current period goal of increasing current net farm income.

Target prices through a deficiency payment program can also facilitate the goals of the various parameterizations of the objective function as to the source of increase in net farm income. When deficiency payments are used to reward and insure producer participation in the set-aside program, Government payments are being used to generate market income. Increases in market income with a set-aside program reflect the low price elasticities of demand of agricultural products and a possible decrease in total variable cost of production by reducing harvested acreages. Following economic theory the change in total revenues will be positive, or in the context of agricultural products cash receipts, from a reduction in supply if demand is price inelastic. The increase in price will offset the reduction in supply and cash receipts will increase.

The above analysis only considers the static direct effect of a change in set-aside acreage of a particular crop. A change in a set-aside acreage can also exhibit static indirect effects as well as dynamic direct and indirect effects. Static indirect effects would include a change in the set-aside acreage of a particular crop affecting other current period crop utilizations and prices through the change in that particular crop price brought about by a production change.

Dynamic direct effects of a change in the set-aside acreage of a particular crop would include the current and future responses of that crop's production, demand, and price and, ultimately, income measures to previous period changes in production, utilization, and price. Indirect dynamic effects would include the cross effects of the previous change in the price of a particular crop upon the supply, utilization, price and income measures of other crops and livestock.

These concepts can be made more concrete with a specific example such as corn set-aside acreage. Figure 6 presents a schematic flow of the static direct and indirect effects and dynamic direct and indirect effects of a change in corn set-aside acreage. Static direct effects would consider the effect upon corn supply, price, utilization and eventually income measures related to corn from a change in

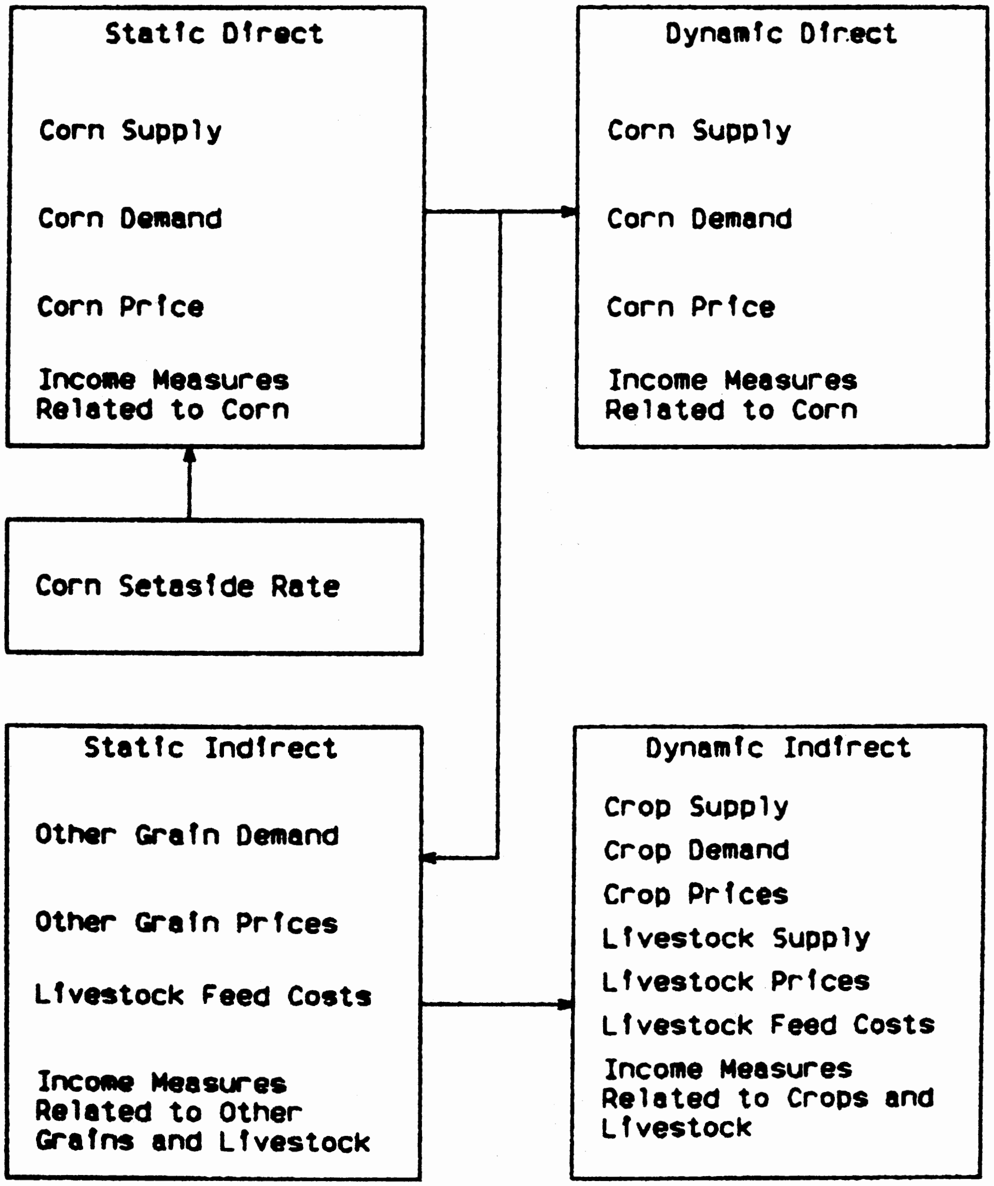

Figure 6. Schematic Flow of Effects of a Change in Corn Set-aside Rate

corn production brought about by the change in corn set-aside rate. Static indirect effects would include the effect that the change in current corn price would exhibit upon the current utilizations and prices of other grains, the feed cost of livestock production, and eventually income measures related to other grains and livestock.

Dynamic direct responses would consider the future response of corn acreage and yield upon supply through production, utilization, and price and eventually income measures related to corn. The dynamic direct response of corn acreage would include the response of corn acreage to changes in previous corn prices and previous changes in corn acreage. Dynamic indirect effects would include the response of other crop acreage to previous changes in other crop prices and own acreages. These responses would include not only the effect of the change in the previous period corn price upon other crop production, but also the effect of previous period changes in other crop prices upon corn acreage. The dynamic indirect effect of changing crop acreages would affect crop productions, supplies, utilizations, and prices as well as livestock production, prices, feed costs and eventually income measures related to both crops and livestock.

An analysis of the direct and indirect static and dynamic effects the optimization technique must consider when determining optimal loan rates would follow the same format as set-aside acreages. Such an analysis would reinforce the point being made here which is that the determination of the optimal control path must consider static and dynamic effects of control variables and also the interrelationship among agricultural commodities.

Results of Applications of Different Parameterizations of Objective Function to Agricultural Policy Analysis and Formulation

Free Choice Application

In the free choice application of the objective function, the control algorithm was free to choose an optimum control path reflecting any combination of Government paypayments and market receipts or income to increase net farm income to the target levels. A summary of the levels of net farm income obtained, and sources of the increases in net farm income for the control period are presented in Table XVI.

The computed levels of net farm income which minimized the objective function were very close to the target levels for all control periods. As is common with quadratic objective functions some target levels were overachieved and others were underachieved. In the second and third years (1980 and 1981) of the control period, the targeted levels of net farm income were overachieved, while in the last year targeted net farm income was underachieved. Of the increase in net farm income from baseline, Government payments comprised 87.5, 69.6, 77.7, and 63.6 percent for 1980, 1981, 1982 and 1983, respectively.

TABLE XVI

TARGET LEVEL, SIMULATED LEVEL, AND SOURCE OF INCREASE IN NET FARM INCOME FOR FREE CHOICE APPLICATION, 1980-83

Item	Unit	1980	1981	1982	1983
Target Level of Net Farm Income	B. $	31.6	32.9	34.2	35.4
Simulated Level of Net Farm Income	B. $	31.6	33.0	34.4	35.1
Simulated Increase in Government Payments	B. $	6.3	6.9	8.6	10.0
Simulated Increase in Market Income	B. $	0.9	3.0	4.1	5.7

Table XVII contains the values of the control variables of policy instruments which produced the optimal solution and simulated values of selected endogenous variables. The values of loan rates, target prices and set-aside rates are higher than recent historical levels as given in Table XVIII. Target prices were increased the most. This re-

TABLE XVII

OPTIMAL VALUES OF CONTROL VARIABLES AND SELECTED ENDOGENOUS VARIABLES FOR FREE CHOICE APPLICATION, 1980-83

Item	Unit	1980	1981	1982	1983
CONTROL VARIABLE					
Loan Rates					
Corn	$/bu.	2.38	2.40	2.58	2.59
Wheat	$/bu.	2.98	3.09	3.27	3.32
Cotton	$/lb.	0.49	0.52	0.55	0.56
Target Prices					
Corn	$/bu.	3.52	3.79	4.11	4.40
Wheat	$/bu.	5.07	4.85	5.31	5.17
Cotton	$/lb.	0.86	0.93	0.94	0.99
Set-aside Rate					
Corn	%	10.9	20.2	29.9	28.9
Wheat	%	12.5	16.4	23.4	24.0
Cotton	%	20.1	16.6	29.7	29.9
ENDOGENOUS VARIABLES					
Effective Set-aside Rate					
Corn	%	5.4	10.1	14.9	14.9
Wheat	%	7.5	9.9	14.0	14.4
Cotton	%	18.1	23.9	26.7	26.9
Reduction in Production from Baseline					
Wheat	%	4.5	2.7	3.7	4.0
Cotton	%	12.7	16.9	11.8	14.3
Feed Grains in Aggregate	%	2.8	5.9	8.5	8.6
Harvested Acreage					
Corn	M. ac.	69.9	69.2	67.2	67.0
Wheat	M. ac.	64.2	63.5	61.6	62.9
Cotton	M. ac.	9.5	8.9	9.1	9.3
Feed Grains in Aggregate	M. ac.	103.0	103.2	99.9	99.8

TABLE XVII (Continued)

Item	Unit	1980	1981	1982	1983
Yield					
Corn	bu./ac.	100.2	100.4	100.7	101.3
Wheat	bu./ac.	32.5	32.9	32.4	32.5
Cotton	lb./ac.	490.2	509.9	543.0	553.3
Feed Grains in Aggregate	T./ac.	2.28	2.27	2.36	2.31
Exports					
Corn	M. bu.	2146.5	2160.2	2107.2	2099.9
Wheat	M. bu.	1251.9	1270.1	1287.4	1297.8
Cotton	M. bales	5.1	4.3	4.5	4.5
Feed Grains in Aggregate	M. ton	68.5	68.9	66.9	66.8
Total Utilization					
Corn	M. bu.	6969.4	6952.5	6804.9	6762.8
Wheat	M. bu.	2043.7	2067.8	2077.6	2093.2
Cotton	M. bales	11.4	10.4	10.6	10.8
Feed Grains in Aggregate	M. ton	237.0	236.7	230.6	229.6
Ending Year Carry Out					
Corn	M. bu.	1851.1	1844.6	1808.4	1832.9
Wheat	M. bu.	1020.1	1039.4	954.0	910.6
Cotton	M. bales	2.5	1.7	1.6	1.7
Feed Grains in Aggregate	M. ton	62.7	61.9	60.9	62.0
Set-aside Payment Rate					
Corn	$/bu.	0.00	0.00	0.00	0.00
Wheat	$/bu.	0.00	0.00	0.00	0.00
Cotton	$/bu.	0.21	0.26	0.45	0.43
Deficiency Payments					
Corn	B. $	3.8	4.5	5.4	6.6
Wheat	B. $	1.4	1.3	1.6	1.3
Cotton	B. $	0.9	0.3	0.4	0.5
Feed Grains in Aggregate	B. $	4.5	5.4	6.4	7.9
Set-aside Payments					
Corn	B. $	0.0	0.0	0.0	0.0
Wheat	B. $	0.0	0.0	0.0	0.0
Cotton	B. $	0.2	0.3	0.4	0.5
Feed grains in Aggregate	B. $	0.0	0.0	0.0	0.0

TABLE XVII (Continued)

Item	Unit	1980	1981	1982	1983
Commodity Prices					
Corn	$/bu.	2.46	2.54	2.64	2.60
Wheat	$/bu.	3.87	3.87	4.01	4.15
Cotton	$/lb.	0.65	0.84	0.85	0.86
Feed grains in Aggregate	$/ton	84.99	87.98	90.81	92.14
Cattle	$/cwt.	57.00	60.77	61.46	63.69
Hogs	$/cwt.	41.00	49.97	49.02	49.66
Milk	$/cwt.	11.69	13.21	13.54	13.67
Retail Meat Prices					
Choice beef	$/lb.	2.36	2.62	2.68	2.75
Pork	$/lb.	1.24	1.50	1.64	1.76
Milk	$/1/2 gal.	1.05	1.20	1.26	2.34

TABLE XVIII

HISTORICAL VALUES OF CONTROL VARIABLES, 1976-1979

Item	Unit	1976	1977	1978	1979
Loan Rate					
Corn	$/bu.	1.50	2.00	2.00	2.10
Wheat	$/bu.	2.25	2.25	2.35	2.50
Cotton	$/bu.	0.45	0.45	0.48	0.50
Target Price					
Corn	$/bu.	1.57	2.00	2.10	2.20
Wheat	$/bu.	2.90	2.90	3.40	3.40
Cotton	$/bu.	0.48	0.48	0.52	0.58
Set-aside Rate					
Corn	%	0.0	0.0	10.0	10.0
Wheat	%	0.0	0.0	20.0	20.0
Cotton	%	0.0	0.0	0.0	0.0

flects the ability of a deficiency payment program to increase net farm income through increases in Goverment payments.

The baseline values of set-aside rates were zero, for all crops for all control periods. The selection of non-zero set-aside rates implies reduction in crop production and increases in crop market prices. With increases in crop market prices, utilization of crops were reduced from baseline levels.

Table XVII also contains other data from the free choice application including the effective set-aside rate and actual reduction in crop production from baseline levels. The effective set-aside rate reflects set-aside program participation as well as the set-aside rate. Since in this application of the objective function, set-aside program participation was less than unity for all crops, the effective set-aside rate will be less than the set-aside rate. The actual reduction in crop production from baseline levels will differ from the effective set-aside rate for two reasons which are slippage and the dynamic response of crop producers to increased crop prices and changes in crop acreages. Slippage is the portion of each acre of set-aside that does not actually result in reducing crop production, due to farmers declaring their least productive land as set-aside and farmers using variable resources more intensely on the land left in cultivation to increase production. Tweeten (1970) reports that prior to 1970 the slippage rate for feed grains was about 0.40, meaning that for each acre set-aside, production was reduced by only 0.6 acres. Garst and Miller (1975) report the slippage rate for wheat at 0.39 during 1960-70, and being as high as 0.59 between 1971 and 1974. The slippage rates used in this study are 0.40 for feed grains and cotton and 0.60 for wheat.

The slippage rate and producer set-aside program participation are not the only factors which determine the effects of set-aside rates upon crop production. Dynamic direct and indirect responses of changing crop prices will also affect crop production. For the first control period, the increased set-aside rates from baseline will generate a higher crop market price. A higher crop price will affect next period's acreage of not only that particular crop, but also the acreage of other crops. There will also be a response in crop yields to increased crop prices. Farmers will use more resources as crop prices increase which will increase per acre yields.

The price of corn generated by the set-aside rates given in Table XVII ranged from 2.46 to 2.60 per bushel, while the price of wheat ranged from 3.87 to 4.15 per bushel. Cotton price increased substantially from 1980 to 1981, but then exhibited a slowly increasing pattern across the remaining control periods.

Livestock prices also increased from baseline levels in the last three control periods. This occurred from the indirect dynamic response of livestock production to previous increases in grain prices. As grain prices increased, livestock production declined and resulted in increased livestock prices at both farm and retail levels.

Target prices in the optimal solution generally provided sufficiently high deficiency payment levels to achieve desired farmer participation in the set-aside program without additional set-aside payments. Using the breakeven analysis described in Chapter II, only cotton farmers required set-aside payments in addition to deficiency payments to justify participating in the set-aside program.

The data presented in Table XIX help isolate and explain the relative contributions of Government payments and market income in the achievement of the net farm income targets. These data represent changes in simulated income and expense variables from baseline levels for the optimal control path of the free choice application of the objective function. As an example, in 1983 Government payments were increased by 10.0 billion dollars. Livestock cash receipts and livestock value of home consumption increased by 3.4 billion dollars, while crop cash receipts increased by 1.6 billion. Both of these increases in cash receipts are due to reduced production and price inelastic demands. The reduced crop production was, of course, due to less harvested acreage while livestock production declined due to increased grain prices. The three sources of increased gross farm income -- 10.0 billion dollars in Government payments, 3.4 billion dollars in livestock cash receipts and value of home consumption, and 1.6 billion in crop cash receipts -- sum to the 15.0 billion dollar increase in gross farm income.

TABLE XIX

INCREASE IN NET FARM INCOME BY GROSS SOURCE FOR THE FREE CHOICE APPLICATION, 1980-83

Item	Unit	1980	1981	1982	1983
Government Payments	B. $	6.3	6.9	8.6	10.0
Livestock Cash Receipts and Value of Home Consumption	B. $	0.0	0.8	1.4	3.4
Crop Cash Receipts	B. $	0.3	1.4	1.9	1.6
Livestock Variable Cost of Production	B. $	-0.1	-0.5	-0.9	-1.2
Crop Variable Cost of Production	B. $	0.7	1.3	1.7	1.9
Total	B. $	7.2	9.9	12.7	15.7

To determine either a level of net farm income or a change in net farm income, production costs as well as gross farm income must be considered. As shown in Table XIX, livestock variable production costs increased. As the market prices of feed grain prices increased over time, so did livestock variable production costs. Crop production costs were reduced from baseline levels. This reflected the increased set-aside rates and their effect of reducing crop harvested acreage. If the changes in variable production costs are summed, the result yields 0.7 billion dollars total reduction in variable cost of production. When this variable cost saving is added to the 15.0 billion dollar increase in gross farm income, the result will yield the 15.7 billion dollar computed increase in net farm income.

Table XX presents the same income and expense data as Table XIX but changes in production costs are allocated to sources. By summarizing the data in this fashion, Table XX breaks out the net increase in net farm income from baseline by source of increase. As an example consider the simulated income and expense data for the control year 1983. When the 1.2 billion dollar increase in livestock cost of production is subtracted from the 3.4 billion dollar increase in livestock cash receipts and value of home consumption, the net contribution of the livestock sector is 2.2 billion dollars. In the case of the crop sector, if the 1.9 billion dollar reduction in crop variable cost of production is added to the 1.6 billion dollar increase in crop cash receipts the result is a 3.5 billion dollar net contribution to farm income by the crop sector. As in the previous table these data show that the main source of the increase in net farm income is Government payments. However, in apparent contrast to the gross source data in Table XIX, net contributions to the increase in net farm income was greater from crops than from livestock.

TABLE XX

INCREASE IN NET FARM INCOME BY NET SOURCE FOR FREE CHOICE APPLICATION, 1980-83[1]

Item	Unit	1980	1981	1982	1983
Government Payments	B. $	6.3 (87.5)	6.9 (69.6)	8.6 (67.7)	10.0 (63.6)
Livestock	B. $	-0.1 (-1.4)	0.3 (3.0)	0.5 (3.9)	2.2 (14.0)
Crops	B. $	1.0 (13.9)	2.7 (27.3)	3.6 (28.4)	3.5 (22.4)
Total	B. $	7.2 (100.0)	9.9 (100.0)	12.7 (100.0)	15.7 (100.0)

[1]Percent of the total increase in net farm income are in parentheses underneath the respective net source.

0, 30, 50, 70, and 100 Applications

The remaining applications of the quadratic criterion function used the same net farm income targets as the free choice application. However, varying portions of the increase in net farm income were allowed to come from Government payments (the rest of the increase in net farm income coming from the market place) in the remaining applications.

In terms of percentages Government payments were constrained to contributing 0, 30, 50, 70, and 100 percent of the desired increase in net farm income, respectively, in the five applications.

The 0 percent increase in Government payments application required the determination of an optimal control path or policy which achieved the target net farm income levels completely from the market place. Possible sources of increases in net farm income include increases in livestock cash receipts and value of home consumption, crop cash receipts, and reductions in variable production costs. In the following discussion this application will be referred to as the 0 application.

The 30, 50, 70, and 100 percent of net farm income increase from Government payment applications required the determination of optimal control paths to obtain the net farm income targets using a specific mix of Government payments and market income. In the following discussion, these applications will be referred to as the 30, 50, 70, and 100 applications. The 30 application required the selection of a control path which allowed 30 percent of increase in net farm income to originate from Government payments and 70 percent from the market place. The 50 application required a control solution which generated equal increases in market income and Government payments to achieve the target levels of net farm income. The 70 application required 70 percent of the increase in net farm income to come from Government payments and 30 percent from the market place. Finally, the 100 application required a control solution which achieved the desired increases in farm income with the use of only Government payments.

For each application the percentage of Government payments contribution to net farm income is held constant except in the first control period of the 30, 50, and 70 applications. In these applications Government payments were allowed to be 70, 80, and 90 percent of the increase in net farm income, respectively, in the first control period. This was done because the dynamic characteristics of crop income accounting and livestock production response made lower percentages unfeasible to obtain in the first period. Crop cash receipts include production and prices measured in the current and previous crop or marketing years (Oct. 1 - Sept. 30 in case of feed grains). However, in attempting to influence the crop cash receipts for the first control period the optimization algorithm can only "get to" or influence the current crop year price and production even though the previous crop year price and production affect the calendar year income measures. Also the livestock sector of the model responds to lagged or previous changes in grain prices. Hence, in the first control period the livestock sector cannot adjust production. Thus, to initiate the applications it was necessary to raise the percent of net farm income increase contributed by Government payments in the first year of the 30, 50 and 70 applications.

Table XXI presents the simulated levels of net farm income which minimized the objective function in the 0, 30, 50, 70, and 100 applications. Also presented in the Table XXI are the percent error of the simulated levels of net farm income in achieving the target levels of net farm income. The target levels of net farm income were the same for these applications of the objective function as the free choice application. These target levels were 31.6 billion dollars, 32.9 billion dollars, 34.2 billion dollars, and 35.4 billion dollars for the first through fourth control periods, (1980-83), respectively. A negative percent error would indicate underachieving a target level of net farm income while a positive percent error would indicate overachieving a target level of net farm income. The largest percent error in absolute value occurred in the first control period of the 0 application. This was caused by the dynamic characteristics of agricultural income accounting and the lags in livestock production response discussed above. Overall the 30 application of the objective function missed the target levels of net farm income the most. This brings out, however, an important consideration in comparing the 30 application with either the 0 application or the 50 application. If farm program participation is to be adequately rewarded, there are absolute levels of Government payments which are necessary to accomplish the generation of increase in market income which will obtain a target level of net farm income. As will be seen later, restrictions on amounts of increases in Government payments will also have ramifications upon the composition and distribution of Government payments.

TABLE XXI

SIMULATED NET FARM INCOME AND PERCENT ERROR IN SIMULATED NET FARM INCOME IN ACHIEVING TARGET NET FARM INCOME FOR 0, 30, 50 70 and 100 APPLICATION, 1980-83[1]

Item	Unit	1980	1981	1982	1983
Simulated Net Farm Income					
Application					
0	B. $	26.6	34.0	33.8	35.6
30	B. $	30.8	30.8	32.4	35.1
50	B. $	31.5	33.3	34.5	36.1
70	B. $	31.5	32.2	33.2	34.7
100	B. $	32.3	33.0	34.0	35.5
Percent Error[2]					
Application					
0	%	-15.8	3.3	-1.2	0.6
30	%	-2.5	-6.4	-5.3	-0.8
50	%	-0.3	0.9	0.9	0.8
70	%	-0.3	-2.1	-2.9	-1.9
100	%	-2.2	0.3	0.5	0.3

[1]The 0, 30, 50, 70, and 100 applications refer to the respective situations where 0, 30, 50, 70, and 100 percent of the increase in net farm income came from Government payments.

[2]Percent error is defined as simulated net farm income minus target net farm income divided by target net farm income.

Table XXII presents the optimal values of the target prices for corn, wheat, and cotton for the 30, 50, 70, and 100 applications. Target prices are lower as the percent of net farm income coming from Government payments is reduced. The lowest set of target prices (30 application) is higher than recent historical values of these policy instruments (Table XVII). Corn target prices ranged from 3.28 dollars per bushel in the second control period of the 30 application to 5.25 dollars per bushel in the last control period of the 100 application. The lowest wheat target price was 4.28 per bushel while the highest wheat target price was 5.73 per bushel. These occurred in the same control periods as the corn target price extremes. Cotton target price ranged from 0.72 to 0.95 dollars per pound. These extremes occurred in the second control period of the 30 application and the third control period of the 100 application.

In the period 1976-1979, the ratio of wheat target price to corn target price averaged 1.60 and the ratio of cotton target price to corn target price average .26 (Table XVIII). The optimal target prices reported in Table XXII represent average ratios of 1.28 and .22, respectively. Corn target prices were increased, from a historical standpoint, relatively more than either wheat or cotton target prices.

Table XXIII contains the optimal set-aside rates of the 0, 30, 50, 70 and 100 applications. Also included in Table XXIII are the effective set-aside rates and actual reduction

TABLE XXII

OPTIMAL TARGET PRICES OF CORN, WHEAT AND COTTON FOR THE 30, 50, 70 AND 100 APPLICATIONS, 1980-83[1]

Item	Unit	1980	1981	1982	1983
Corn					
Application					
30	$/bu.	3.53	3.28	3.56	3.22
50	$/bu.	3.69	3.59	3.88	4.15
70	$/bu.	3.50	3.71	4.13	4.61
100	$/bu.	3.62	3.99	4.50	5.25
Wheat					
Application					
30	$/bu.	4.86	4.28	4.42	4.09
50	$/bu.	4.87	4.89	4.58	4.95
70	$/bu.	5.01	4.89	5.17	5.39
100	$/bu.	5.47	5.17	5.30	5.73
Cotton					
Application					
30	$/lb.	0.78	0.72	0.73	0.82
50	$/lb.	0.78	0.83	0.80	0.90
70	$/lb.	0.89	0.84	0.84	0.88
100	$/lb.	0.84	0.91	0.95	0.89

[1]See footnote 1 of Table XXI.

TABLE XXIII

OPTIMAL SET-ASIDE RATES OF CORN, WHEAT AND COTTON, SIMULATED EFFECTIVE SET-ASIDE RATES OF CORN, WHEAT AND COTTON AND REDUCTION IN PRODUCTION FROM BASELINE OF FEED GRAINS IN AGGREGATE, WHEAT AND COTTON FOR 0, 30, 50, 70 and 100 APPLICATIONS, 1980-83[1]

Item	Unit	1980	1981	1982	1983
SET-ASIDE RATES					
Corn					
Application					
0	%	16.4	22.9	27.8	29.3
30	%	16.4	35.0	55.0	58.6
50	%	18.2	36.1	45.0	46.1
70	%	8.6	11.5	21.3	22.1
100	%	2.2	2.6	2.6	4.0
Wheat					
Application					
0	%	22.3	23.9	24.4	25.9
30	%	13.0	22.0	26.5	33.7
50	%	20.8	21.3	32.7	36.8
70	%	8.2	10.1	12.0	15.9
100	%	2.1	2.6	2.6	4.0
Cotton					
Application					
0	%	18.3	20.8	20.9	24.1
30	%	12.8	39.0	54.7	58.3
50	%	26.2	36.8	44.7	45.3
70	%	12.5	16.5	20.7	21.8
100	%	2.2	2.2	4.4	4.7
EFFECTIVE SET-ASIDE RATE					
Corn					
Application					
0	%	16.4	22.9	27.8	29.3
30	%	8.2	17.5	27.4	29.3
50	%	9.1	18.0	22.5	23.1
70	%	4.3	5.8	10.6	11.0
100	%	1.1	1.3	1.3	2.0
Wheat					
Application					
0	%	22.3	23.9	24.4	25.9
30	%	7.8	13.2	15.9	20.2
50	%	12.5	12.8	19.6	22.1
70	%	4.9	6.1	7.2	9.6
100	%	1.3	2.2	2.3	3.7

TABLE XXIII (Continued)

Item	Unit	1980	1981	1982	1983
Cotton					
Application					
0	%	18.3	20.8	20.9	24.1
30	%	11.5	35.1	49.2	52.5
50	%	23.5	33.1	40.2	40.8
70	%	11.3	14.9	18.5	19.7
100	%	1.9	1.9	4.0	4.3
REDUCTION IN PRODUCTION FROM BASELINE					
Feed Grains in Aggregate					
Application					
0	%	13.1	22.8	28.8	30.9
30	%	4.7	9.9	16.2	17.2
50	%	5.2	10.5	13.3	13.5
70	%	2.4	3.0	5.5	6.2
100	%	0.1	<0.1	<0.1	<0.1
Wheat					
Application					
0	%	22.8	28.7	29.2	31.1
30	%	4.7	3.5	4.5	6.3
50	%	7.4	3.7	5.0	6.1
70	%	2.9	1.8	2.1	2.6
100	%	0.7	0.6	0.5	0.8
Cotton					
Application					
0	%	18.9	21.9	14.4	21.7
30	%	8.1	25.5	31.4	33.0
50	%	16.5	23.7	21.9	29.9
70	%	7.8	10.6	8.6	10.2
100	%	1.3	1.4	2.0	2.0

[1]See footnote 1 of Table XXI.

in production from baseline levels of feed grains in aggregate, wheat and cotton. As discussed earlier actual reduction in production from baseline levels can vary from optimal set-aside rates for three reasons which are the effectiveness of set-aside rates in relation to producer participation, the lagged response of acreage and yields to previous crop price changes, and the lagged response of crop acreage and yields to previous changes in crop acreages and yields. As Government payments declined as a percentage of the increase in net farm income, set-aside rates increased. The effective set-aside rates and percent reduction in production from baseline also increased. In the 0 application, which could be likened to a marketing quota program, the effective set-aside rate and set-aside rate are equal since set-aside program participation is assumed to be mandatory. The increase in set-aside rates reflect the ability to increase market income and offset the reductions in Government payments by reducing crop production when crop demands are price inelastic.

Crop market prices and livestock prices are given in Table XXIV along with carry-out or ending stock levels of feed grains wheat and cotton. The price of corn per bushel ranged from 2.32 dollars in the last control period of the 100 application 3.40 per bushel in the third control period of the 0 application. The average price of corn over all control periods and applications was 2.72 dollars per bushel. Wheat price ranged from 3.65 dollars per bushel in

TABLE XXIV

SIMULATED CROP PRICES, LIVESTOCK PRICES, AND ENDING CARRY OUTS OF FEED GRAINS IN AGGREGATE, WHEAT AND COTTON 0, 30, 50, 70, and 100 APPLICATIONS, 1980-83[1]

Item	Unit	1980	1981	1982	1983
CROP PRICES					
Corn					
Application					
0	$/bu.	2.90	3.25	3.40	3.38
30	$/bu.	2.55	2.71	2.97	2.93
50	$/bu.	2.57	2.73	2.83	2.78
70	$/bu.	2.45	2.48	2.52	2.53
100	$/bu.	2.38	2.35	2.33	2.32
Wheat					
Application					
0	$/bu.	5.03	5.82	5.88	6.22
30	$/bu.	3.88	3.93	4.09	4.35
50	$/bu.	4.04	3.99	4.13	4.33
70	$/bu.	3.77	3.79	3.89	4.03
100	$/bu.	3.65	3.67	3.75	3.86
Cotton					
Application					
0	$/bu.	0.71	0.94	0.94	0.96
30	$/bu.	0.61	0.94	1.13	1.11
50	$/bu.	0.69	0.95	1.00	1.02
70	$/bu.	0.61	0.75	0.79	0.79
100	$/bu.	0.56	0.61	0.67	0.66
Grain Sorghum					
Application					
0	$/bu.	2.75	2.84	3.03	2.94
30	$/bu.	2.41	2.49	2.72	2.64
50	$/bu.	2.43	2.50	2.62	2.61
70	$/bu.	2.33	2.35	2.40	2.40
100	$/bu.	2.27	2.22	2.25	2.23
Barley					
Application					
0	$/bu.	2.57	3.10	2.89	2.92
30	$/bu.	2.38	2.46	2.61	2.60
50	$/bu.	2.39	2.54	2.58	2.48
70	$/bu.	2.34	2.36	2.40	2.35
100	$/bu.	2.27	2.22	2.25	2.23

TABLE XXIV (Continued)

Item	Unit	1980	1981	1982	1983
<u>Oats</u>					
Application					
0	$/bu.	1.37	1.42	1.53	1.51
30	$/bu.	1.33	1.35	1.42	1.45
50	$/bu.	1.33	1.35	1.42	1.45
70	$/bu.	1.33	1.32	1.36	1.36
100	$/bu.	1.33	1.31	1.33	1.31
<u>Feed Grains in Aggregate</u>					
Application					
0	$/ton	90.83	106.40	115.07	117.63
30	$/ton	86.13	91.91	98.53	102.82
50	$/ton	86.43	92.65	97.13	98.48
70	$/ton	84.79	86.83	87.96	88.94
100	$/ton	83.71	83.36	82.53	82.19
<u>Soybeans</u>					
Application					
0	$/bu.	6.43	6.66	6.97	6.90
30	$/bu.	6.20	6.29	6.51	6.69
50	$/bu.	6.20	6.35	6.54	6.52
70	$/bu.	6.20	6.23	6.28	6.21
100	$/bu.	6.20	6.13	6.09	6.03
LIVESTOCK PRICES					
<u>Cattle</u>					
Application					
0	$/cwt.	57.0	64.69	65.50	69.47
30	$/cwt.	59.0	61.03	62.50	66.50
50	$/cwt.	57.0	61.26	62.63	65.51
70	$/cwt.	57.0	59.26	60.07	61.29
100	$/cwt.	57.0	59.00	60.00	61.00
<u>Hogs</u>					
Application					
0	$/cwt.	41.0	61.39	56.78	61.63
30	$/cwt.	41.0	52.14	42.36	55.70
50	$/cwt.	41.0	56.72	51.37	52.38
70	$/cwt.	41.0	49.63	47.72	47.91
100	$/cwt.	41.0	47.66	46.05	44.65

TABLE XXIV (Continued)

Item	Unit	1980	1981	1982	1983
Milk					
Application					
0	$/cwt.	11.69	13.97	14.70	15.01
30	$/cwt.	11.69	13.35	13.82	14.25
50	$/cwt.	11.69	13.39	13.85	14.01
70	$/cwt.	11.69	13.18	13.08	13.47
100	$/cwt.	11.69	13.05	13.21	13.14
ENDING CARRY-OUT					
Feed Grains in Aggregate					
Application					
0	M. ton	56.5	52.6	50.3	51.4
30	M. ton	61.3	59.0	55.9	56.7
50	M. ton	60.9	58.9	58.2	60.3
70	M. ton	62.9	66.6	66.5	67.8
100	M. ton	64.4	67.1	67.7	67.9
Wheat					
Application					
0	M.bu.	853.3	770.9	715.1	786.0
30	M.bu.	1018.0	1028.9	941.0	883.6
50	M.bu.	990.9	1018.6	935.4	885.9
70	M.bu.	1035.6	1053.6	972.9	927.8
100	M.bu.	1058.0	1074.5	994.8	951.6
Cotton					
Application					
0	M.bales	2.2	1.4	1.4	1.3
30	M.bales	2.7	1.4	1.0	1.0
50	M.bales	2.7	1.3	1.0	1.1
70	M.bales	2.8	2.0	1.8	1.9
100	M.bales	3.2	2.6	2.2	2.4

[1]See footnote 1 of Table XXI.

first control period of the 100 application to 6.22 dollars per bushel in the last control period of the 0 application. The overall average wheat price was 4.31 dollars per bushel. Cotton price ranged from 0.56 dollars per pound to 1.13 dollars per pound, while the overall average cotton price was 0.82 dollars per pound. Table XXIV also contains the the prices of soybeans and oats. For these crops set-aside rates were held at zero for all control periods. Even though these crops did not have direct acreage restriction policy instruments, which would directly affect their prices, their prices were increased from baseline levels. This would be brought about by the indirect dynamic response of these crop acreages to increases in the prices of other crops.

Livestock prices were increased from baseline levels from from the indirect dynamic response of livestock production to increased grain prices. The more the increase in grain prices; the more the reduction in livestock production and increase in livestock prices. Thus, as would be expected, the 0 application resulted in the highest livestock prices. Of the POLYSIM livestock categories (cattle, hogs, sheep, chickens, turkeys, eggs, and dairy) hog prices showed the largest increase which was as expected since hogs consume the majority of grains fed to livestock (USDA, 1974).

A commodity variable closely associated with changes in commodity prices is the carry-out or ending stock of the commodities. Reductions in the carry-out or ending stocks of crops can be caused by increased demand, reduced supply, or a combination of the two. In this control study the reduction in carry-outs (Table XXIV) from baseline levels would reflect supply reduction through a decrease in current production. Carry-outs of feed grains, wheat, and cotton, for the 0, 30, 50, 70, and 100 applications exhibited an inverse relationship to set-aside rates and market prices. More detailed simulated data on commodity supply and utilization data and income related data associated with these applications of the objective function are contained in Appendix C.

Table XXV contains set-aside payment rates for corn, wheat and cotton. As the specified proportion of income increase from Government payments was reduced from 100 to 30 percent, the optimal solutions reflect an increase in wheat and cotton set-aside payment rates. In these crops, the optimal target prices were not high enough to insure the desired program participation through deficiency payments and were supplemented with set-aside payments. This situation did not occur to the same extent in feed grains. The optimal target prices were high enough to insure desired levels of program participation and it was not necessary to supplement feed grain deficiency payments with set-aside payments.

TABLE XXV

SIMULATED SET-ASIDE PAYMENT RATE OF CORN, WHEAT AND COTTON FOR 30, 50, 70, and 100 APPLICATIONS, 1980-83[1]

Item	Unit	1980	1981	1982	1983
CORN					
Application					
30	$/bu.	0.00	0.00	0.00	0.82
50	$/bu.	0.00	0.00	0.00	0.00
70	$/bu.	0.00	0.00	0.00	0.00
100	$/bu.	0.00	0.00	0.00	0.00
WHEAT					
Application					
30	$/bu.	0.00	1.14	0.94	2.23
50	$/bu.	0.00	0.00	1.04	0.83
70	$/bu.	0.00	0.00	0.00	0.00
100	$/bu.	0.00	0.00	0.00	0.00
COTTON					
Application					
30	$/lb.	0.20	0.21	0.54	0.74
50	$/lb.	0.27	0.30	0.56	0.59
70	$/lb.	0.18	0.21	0.34	0.36
100	$/lb.	0.14	0.16	0.18	0.22

[1]See footnote 1 of Table XXI.

Table XXVI presents data reflecting the composition of Government payments by type of payment and the distribution of Government payments by crops. As the percent of increase in net farm income originating from the Government declined, deficiency payments declined and set-aside payments increased. In general, deficiency payments accounted for the majority of all Government payments ranging from 27.9 percent to 97.5 percent. The extremes occurred in the fourth control period of the 30 application and the fourth control period of the 100 application.

As an example explanation of the distribution data presented in Table XXVI consider the first control period of the 30 application. Of the total Government payments paid to feed grains, wheat and cotton, feed grains received 69.8 percent, wheat 17.5 percent and cotton 12.7 percent. In general, as increases in Government payments were restricted, the relative shares of the Government payments of cotton and wheat were affected less than feed grains. The optimal solutions tended to favor cash crops. As shown in Table XV of Chapter III, a farmer markets directly more wheat and cotton production than feed grains, which can be fed to on-farm livestock. Thus, cash receipts of crops with a high sales proportion were increase more from increased market prices (brought about by increased set-aside rates) than were crops with low sales proportions.

The optimal loan rates for corn, wheat and cotton are given in Table XXVII. In general loan rates tended to

TABLE XXVI

RELATIVE COMPOSITION AND DISTRIBUTION OF GOVERNMENT PAYMENTS FOR 30, 50, 70 AND 100 APPLICATIONS, 1980-83[1]

Item	Unit	1980	1981	1982	1983
COMPOSITION					
Deficiency					
Application					
30	%	94.5	81.0	70.7	27.9
50	%	91.6	86.7	75.1	79.0
70	%	93.7	92.9	92.6	93.4
100	%	95.8	96.4	96.9	97.5
Set-aside					
Application					
30	%	1.9	16.2	29.3	71.7
50	%	3.3	7.1	19.8	16.8
70	%	1.6	2.0	3.4	3.2
100	%	0.2	0.2	0.3	0.4
Storage					
Application					
30	%	3.6	2.8	0.0	0.4
50	%	5.1	6.2	5.1	4.2
70	%	4.7	5.1	4.0	3.4
100	%	4.0	3.4	2.8	2.1
DISTRIBUTION					
Feed Grains in Aggregate					
Application					
30	%	69.8	68.4	61.1	55.5
50	%	73.5	69.1	69.1	72.6
70	%	62.6	72.9	75.8	78.6
100	%	61.7	68.6	74.4	79.2
Wheat					
Application					
30	%	17.5	23.7	16.6	16.6
50	%	16.2	23.6	16.2	14.3
70	%	20.3	20.3	18.6	15.4
100	%	25.6	20.6	16.8	15.1

TABLE XXVI (Continued)

Item	Unit	1980	1981	1982	1983
<u>Cotton</u>					
Application					
30	%	12.7	7.9	22.2	27.7
50	%	10.3	7.3	14.7	13.1
70	%	17.6	6.7	5.5	5.9
100	%	12.8	10.8	8.8	5.6

[1]See footnote 1 of Table XXI.

TABLE XXVII

OPTIMAL LOAN RATES OF CORN, WHEAT AND COTTON FOR 0, 30, 50, 70 AND 100 APPLICATIONS, 1980-83[1]

Item	Unit	1980	1981	1982	1983
Corn					
Application					
0	$/bu.	2.68	2.78	2.79	2.96
30	$/bu.	2.08	2.09	2.11	2.29
50	$/bu.	2.31	2.51	2.61	2.78
70	$/bu.	2.26	2.48	2.52	2.53
100	$/bu.	2.20	2.20	2.32	2.32
Wheat					
Application					
0	$/bu.	2.93	3.15	3.19	3.42
30	$/bu.	2.42	2.62	2.62	2.63
50	$/bu.	2.79	3.09	3.51	3.63
70	$/bu.	2.85	2.90	3.08	3.11
100	$/bu.	2.68	2.73	2.76	2.76
Cotton					
Application					
0	$/lb.	0.52	0.52	0.53	0.54
30	$/lb.	0.38	0.38	0.42	0.42
50	$/lb.	0.48	0.51	0.51	0.56
70	$/lb.	0.45	0.50	0.50	0.51
100	$/lb.	0.38	0.39	0.55	0.44

[1]See footnote 1 of Table XXI.

increase as the percent of the increase in net farm income which could come from Government payments was reduced. This reflected a movement toward price supporting with the farmer-held reserve and CCC stock programs. Stock programs served as "back-ups" to the set-aside program to support prices and incomes. Even though loan rates tend to be higher as the proportion of increased income from the Government declined, there was an exception. Loan rates were lower in the 30 application when compared to the 50 application. In addition to defining price support levels, loan rates define release and call prices of the farmer held reserve program. A type of Government payment, storage payments, is also defined in terms of release and call prices. When the market price of a grain exceeds the release prices for that grain, the Secretary of Agriculture under the provisions of the 1977 Agriculture Act can stop storage payments. This was assumed to occur in this study. By selecting loan rates which defined release prices below market prices, storage payments could be partially or totally eliminated. The ability then exists to increase other forms of Government payments (deficiency and set-aside) which can be used to generate increases in net farm income from the market place.

Table XXVIII presents the contributions to increases in net farm income by net source of increase for the 0, 30, 50, 70, and 100 percent applications. As in the case of the free choice application (Table XX), the three sources of net contributions are Government payments, livestock markets,

TABLE XXVIII

RELATIVE CONTRIBUTIONS TO INCREASE IN NET FARM
NET FARM BY NET SOURCE FOR 0, 30, 50, 70
AND 100 APPLICATIONS, 1980-83[1]

Item	Unit	1980	1981	1982	1983
Government Payments					
Application					
0	%	-27.3	-4.6	-4.1	-3.1
30	%	84.4	38.9	35.5	30.6
50	%	81.7	49.0	48.4	47.9
70	%	91.5	74.7	75.7	73.2
100	%	97.5	96.0	96.7	96.3
Livestock					
Application					
0	%	-27.3	42.2	34.7	47.5
30	%	-3.1	19.5	16.8	30.6
50	%	-2.8	17.6	14.3	20.1
70	%	-1.4	8.8	5.7	9.8
100	%	0.0	2.0	0.0	1.2
Crops					
Application					
0	%	154.6	62.4	69.4	55.6
30	%	18.8	41.6	47.7	38.8
50	%	21.1	33.4	37.1	32.0
70	%	9.9	16.5	18.3	17.0
100	%	2.5	2.0	3.3	2.5

[1]See footnote 1 of Table XXI.

and crop markets. In the 0 application Government payments were actually reduced from baseline levels. This resulted from the fact that baseline Government payments contained some deficiency payments. In this application deficiency payments and set-aside payments were not allowed. The reduction in Government payments were offset by increased market income. As the percent of the increase in net farm income which could originate from Government payments was reduced, the contributions to net farm income of crop and livestock market receipts increased. The net contributions of crop markets to increasing net farm income was much larger than the contributions of livestock markets. The gains made in livestock gross income (livestock cash receipts and small increases in value of home consumption) were offset to a great extent by increases in feed costs. This would be as expected since control variables or policy instruments are associated with crops. Any gains in income accruing to livestock are, as stated above, indirect responses to changing grain prices. These agricultural policy formulations do, however, emphasize that agricultural policy prescriptions must consider the interrelationship among agricultural commodities.

The objective function used in this control study did not include a measure of consumer food costs as a performance variable. The various agricultural policy solutions developed here do, however, have implications upon consumer food costs. As has been seen earlier, as the increase in Government payments was reduced, the optimum solutions reflect policies which increase net farm income from sources originating in the market place. Some retail prices of food items are computed by the model of the system being controlled in this study (POLYSIM). Table XXIX presents selected retail meat prices associated with optimal solutions of the 0, 30, 50, 70 and 100 percent applications. The retail meat prices reflect the indirect response of the livestock sector to increasing grain prices. The increased grain prices reduce livestock production and also the amount of meat available for domestic consumption. The reduction in available meat for consumption increased the retail price of meats.

TABLE XXIX

SIMULATED RETAIL MEAT PRICES FOR 0, 30, 50, 70
AND 100 APPLICATIONS, 1980-83[1]

Item	Unit	1980	1981	1982	1983
Choice Beef					
Application					
0	$/lb.	2.36	2.73	2.79	2.89
30	$/lb.	2.36	2.64	2.71	2.82
50	$/lb.	2.36	2.65	2.71	2.78
70	$/lb.	2.36	2.62	2.67	2.73
100	$/lb.	2.36	2.60	2.65	2.69
Pork					
Application					
0	$/lb.	1.23	1.70	1.78	2.01
30	$/lb.	1.23	1.54	1.68	1.89
50	$/lb.	1.23	1.55	1.68	1.82
70	$/lb.	1.23	1.49	1.61	1.73
100	$/lb.	1.23	1.46	1.58	1.66
Fresh Whole Milk					
Application					
0	$/1/2gal.	1.05	1.27	1.35	1.45
30	$/1/2gal.	1.05	1.21	1.29	1.39
50	$/1/2gal.	1.05	1.22	1.29	1.37
70	$/1/2gal.	1.05	1.20	1.26	1.32
100	$/1/2gal.	1.05	1.18	1.24	1.29

[1]See footnote 1 of Table XXI.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

Problem Statement

Consumers of agricultural commodities or products, agricultural producers and taxpayers view the United States agricultural sector from a different perspective and use different criterion or goal structures to gauge its performance. The goals tend to be conflicting. Consumer groups prefer low food costs. Farm groups want adequate levels of income from the products they produce. Taxpayers are, of course, a subset of both consumer and farm groups, but the vast majority of taxpayers are consumers. The preference of taxpayers are for low federal outlays on Government farm programs. The agricultural policy decision maker must decide upon agricultural policy which considers the various and, in general, conflicting goals of society. Control theory provides a conceptual framework for analyzing and formulating agricultural policy. Multi-period control theory is a planning tool. It provides and considers the basic components of policy decision making whether agricultural or public policy. However, one significant use of control methods has largely been ignored in past control studies. This is the ability of control methodology to facilitate the development of a consensus among decision makers in policy formulation when the preferences of decision makers vary. By exposing multiple policy prescriptions, not just single policy prescriptions, the bargaining process of public decision making can be greatly facilitated.

Objectives

The general objective of this thesis was to demonstrate that control theory can be used to generate economic intelligence in regard to agricultural policy formulation and analysis. Specific objectives were 1) to develop a performance measure which reflects alternative agricultural policy formulations which can occur as the preferences of agricultural policy decision makers vary for obtaining specified goals for annual net farm income and 2) to indicate the sets of agricultural policies that are consistent with the alternative preferences of decision makers for a given economic environment for agriculture. The objectives of this thesis were accomplished by adapting control theory methods to an economic model which simulates the United States agricultural sector. The economic model used was the National Agricultural Policy Simulator Simultaneous Version (POLYSIM).

Methodology

This thesis used deterministic control theory. The methodology includes: 1) the development of a mathematical model of the system or process to be controlled, 2) a mathematical statement of how the performance of the system is to be measured, 3) the selection of the control variables from the set of policy instruments defined in the system and 4) the choice of both the optimization approach and technique to determine an optimal control path.

The system or process to be controlled was the United States agricultural sector as described mathematically by the National Agricultural Policy Simulator Simultaneous Version (POLYSIM). POLYSIM is a Fortran IV computer program that simulates the effects of alternative farm programs and policy instrument levels upon ESCS baseline projections of seven crops (wheat, soybeans, cotton, corn, grain sorghum, oats and barley) and seven livestock groups (beef, hogs, sheep, chickens, turkeys, eggs, and dairy).

The performance of the United States agricultural sector was measured by different parameterizations of a quadratic objective function. Each application of objective function had the same overall objective which was to obtain target levels of net farm income across a 1980-83 control period. The different parameterizations of the objective function reflected different of preferences of decision makers as to source (Government payments and the market place) of increase in net farm income. This use of an objective function can be viewed as defining a policy possibility frontier for obtaining target levels of net farm income.

The policy instruments used in this study as control variables were the target price, set-aside rate, and loan rate of corn, wheat, and cotton. In addition to these control variables, the target price and set-aside rate of barley and grain sorghum were based upon the corresponding corn policy instruments as were the loan rates of barley, grain sorghum, and oats. A farmer-held reserve program was assumed for all feed grains and wheat while a Commodity Credit Corporation stock program was assumed for soybeans and cotton.

The optimization of the different applications of the quadratic objective function was conducted by the Box Complex optimization technique (Box, 1965). The Box Complex optimization technique provides as a simultaneous solution to the control problem. The values for all control variables for all time periods were determined simultaneously.

Results

Six applications of a quadratic objective function to agricultural policy analysis and formulation were conducted for the control period 1980-83. Each application had the same overall objective which was to obtain target levels of net farm income which were 31.6 billion dollars for 1980, 32.9 billion dollars for 1981, 34.2 billion dollars for

1982, and 35.4 billion dollars for 1983. The differences in the applications of the quadratic objective function were in relation to sources of increase in net farm income. One application, the free choice, allowed the determination of an optimal control path which results in any possible combination of increase in Government payments and market income to obtain the target levels of net farm income. In this application of the objective function, Government payments accounted for 87.5, 69.6, 67.7, and 63.6 percent of the increase in net farm income from baseline for the control periods 1980, 1981, 1982, 1983, respectively. Of the two possible sources of increase in market income -- crop markets and livestock markets -- crop markets contributed the most to the increase in net farm income. The contribution of crop markets averaged 23.0 percent of the total increase in net farm income from baseline for all control periods while livestock markets contributed an average of 4.9 percent of the same total increase.

The remaining applications of the quadratic objective function required the determination of optimal control paths which result in exact increases in Government payments and market income. The increases in Government payments were 0, 30, 50, 70, and 100 percent of the total increase in net farm income (baseline to target level)for the respective application. The remaining percentage increase in net farm income would come from the market place.

In these applications of the quadratic objective function, target prices varied directly with the percent of the increase in net farm income which came from Government payments. The applications with the higher Government payments increases had higher target prices.

The objective function optimizing solution for loan rates reflect the reverse pattern of target prices. Higher loan rates were associated with lower levels of Government payments.

Optimal set-aside rates increased as the Government payments component of net farm income was reduced. Set-aside rates increased market income and net farm income in three ways: increased cash receipts from the direct response of crop prices, increased livestock cash receipts from the indirect response of livestock production and prices, and reduction in variable costs of production. However, these cost savings were only in the form of crop variable cost reductions. Livestock variable production costs were increased from baseline levels due to increased grain prices brought about by reduction in grain production.

Grain prices and all other commodity prices were increased as crop production was reduced. Thus, as the allowable increase in Government payments to meet target levels of net farm income was reduced, all model (POLYSIM) crop and livestock prices increased. The increased commodity prices compensated for the changing or varying levels of Government payments in increasing net farm income by increasing market income.

Limitations and Suggestions for Further Research

Richardson (1978) has suggested two major limitations to agricultural policy formulation and analysis with control methods. These are measuring the performance of the system or process to be controlled and developing the mathematical description or statement of the system or process to be controlled.

Since multiple measures of performance were used the problem of performance measurements was mitigated to a great extent in this study. Several optimal control policies were developed which reflected different decision maker preferences. However, all of the different applications of the quadratic criterion function had the same overall objective -- to achieve target levels of net farm income. Other levels of target net farm income levels could be used as well as other performance variables in the quadratic criterion function. Specifically, measures of consumer food costs could be included in the criterion function. The resulting policy solutions and associated simulation results could then be compared to the results of this study.

The development of the mathematical description of system or process to be controlled can be viewed as a limitation of control methods. But, this limitation can also be viewed as having a very positive contribution. When the researcher is forced to model the system, he is learning about the system. The more knowledge known about the system the better the results of policy formulation and analysis with control methods. However, as with many economic models, POLYSIM uses estimated parameters (elasticities, flexibilities and adjustment coefficients) and specifically an ESCS baseline data set. As stated in Chapter III, parameter estimates were obtained from econometric studies and will, in general, not be the true parameter values. The baseline data set used by POLYSIM could be another limitation if it is not a reasonably accurate forecast of supply, use, price and income measures across the control period. Infact, shortly after the control computer "runs" were completed for this study, a major drought (summer 1980) was experienced in the United States which primarily effected the production and prices of corn, soybeans and cotton. In reference to baseline projections for 1980, production projections were too high while price projections were too low. The effects of the 1980 drought will no doubt linger into future time periods which are part of the control or planning horizon used in this study. This baseline error, however, does not mean that agricultural policy analysis and formulation with control theory, such as conducted in this study, is of little use in decision making. It does, however, reflect that the optimal contol policies of this study are deterministic. In the development of control policies of this thesis, stochastic influences (such as weather) were not considered. The agricultural sector of the United States is, without doubt, subject to random shocks. Random shocks to the United States agricultural sector, regardless of origin, can affect the robustness of the policies presented here. The development of stochastic control policies would attempt to account for these stochastic influences which enter the United States Agricultural sector and can affect control policy formulation. Theoretical methodology for dealing with stochastic control problems exists. In general, this methodology is based upon past (before the beginning of the control period) stochastic knowledge and/or stochastic knowledge existing in the control period and assume that performance variables are differentiable with respect to all control variables (Holbrook, 1975; Chow, 1976). For the control problem as formulated in this thesis, this assumption of differentiability is not guaranteed. As an example, deficiency payments which comprise a portion of net farm income are only defined if target prices are above crop market prices. Thus, the solution of a stochastic control problem using the performance variables defined in this thesis would require the development and use of stochastic control methodology not based upon the differentiability assumption. One form of stochastic control methodology, adaptive, adjusts the optimal control paths across the planning horizon to reflect new information about stocastic influences. Adaptive control methods could be, given a solution to the differentiation problem discussed above is found, the most "fruitful" control method to apply to agricultural policy analysis and formulation problems.

In considering these limitations, this researcher proposes that "long-term" or multiple period optimal control policies should be used in tandem with adaptive control policies. Adaptive control policies would modify the "long-term" optimal control solution to reflect new information. Thus, the control results of this study can be viewed as a first step to agricultural policy formulation and analysis with control methods.

Conclusions

Control theory can be used to generate economic intelligence in regard to agricultural policy analysis and formulation. The ability to develop agricultural policy which aligns with decision maker preferences on source of increase in net farm income exists as shown in this study. Even though, no one policy decision maker's preferences may align exactly with one of the solutions presented here, the solutions presented in this study could be used in this situation. For the decision maker with preferences other than represented in this study, the optimal control solutions of this study can represent reference or starting points in formulating their policy prescription. As an example consider a decision maker(s) with preferences for the same overall target levels of net farm income used in this study, but with preferences for increases in market income sources and Government payments to meet target net farm income levels other than used in this study. By analyzing the optimal control policies of this study which bound their preferences, decision maker(s) could use the optimal control policies of this study to formulate what their policy prescription should be.

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APPENDIXES

APPENDIX A

LISTING OF COMPUTER PROGRAMMING ADDED TO POLYSIM FOR CONTROL APPLICATION

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         000000000111111111122222222223333333333444444444455555555556666666666777777777778
         123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890
CARD
      BLOCK DATA                                                        00000100
      COMMON /BLK7/ NB1(34),NB2(06),NB3(13),NB4(07),NB5(07)             00000200
      DATA NB1/238,239,240,102,84,38,30,264,26,242,243,244,103,246,248, 00000300
     1105,250,252,104,241,22,245,249,253,227,42,228,229,230,99,193,     00000400
     285,76,55/                                                         00000500
      DATA NB2/32,40,36,28,24,44/                                       00000600
      DATA NB3/31,39,263,27,231,232,233,234,235,236,193,85,23/          00000700
      DATA NB4/27,102,26,103,105,104,28/                                00000800
      DATA NB5/12,54,55,61,117,62,56/                                   00000900
      END                                                               00001000
      COMMON /BLK1/ C(14,360),B(14,350),C1(14,50),R(14,350),EXOG(14,240)00001100
     1,OLDEXO(14,240),NGAUSS(14,3),NF1(40),NBAR(7)                      00001200
      DOUBLE PRECISION C,B,C1,R,EXOG,OLDEXO                             00001300
      COMMON /BLK2/ E(275),ADJ(100),CONST(120),EE(275),DM(7,9),PM(7,9)  00001400
      COMMON /BLK3/ ACRE(14,30),YIELD(16,7),DUM(14,7)                   00001500
      DOUBLE PRECISION ACRE                                             00001600
      COMMON /BLK4/ KPAR(350),KRAY(350),KGR(200),KDR(200),INDE1(200)    00001700
     1,INDE2(200),INDE3(200),INDE4(200),INDE5(350),INDE6(350),NYEAR(10) 00001800
      INTEGER US(33,20),SIMNAM(20)                                      00001900
      COMMON /BLK5/ US,SIMNAM                                           00002000
      INTEGER SUMFIL(160),SUMTAB(160,6),SUMF(160)                       00002100
      COMMON /BLK6/ SUMFIL,SUMTAB,SUMF,NAAA                             00002200
      COMMON /BLK7/ NB1(34),NB2(06),NB3(13),NB4(07),NB5(07)             00002300
      COMMON/BLK8/  LFM,NPRB,IEN,IFSTYR,ISIMND,IMONTH,IDAY,IBASYR,NPRE, 00002400
     1NESTOR,KING,NPRDM,IDROP,IFLAG,NFSTST,NSANDY,NSUZY,IHOLD1,NSANDI   00002500
     3,NRPB,INDXX                                                       00002600
      COMMON /BLK9/ NC,N,NZZ2,IVAL                                      00002700
      INTEGER DIVAC,TARGET,FREMKT                                       00002800
      COMMON /BLK10/ DIVAC,TARGET,FREMKT,LOAN,IAJSET,JA73,JLRPOL,NSUPFG,00002900
     1JSUPCU,JSUPWH,JSUPSO,IAJLOT,IAPART                                00003000
      COMMON /BLK11/ I,J,NOBS,NOB,NSHOOT,NOEX,NERD                      00003100
      COMMON /BLK12/ DUMP1(14,7),DUMP2(14,7),DUMP5(14,7),DUMP6(14,7)    00003200
      DOUBLE PRECISION DUMP1,DUMP2,DUMP5,DUMP6                          00003300
      COMMON /BLK13/ KROP(7,14),J37                                     00003400
      COMMON /BLK14/ IDATA(4,350),CDATA(14,100),INTER,NTER              00003500
      COMMON /BLK25/ ITMAX,IQ,NO,GAMMA,IBASE,KODE,IPRINT,IC,BEG,END,    00003600
     1BEG2,M,K,IEV1,IEV2,K1,N2,M2,N22(20),M22(20)                       00003700
      INTEGER GAMMA,BEG,END,BEG2                                        00003800
      COMMON /BLK26/ R1(60,60),X(60,150),F(60),G(150),H(150),XC(100),   00003900
     1GL(99),HL(99),H1(12,12),A(12),GH1(60,4,10),ALPHA,BETA,DELTA       00004000
      DOUBLE PRECISION R1,X,F,G,H,GL,HL,H1,A,ALPHA,BETA,DELTA           00004100
      DEFINE FILE 10(999,90,U,JNEXT)                                    00004200
      DEFINE FILE 11(50,700,U,JNEWT)                                    00004300
      DEFINE FILE 12(100,200,U,JENB)                                    00004400
12345 FORMAT(1H0, 'POLYSIM     MAIN    BEGUN')                          00004500
    2 FORMAT(' ','ITERATION NUMBER ',I4)                                00004600
      WRITE(8,12345)                                                    00004700
      CALL INT1                                                         00004800
      DO 1900  LFM=1,100                                                00004900
  200 CALL INITAL                                                       00005000
      CALL INT2                                                         00005100
      IF(IFLAG.EQ.5) GO TO 200                                          00005200
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC00005300
C                                                                       00005400
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000000000111111111122222222223333333333444444444455555555556666666666777777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
C                                                                       00005500
      CALL CONTR                                                        00005600
C                                                                       00005700
C                                                                       00005800
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC00005900
      CALL NUMIT                                                        00006000
      CALL PRICED                                                       00006100
      IF(NOB.LE.5) CALL WRITE                                           00006200
      IF(NOB.LE.5) CALL WRITE1                                          00006300
      IF(NOB.LE.5) CALL WRITE5                                          00006400
      IF(NOB.LE.5) CALL WRITE6                                          00006500
      IF(NOB.LE.5) CALL WRITE3                                          00006600
      IF(NOB.LE.5) CALL WRITE4                                          00006700
 1900 CONTINUE                                                          00006800
        STOP                                                            00006900
       END                                                              00007000
      SUBROUTINE CENTR                                                  00007100
      COMMON /BLK25/ ITMAX,IQ,NO,GAMMA,IBASE,KODE,IPRINT,IC,BEG,END,    00007200
     1BEG2,M,K,IEV1,IEV2,K1,N2,M2,N22(20),M22(20)                       00007300
      INTEGER GAMMA,BEG,END,BEG2                                        00007400
      COMMON /BLK26/ R1(60,60),X(60,150),F(60),G(150),H(150),XC(100),   00007500
     1GL(99),HL(99),H1(12,12),A(12),GH1(60,4,10),ALPHA,BETA,DELTA       00007600
      DOUBLE PRECISION R1,X,F,G,H,GL,HL,H1,A,ALPHA,BETA,DELTA           00007700
 1234 FORMAT(' ',2X, 'SUBROUTINE CENTR')                                00007800
      NDEBUG=0                                                          00007900
      IF(NDEBUG.NE.0) WRITE(6,1234)                                     00008000
      DO 20  J=BEG,END                                                  00008100
      XC(J) = 0.0                                                       00008200
      DO 10  IL=1,K1                                                    00008300
   10 XC(J) = XC(J) + X(IL,J)                                           00008400
      RK = K1                                                           00008500
   20 XC(J) = (XC(J)-X(IEV1,J))/(RK-1.0)                                00008600
      RETURN                                                            00008700
      END                                                               00008800
      SUBROUTINE CHECK                                                  00008900
      COMMON /BLK11/ I,J,NOBS,NOB,NSHOOT,NOEX,NERD                      00009000
      COMMON /BLK25/ ITMAX,IQ,NO,GAMMA,IBASE,KODE,IPRINT,IC,BEG,END,    00009100
     1BEG2,M,K,IEV1,IEV2,K1,N2,M2,N22(20),M22(20)                       00009200
      INTEGER GAMMA,BEG,END,BEG2                                        00009300
      COMMON /BLK26/ R1(60,60),X(60,150),F(60),G(150),H(150),XC(100),   00009400
     1GL(99),HL(99),H1(12,12),A(12),GH1(60,4,10),ALPHA,BETA,DELTA       00009500
      DOUBLE PRECISION R1,X,F,G,H,GL,HL,H1,A,ALPHA,BETA,DELTA           00009600
    1 FORMAT( ' ',2I4,3F15.4)                                           00009700
 1234 FORMAT(' ',2X, 'SUBROUTINE CHECK')                                00009800
      NDEBUG=0                                                          00009900
      IF(NDEBUG.NE.0) WRITE(6,1234)                                     00010000
      ICOUNT=0                                                          00010100
   10 KT = 0                                                            00010200
      ICOUNT=1+ ICOUNT                                                  00010300
      CALL CONSTT                                                       00010400
C     CHECK AGAINST EXPLICIT CONSTRAINTS                                00010500
      DO 50 J=BEG,END                                                   00010600
      IF (X(I,J)-G(J)) 20,20,30                                         00010700
   20 X(I,J) = G(J) + DELTA                                             00010800
```

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000000000111111111122222222223333333333444444444455555555556666666666777777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
      GO TO 50                                                          00010900
   30 IF (H(J)-X(I,J)) 40,40,50                                         00011000
   40 X(I,J) = H(J) - DELTA                                             00011100
   50 CONTINUE                                                          00011200
      IF (KODE) 110,110,60                                              00011300
C     CHECK AGAINST THE IMPLICIT CONSTRAINTS                            00011400
   60 NN = END + 1                                                      00011500
      DO 100 J=NN,M                                                     00011600
      CALL CONSTT                                                       00011700
      IF(NDEBUG.NE.0) WRITE(6,1) J,I,X(I,J),G(J), H(J)                  00011800
      IF (X(I,J)-G(J)) 80,70,70                                         00011900
   70 IF (H(J)-X(I,J)) 80,100,100                                       00012000
   80 IEV1 = I                                                          00012100
      KT = 1                                                            00012200
      CALL CENTR                                                        00012300
      DO 90 JJ=BEG,END                                                  00012400
      X(I,JJ) = (X(I,JJ) + XC(JJ))/2.0                                  00012500
   90 CONTINUE                                                          00012600
  100 CONTINUE                                                          00012700
      IF (KT) 110, 110, 10                                              00012800
  110 RETURN                                                            00012900
      END                                                               00013000
      SUBROUTINE CONSTT                                                 00013100
C     SUBROUTINE CONSTT IS PROVIDED FOR THE USER TO ENTER THE           00013200
C     LOWER & UPPER BOUNDARY CONSTRAINTS FOR THE CONTROL VARIABLES.     00013300
C     THE LOWER BOUNDARY CONSTRAINTS ARE ENTERED IN THE 'G()' ARRAY,    00013400
C     AND THE UPPER BOUNDAYR CONSTRAINTS ARE ENTERED IN THE 'H()' ARRAY.00013500
      COMMON /BLK1/ C(14,360),B(14,350),C1(14,50),R(14,350),EXOG(14,240)00013600
     1,OLDEXO(14,240),NGAUSS(14,3),NF1(40),NBAR(7)                      00013700
      DOUBLE PRECISION C,B,C1,R,EXOG,OLDEXO                             00013800
      COMMON /BLK11/ I,J,NOBS,NOB,NSHOOT,NOEX,NERD                      00013900
      COMMON /BLK25/ ITMAX,IQ,NO,GAMMA,IBASE,KODE,IPRINT,IC,BEG,END,    00014000
     1BEG2,M,K,IEV1,IEV2,K1,N2,M2,N22(20),M22(20)                       00014100
      INTEGER GAMMA,BEG,END,BEG2                                        00014200
      COMMON /BLK26/ R1(60,60),X(60,150),F(60),G(150),H(150),XC(100),   00014300
     1GL(99),HL(99),H1(12,12),A(12),GH1(60,4,10),ALPHA,BETA,DELTA       00014400
      DOUBLE PRECISION R1,X,F,G,H,GL,HL,H1,A,ALPHA,BETA,DELTA           00014500
 1234 FORMAT(' ',2X, 'SUBROUTINE CONSTT')                               00014600
      NDEBUG=0                                                          00014700
      IF(NDEBUG.NE.0) WRITE(6,1234)                                     00014800
      DO 100 J1=1,END                                                   00014900
C     LOWER BOUNDARY CONSTRAINTS.                                       00015000
      G(J1)=GL(J1)                                                      00015100
C     UPPER BOUNDARY CONSTRAINTS.                                       00015200
      H(J1)=HL(J1)                                                      00015300
  100 CONTINUE                                                          00015400
      X(I,37)=EXOG(3,225)*X(I,1)-X(I,13)                                00015500
      X(I,38)=EXOG(4,225)*X(I,2)-X(I,14)                                00015600
      X(I,39)=EXOG(5,225)*X(I,3)-X(I,15)                                00015700
      X(I,40)=EXOG(6,226)*X(I,4)-X(I,16)                                00015800
      G(37)=0.0                                                         00015900
      G(38)=0.0                                                         00016000
      G(39)=0.0                                                         00016100
      G(40)=0.0                                                         00016200
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00000000011111111112222222222333333333344444444445555555555666666666677777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
      H(37)=3.0                                                         00016300
      H(38)=3.0                                                         00016400
      H(39)=3.0                                                         00016500
      H(40)=3.0                                                         00016600
      X(I,41)=EXOG(3,226)*X(I,5)-X(I,17)                                00016700
      X(I,42)=EXOG(4,226)*X(I,6)-X(I,18)                                00016800
      X(I,43)=EXOG(5,226)*X(I,7)-X(I,19)                                00016900
      X(I,44)=EXOG(6,226)*X(I,8)-X(I,20)                                00017000
      G(41)=0.0                                                         00017100
      G(42)=0.0                                                         00017200
      G(43)=0.0                                                         00017300
      G(44)=0.0                                                         00017400
      H(41)=3.0                                                         00017500
      H(42)=3.0                                                         00017600
      H(43)=3.0                                                         00017700
      H(44)=3.0                                                         00017800
      X(I,45)=EXOG(3,227)*X(I,9)- X(I,21)                               00017900
      X(I,46)=EXOG(4,227)*X(I,10)-X(I,22)                               00018000
      X(I,47)=EXOG(5,227)*X(I,11)-X(I,23)                               00018100
      X(I,48)=EXOG(6,227)*X(I,12)-X(I,24)                               00018200
      G(45)=0.0                                                         00018300
      G(46)=0.0                                                         00018400
      G(47)=0.0                                                         00018500
      G(48)=0.0                                                         00018600
      H(45)=2.0                                                         00018700
      H(46)=2.0                                                         00018800
      H(47)=2.0                                                         00018900
      H(48)=2.0                                                         00019000
      X(I,49)=X(I,17)-X(I,13)                                           00019100
      X(I,50)=X(I,18)-X(I,14)                                           00019200
      X(I,51)=X(I,19)-X(I,15)                                           00019300
      X(I,52)=X(I,20)-X(I,16)                                           00019400
      G(49)=0.0                                                         00019500
      G(50)=0.0                                                         00019600
      G(51)=0.0                                                         00019700
      G(52)=0.0                                                         00019800
      H(49)=3.0                                                         00019900
      H(50)=3.0                                                         00020000
      H(51)=3.0                                                         00020100
      H(52)=3.0                                                         00020200
      X(I,53)=X(I,5)-X(I,1)                                             00020300
      X(I,54)=X(I,6)-X(I,2)                                             00020400
      X(I,55)=X(I,7)-X(I,3)                                             00020500
      X(I,56)=X(I,8)-X(I,4)                                             00020600
      G(53)=0.0                                                         00020700
      G(54)=0.0                                                         00020800
      G(55)=0.0                                                         00020900
      G(56)=0.0                                                         00021000
      H(53)=3.0                                                         00021100
      H(54)=3.0                                                         00021200
      H(55)=3.0                                                         00021300
      H(56)=3.0                                                         00021400
      X(I,57)=X(I,14)-X(I,13)                                           00021500
      X(I,58)=X(I,15)-X(I,14)                                           00021600
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    12345678901234567890123456789012345678901234567890123456789012345678901234567890
CARD
          X(I,59)=X(I,16)-X(I,15)                                               00021700
          G(57)=0.0                                                             00021800
          G(58)=0.0                                                             00021900
          G(59)=0.0                                                             00022000
          H(57)=3.0                                                             00022100
          H(58)=3.0                                                             00022200
          H(59)=3.0                                                             00022300
          X(I,60)=X(I,18)-X(I,17)                                               00022400
          X(I,61)=X(I,19)-X(I,18)                                               00022500
          X(I,62)=X(I,20)-X(I,19)                                               00022600
          G(60)=0.0                                                             00022700
          G(61)=0.0                                                             00022800
          G(62)=0.0                                                             00022900
          H(60)=3.0                                                             00023000
          H(61)=3.0                                                             00023100
          H(62)=3.0                                                             00023200
          X(I,63)=X(I,22)-X(I,21)                                               00023300
          X(I,64)=X(I,23)-X(I,22)                                               00023400
          X(I,65)=X(I,24)-X(I,23)                                               00023500
          G(63)=0.0                                                             00023600
          G(64)=0.0                                                             00023700
          G(65)=0.0                                                             00023800
          H(63)=3.0                                                             00023900
          H(64)=3.0                                                             00024000
          H(65)=3.0                                                             00024100
          X(I,66)=X(I,26)-X(I,25)                                               00024200
          X(I,67)=X(I,27)-X(I,26)                                               00024300
          X(I,68)=X(I,28)-X(I,27)                                               00024400
          G(66)=0.0                                                             00024500
          G(67)=0.0                                                             00024600
          G(68)=0.0                                                             00024700
          H(66)=.5                                                              00024800
          H(67)=.5                                                              00024900
          H(68)=.5                                                              00025000
          X(I,69)=X(I,30)-X(I,29)                                               00025100
          X(I,70)=X(I,31)-X(I,30)                                               00025200
          X(I,71)=X(I,32)-X(I,31)                                               00025300
          G(69)=0.0                                                             00025400
          G(70)=0.0                                                             00025500
          G(71)=0.0                                                             00025600
          H(69)=.5                                                              00025700
          H(70)=.5                                                              00025800
          H(71)=.5                                                              00025900
          X(I,72)=X(I,34)-X(I,33)                                               00026000
          X(I,73)=X(I,35)-X(I,34)                                               00026100
          X(I,74)=X(I,36)-X(I,35)                                               00026200
          G(72)=0.0                                                             00026300
          G(73)=0.0                                                             00026400
          G(74)=0.0                                                             00026500
          H(72)=.5                                                              00026600
          H(73)=.5                                                              00026700
          H(74)=.5                                                              00026800
          RETURN                                                                00026900
          END                                                                   00027000
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00000000011111111112222222222333333333344444444445555555555666666666677777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
      SUBROUTINE CONTR                                                  00027100
      COMMON /BLK1/ C(14,360),B(14,350),C1(14,50),R(14,350),EXOG(14,240)00027200
     1,OLDEXO(14,240),NGAUSS(14,3),NF1(40),NBAR(7)                      00027300
      DOUBLE PRECISION C,B,C1,R,EXOG,OLDEXO                             00027400
      COMMON /BLK2/ E(275),ADJ(100),CONST(120),EE(275),DM(7,9),PM(7,9)  00027500
      COMMON /BLK3/ ACRE(14,30),YIELD(16,7),DUM(14,7)                   00027600
      DOUBLE PRECISION ACRE                                             00027700
      COMMON /BLK4/ KPAR(350),KRAY(350),KGR(200),KDR(200),INDE1(200)    00027800
     1,INDE2(200),INDE3(200),INDE4(200),INDE5(350),INDE6(350),NYEAR(10) 00027900
      INTEGER US(33,20),SIMNAM(20)                                      00028000
      COMMON /BLK5/ US,SIMNAM                                           00028100
      INTEGER SUMFIL(160),SUMTAB(160,6),SUMF(160)                       00028200
      COMMON /BLK6/ SUMFIL,SUMTAB,SUMF,NAAA                             00028300
      COMMON /BLK7/ NB1(34),NB2(06),NB3(13),NB4(07),NB5(07)             00028400
      COMMON/BLK8/  LFM,NPRB,IEN,IFSTYR,ISIMND,IMONTH,IDAY,IBASYR,NPRE, 00028500
     1NESTOR,KING,NPRDM,IDROP,IFLAG,NFSTST,NSANDY,NSUZY,IHOLD1,NSANDI   00028600
     3,NRPB,INDXX                                                       00028700
      COMMON /BLK9/ NC,N,NZZ2,IVAL                                      00028800
      INTEGER DIVAC,TARGET,FREMKT                                       00028900
      COMMON /BLK10/ DIVAC,TARGET,FREMKT,LOAN,IAJSET,JA73,JLRPOL,NSUPFG,00029000
     1JSUPCO,JSUPWH,JSUPSO,IAJLOT,IAPART                                00029100
      COMMON /BLK11/ I,J,NOBS,NOB,NSHOOT,NOEX,NERD                      00029200
      COMMON /BLK12/ DUMP1(14,7),DUMP2(14,7),DUMP5(14,7),DUMP6(14,7)    00029300
      DOUBLE PRECISION DUMP1,DUMP2,DUMP5,DUMP6                          00029400
      COMMON /BLK13/ KROP(7,14),J37                                     00029500
      COMMON /BLK14/ IDATA(4,350),CDATA(14,100),INTER,NTER              00029600
      COMMON /BLK20/ AE(7,8),BE(7,8),NG(160)                            00029700
      COMMON /BLK25/ ITMAX,IQ,NO,GAMMA,IBASE,KODE,IPRINT,IC,BEG,END,    00029800
     1BEG2,M,K,IEV1,IEV2,K1,N2,M2,N22(20),M22(20)                       00029900
      INTEGER GAMMA,BEG,END,BEG2                                        00030000
      COMMON /BLK26/ R1(60,60),X(60,150),F(60),G(150),H(150),XC(100),   00030100
     1GL(99),HL(99),H1(12,12),A(12),GH1(60,4,10),ALPHA,BETA,DELTA       00030200
      DOUBLE PRECISION R1,X,F,G,H,GL,HL,H1,A,ALPHA,BETA,DELTA           00030300
      DOUBLE PRECISION DUMMY                                            00030400
      DOUBLE PRECISION RANDOM                                           00030500
      DOUBLE PRECISION RNDM                                             00030600
      NDEBUG=0                                                          00030700
    3 FORMAT (' ',I4,10(10F10.5,/))                                     00030800
    7 FORMAT('0',T8,'J',T17,'                ',T42,'X(1,J)',T59,'G(J)', 00030900
     1 T74,'H(J)')                                                      00031000
    8 FORMAT(' ',//, ' THE USER PROVIDED VALUES FOR POINTS 1-K')        00031100
   10 FORMAT (1H1,//,18X,24HCOMPLEX PROCEDURE OF BOX)                   00031200
   11 FORMAT(' ',/,T3,'PARAMETERS',/                                    00031300
     1,T5,'NO. OF EXPLICIT CONTROL VAR(N) =',I4,/                       00031400
     1,T5,'NO. OF IMPLICIT CONTROL VAR(IC =',I4,/                       00031500
     3,T5,'NO. OF TOTAL    CONTROL VAR(M) =',I4,//                      00031600
     3,T5,'NO. OF POINTS ON SURFACE(K)    =',I4,/                       00031700
     3,T5,'NO. OF MAXIMUM ITERATION(ITMAX)=',I4,/                       00031800
     3,T5,'NO. OF REPEAT ITERATIONS(GAMMA)=',I4,//                      00031900
     3,T5,'REFLECTION FACTOR     (ALPHA)   =', F6.2,/                   00032000
     3,T5,'DEGREE OF ACCURACY    (BETA)    =', F6.2    ,/               00032100
     3,T5,'WITHIN BOUNDS ADJUST  (DELTA)   =', F8.4,/        )          00032200
   12 FORMAT (//,2X,14HRANDOM NUMBERS)                                  00032300
   13 FORMAT (/,3(2X,2HR(,I2,1H,,I2,4H) = ,F6.4,2X))                    00032400
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12345678901234567890123456789012345678901234567890123456789012345678901234567890
   14 FORMAT (///,2X,30HFINAL VALUE OF THE FUNCTION = ,E20.8)                00032500
   15 FORMAT (//,2X,14HFINAL X VALUES)                                       00032600
   16 FORMAT (/,2X,2HX(,I2,4H) = ,4X,20X,F30.10,10X,I4)                      00032700
   17 FORMAT (///,2X,38HTHE NUMBER OF ITERATIONS HAS EXCEEDED ,I4,10X,       00032800
     118HPROGRAM TERMINATED)                                                 00032900
   18 FORMAT(' ', ' RANDOM NO. SEED IS = ',2X,F12.0  ,/)                     00033000
   19 FORMAT('1',' JOB TERMINATED BECAUSE CARDS FOR COMPLX ARE OUT OF OR00033100
     1DER')                                                                  00033200
C     READ THE I-O CARD                                                      00033300
C     READ THE PARAMETER CARD.                                               00033400
      NO=6                                                                   00033500
      NI=9                                                                   00033600
      READ(NI,001) M2,N2,IPRINT,NDEBUG,IBASE                                 00033700
      READ(NI,002) ALPHA,BETA,DELTA,GAMMA,ITMAX                              00033800
    1 FORMAT(20I4)                                                           00033900
      READ(NI,001) (M22(J1),J1=1,M2)                                         00034000
      READ(NI,001) (N22(J1),J1=1,N2)                                         00034100
    2 FORMAT(3F10.0,2I4)                                                     00034200
      N=N2*NOB                                                               00034300
      END=N2*NOB                                                             00034400
    4 FORMAT(8F10.0)                                                         00034500
      J8=N2*NOB                                                              00034600
      J6=M2*NOB                                                              00034700
      J7=N2*NOB*2                                                            00034800
      DO 3004 J1=1,J6                                                        00034900
 3004 READ(NI,005) (H1(J1,J2),J2=1,J6)                                       00035000
    5 FORMAT(12F6.0)                                                         00035100
      READ(NI,005) (A(J1),J1=1,J6)                                           00035200
      READ(NI,004) (HL(J1),J1=1,J8)                                          00035300
      READ(NI,004) (GL(J1),J1=1,J8)                                          00035400
      BEG=1                                                                  00035500
C     N IS NO. OF EXPLICIT IND. VARIABLES.                           60      00035600
      N=END                                                                  00035700
C     M IS NO. OF IMPLICIT & EXPLICIT CONTROL VARIABLES                      00035800
      M=END+47                                                               00035900
      M=END+20                                                               00036000
      M=END+29                                                               00036100
      M=END+36                                                               00036200
      M=END+18                                                               00036300
      KODE=1                                                                 00036400
      BEG2=END+1                                                             00036500
C     IC IS NO. OF IMPLICIT CONTROL VARIABLES IC=M-N                         00036600
      IC=M-END                                                               00036700
C     K IS NO. OF POINTS ON THE COMPLEX.                             30 MAX00036800
      K=END+ 1                                                               00036900
C     PRINT THE PARAMETER SUMMARY                                            00037000
      WRITE (NO,010)                                                         00037100
      WRITE(6,11) N,IC,M,K,ITMAX,GAMMA,ALPHA,BETA,DELTA                      00037200
      WRITE(NO,3005)                                                         00037300
      DO 820 J2=1,J6                                                         00037400
      WRITE(NO,830) J2,J2,H1(J2,J2)                                          00037500
  820 CONTINUE                                                               00037600
      WRITE(NO,3006)                                                         00037700
      DO 3007 J1=1,M2                                                        00037800
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000000000111111111122222222223333333333444444444455555555556666666666777777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
      DO 3007 J2=3,NOBS                                                 00037900
      J3=J2-2 +(J1-1)*NOB                                               00038000
 3007 WRITE(NO,3008)    J2,M22(J1), A(J3)                               00038100
      WRITE(NO,3010)                                                    00038200
      DO 3011 J1=1,N2                                                   00038300
      DO 3011 J2=3,NOBS                                                 00038400
      J3=J2-2 +(J1-1)*NOB                                               00038500
 3011 WRITE(NO,3012) J2,N22(J1),GL(J3),HL(J3)                           00038600
  830 FORMAT(/,2X,2HH(,I2,1H,,I2,4H) = ,E10.4)                          00038700
 3008 FORMAT('0','C( ',I2,1H,,I3,4H) = ,F20.6)                          00038800
 3010 FORMAT('1','CONSTRAINT INFORMATION')                              00038900
 3012 FORMAT('0',2X,'EXOG(',I2,',',I3,2X,'LOWER BOUND = ',F16.3,        00039000
     1 2X,'UPPER BOUND = ',F16.3)                                       00039100
 3006 FORMAT('0','THE TARGET VALUES FOR PERFORMANCE VARIABLES')         00039200
 3005 FORMAT('1','THE WEIGHTING MATRIX ')                               00039300
C       ZERO OUT THE X MATRIX                                           00039400
      DO 41 II=1,K                                                      00039500
      DO 31 J=BEG,M                                                     00039600
   31 X(II,J) = 0.0                                                     00039700
   41 CONTINUE                                                          00039800
      IF(IBASE.NE.1) GO TO 450                                          00039900
      WRITE(6,8)                                                        00040000
      DO 425 L=1,K                                                      00040100
      READ(NI,004) (X(L,J),J=BEG,END)                                   00040200
  425 WRITE(6,3) L, (X(L,J),J=BEG,END)                                  00040300
      GO TO 210                                                         00040400
  450 CONTINUE                                                          00040500
      IF(IBASE.NE.2) GO TO 210                                          00040600
      DO 337 J1=1,3                                                     00040700
  337 READ(NI,004) (X(J1,J2),J2=1,END)                                  00040800
      DO 338 I=1,3                                                      00040900
  338 CALL CONSTT                                                       00041000
      WRITE(6,7)                                                        00041100
      J1=1                                                              00041200
      J2=2                                                              00041300
      J3=3                                                              00041400
      DO 250 J=BEG,M                                                    00041500
  250 WRITE(NO,006) J1,J,X(J1,J),J2,J,X(J2,J),J3,J,X(J3,J),J,G(J),J,H(J)00041600
    6 FORMAT(/,3(2X,2HX(,I1,1H,,I3,4H) = ,F10.3),2X,2HG(,I3,4H) = ,F10.300041700
     1,2X,2HH(,I3,4H) = ,F10.3)                                         00041800
      IF(IBASE.EQ.3) GO TO 210                                          00041900
      XXX=RANDOM(DUMMY)                                                 00042000
      DO 100 II=1,K                                                     00042100
      DO 100 JJ=BEG,END                                                 00042200
      R1(II,JJ)=RNDM(DUMMY)                                             00042300
  100 CONTINUE                                                          00042400
      WRITE (NO,012)                                                    00042500
      DO 200  J=1,K                                                     00042600
      WRITE(NO,013) (J,L,R1(J,L),L=BEG,END)                             00042700
  200 CONTINUE                                                          00042800
  210 CONTINUE                                                          00042900
C     CALL SUBROUTINE CONSX TO BEGIN OPTIMTZATION.                      00043000
      CALL CONSX                                                        00043100
C     RETURN EITHER WITH OPTIMAL SOLUTION OR AFTER GOING TO THE MAX ITER00043200
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12345678901234567890123456789012345678901234567890123456789012345678901234567890
      IF (IQ-ITMAX) 20,20,30                                            00043300
   20 WRITE (NO,014) F(IEV2)                                            00043400
      WRITE (NO,015)                                                    00043500
C     WRITE OPTIMAL VALUES OF THE CONTROL VARIABLES.                    00043600
      DO 300 J=BEG,M                                                    00043700
      L=J+2                                                             00043800
      WRITE (NO,016) J,                     X(IEV2,J)                   00043900
  300 CONTINUE                                                          00044000
      DO 7000 J1=1,N2                                                   00044100
      DO 7000 J2=3,NOBS                                                 00044200
      J3=J2-2 + (J1-1)*NOB                                              00044300
      EXOG(J2,N22(J1))=X(IEV2,J3)                                       00044400
 7000 CONTINUE                                                          00044500
      CALL FUNC                                                         00044600
      GO TO 999                                                         00044700
C     MAX NO. OF ITERATIONS EXCEEDED SO PRINT THE VALUES OF THE CONTROLS00044800
   30 WRITE (NO,017) ITMAX                                              00044900
      NO=8                                                              00045000
      DO 850 I=1,K                                                      00045100
      DO 900 J=BEG,M                                                    00045200
      L=J+2                                                             00045300
      WRITE (NO,016) J,                     X(I,J) ,I                   00045400
  900 CONTINUE                                                          00045500
  850 CONTINUE                                                          00045600
      NO=6                                                              00045700
C     STORE THE POINTS ON DISK FOR COLD START .'0003' IN CC 28-32 I=0 CD00045800
      DO 875 IKK=1,K                                                    00045900
  875 WRITE(12' IKK) (X(IKK,L),L=1,M)                                   00046000
      DO 7099 J1=1,N2                                                   00046100
      DO 7099 J2=3,NOBS                                                 00046200
      J3=J2-2  +(J1-1)*NOB                                              00046300
 7099 EXOG(J2,N22(J1))=X(IEV2,J3)                                       00046400
      CALL FUNC                                                         00046500
  999 CONTINUE                                                          00046600
      RETURN                                                            00046700
      END                                                               00046800
      SUBROUTINE CONSX                                                  00046900
      COMMON /BLK1/ C(14,360),B(14,350),C1(14,50),R(14,350),EXOG(14,240)0004700C
     1,OLDEXO(14,240),NGAUSS(14,3),NF1(40),NBAR(7)                      0004710C
      DOUBLE PRECISION C,B,C1,R,EXOG,OLDEXO                             0004720C
      COMMON /BLK2/ E(275),ADJ(100),CONST(120),EE(275),DM(7,9),PM(7,9)  0004730C
      COMMON /BLK3/ ACRE(14,30),YIELD(16,7),DUM(14,7)                   0004740C
      DOUBLE PRECISION ACRE                                             0004750C
      COMMON /BLK4/ KPAR(350),KRAY(350),KGR(200),KDR(200),INDE1(200)    00047600
     1,INDE2(200),INDE3(200),INDE4(200),INDE5(350),INDE6(350),NYEAR(10) 00047700
      INTEGER US(33,20),SIMNAM(20)                                      00047800
      COMMON /BLK5/ US,SIMNAM                                           00047900
      INTEGER SUMFIL(160),SUMTAB(160,6),SUMF(160)                       00048000
      COMMON /BLK6/ SUMFIL,SUMTAB,SUMF,NAAA                             00048100
      COMMON /BLK7/ NB1(34),NB2(06),NB3(13),NB4(07),NB5(07)             00048200
      COMMON/BLK8/  LFM,NPRB,IEN,IFSTYR,ISIMND,IMONTH,IDAY,IBASYR,NPRE, 00048300
     1NESTOR,KING,NPRDM,IDROP,IFLAG,NFSTST,NSANDY,NSUZY,IHOLD1,NSANDI   00048400
     3,NRPB,INDXX                                                       00048500
      COMMON /BLK9/ NC,N,NZZ2,IVAL                                      00048600
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      00000000011111111112222222222333333333344444444445555555555666666666677777777778
      12345678901234567890123456789012345678901234567890123456789012345678901234567890
            INTEGER DIVAC,TARGET,FREMKT                                         00048700
            COMMON /BLK10/ DIVAC,TARGET,FREMKT,LOAN,IAJSET,JA73,JLRPOL,NSUPFG,00048800
           1JSUPCO,JSUPWH,JSUPSO,IAJLOT,IAPART                                  00048900
            COMMON /BLK11/ I,J,NOBS,NOB,NSHOOT,NOEX,NERD                        00049000
            COMMON /BLK12/ DUMP1(14,7),DUMP2(14,7),DUMP5(14,7),DUMP6(14,7)      00049100
            DOUBLE PRECISION DUMP1,DUMP2,DUMP5,DUMP6                            00049200
            COMMON /BLK13/ KROP(7,14),J37                                       00049300
            COMMON /BLK14/ IDATA(4,350),CDATA(14,100),INTER,NTER                00049400
            COMMON /BLK25/ ITMAX,IQ,NO,GAMMA,IBASE,KODE,IPRINT,IC,BEG,END,      00049500
           1BEG2,M,K,IEV1,IEV2,K1,N2,M2,N22(20),M22(20)                         00049600
            INTEGER GAMMA,BEG,END,BEG2                                          00049700
            COMMON /BLK26/ R1(60,60),X(60,150),F(60),G(150),H(150),XC(100),     00049800
           1GL(99),HL(99),H1(12,12),A(12),GH1(60,4,10),ALPHA,BETA,DELTA         00049900
            DOUBLE PRECISION R1,X,F,G,H,GL,HL,Hl,A,ALPHA,BETA,DELTA             00050000
            DIMENSION N800(7)                                                   00050100
            DATA N800/93,351,96,102,282,26,294/                                 00050200
          1 FORMAT(' ',' GOING TO 170 FOR TIME NO. ',I4,3E15.5)                 00050300
         16 FORMAT(' ','  STORED K POINTS ON DISK FOR ITERATION NO. ',I4)       00050400
         17 FORMAT(' ','  DATA FOR K POINTS READ FROM UNIT 16')                 00050500
        018 FORMAT (//,2X,30HCOORDINATES OF INITIAL COMPLEX)                    00050600
        019 FORMAT (/,5(1X,2HX(,I3,1H,,I3,4H) = ,  F10.3))                      00050700
        021 FORMAT (/,2X,22HVALUES OF THE FUNCTION )                            00050800
         22 FORMAT (  /,5(1X,2HF(,I2,4H) = ,  E13.6))                           00050900
        023 FORMAT (//,2X,17HITERATION NUMBER ,I5)                              00051000
        024 FORMAT (/,2X,30HCOORDINATES OF CORRECTED POINT)                     00051100
        025 FORMAT (/,2X,27HCOORDINATES OF THE CENTROID)                        00051200
        026 FORMAT (/,5(1X,2HX(,I2,6H,C) = ,  E13.6))                           00051300
       1234 FORMAT(' ',2X, 'SUBROUTINE CONSX')                                  00051400
            NDEBUG=0                                                            00051500
            IF(NDEBUG.NE.0) WRITE(6,1234)                                       00051600
      C     IQ     = ITERATION INDEX                                            00051700
      C     IEV1   = INDEX OF POINT WITH MINIMUM FUNCTION VALUE.                00051800
      C     IEV2   = INDEX OF POINT WITH MAXIMUM FUNCTION VALUE.                00051900
      C     I      = POINT INDEX.                                               00052000
      C     KODE   = CONTROL KEY USED TO DETERMINE IF IMPLICIT CONSTRAINTS      00052100
      C              ARE PROVIDED.                                              00052200
      C     K1     = DO LOOP LIMIT                                              00052300
            IQ = 1                                                              00052400
            KODE = 0                                                            00052500
            IF(M-END) 20,20,10                                                  00052600
         10 KODE = 1                                                            00052700
         20 CONTINUE                                                            00052800
      C     CALCULATE COMPLEX POINTS AT RANDOM FRON UNIFORMLY DISTRIBUTED       00052900
      C     NOS. & THE BOUNDARY CONSTRAINTS.                                    00053000
            IF(IBASE.EQ.1 .OR. IBASE.EQ.3) GO TO 61                             00053100
            IROW1=4                                                             00053200
            DO 65 II=IROW1,K                                                    00053300
            DO 50 J=BEG,END                                                     00053400
            I = II                                                              00053500
            CALL CONSTT                                                         00053600
            X(II,J)=G(J)+R1(II,J)*(H(J)-G(J))                                   00053700
         50 CONTINUE                                                            00053800
      C     CHECK THE VALUES OF EXPLICIT VARIABLES                              00053900
            DO 350 J=BEG,END                                                    00054000
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0000000001111111111222222222233333333334444444444555555555566666666667777777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
      IF(X(I,J)- G(J)) 320,320,330                                      00054100
  320 X(I,J) = G(J) + DELTA                                             00054200
      GO TO 350                                                         00054300
  330 IF( H(J)-X(I,J)) 340,340,350                                      00054400
  340 X(I,J) = H(J)- DELTA                                              00054500
  350 CONTINUE                                                          00054600
      CALL CONSTT                                                       00054700
      K1 = II                                                           00054800
      CALL CHECK                                                        00054900
      IF (II-2) 51, 51, 55                                              00055000
   51 IF (IPRINT) 52, 65, 52                                            00055100
   52 WRITE (NO,018)                                                    00055200
      IO = 1                                                            00055300
      WRITE (NO,019) (IO, J, X(IO,J), J= BEG,M)                         00055400
   55 IF (IPRINT) 56, 65, 56                                            00055500
   56 WRITE (NO,019) (II, J, X(II,J), J= BEG,M)                         00055600
   65 CONTINUE                                                          00055700
      GO TO 69                                                          00055800
C         ENTER HERE IF THE USER HAS PROVIDED X VALUES FOR 1 THROUGH K  00055900
C         CALL CONST TO CALCULATE OTHER X VALUES & GET READY TO CALL FUNC00056000
   61 CONTINUE                                                          00056100
      IF(IBASE.EQ.1) GO TO 63                                           00056200
C     READ THE K POINTS FROM DISK, UNIT 16.                             00056300
      DO 62 IKK=1,K                                                     00056400
   62 READ(12' IKK)  (X(IKK,L),L=1,M)                                   00056500
      WRITE(6,17)                                                       00056600
   63 CONTINUE                                                          00056700
      WRITE (NO,018)                                                    00056800
      DO  64  I=1,K                                                     00056900
      CALL CONSTT                                                       00057000
      K1=I                                                              00057100
      CALL CHECK                                                        00057200
      WRITE (NO,019) (I , J, X(I ,J), J= BEG,END)                       00057300
   64 CONTINUE                                                          00057400
   69 K1 = K                                                            00057500
      DO 70 I=1,K                                                       00057600
      CALL OBJT                                                         00057700
   70 CONTINUE                                                          00057800
      KOUNT = 1                                                         00057900
      IA = 0                                                            00058000
      IF (IPRINT) 72, 80, 72                                            00058100
   72 WRITE (NO,021)                                                    00058200
      DO 7000 I= BEG,K                                                  00058300
      WRITE(NO,7001)  (I,J7=1,30)                                       00058400
 7001 FORMAT('0',30A4)                                                  00058500
      WRITE(NO,7002)   I,F(I)                                           00058600
 7002 FORMAT('0',2HF(,I3,4H) = ,F20.6)                                  00058700
      DO 8000 J3=1,7                                                    00058800
      WRITE(NO,7003) (J4,N800(J3),GH1(I,J4,J3),J4=1,4)                  00058900
 7003 FORMAT('0',4(2X,2HC(,I2,1H,,I3,4H) = ,F12.4))                     00059000
 8000 CONTINUE                                                          00059100
      WRITE(NO,7005) (J8,GH1(I ,J8,10),J8=1,4)                          00059200
 7005 FORMAT('0',4(2X,2HP(,I2,4H) = ,F10.3))                            00059300
      WRITE(NO,7004) (I,J5,X(I,J5),J5=BEG,END)                          00059400
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000000000111111111122222222223333333333444444444455555555556666666666777777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
            IF(X(I,J)- G(J)) 320,320,330                                        00054100
      320 X(I,J) = G(J) + DELTA                                                 00054200
          GO TO 350                                                             00054300
      330 IF( H(J)-X(I,J)) 340,340,350                                          00054400
      340 X(I,J) = H(J)- DELTA                                                  00054500
      350 CONTINUE                                                              00054600
          CALL CONSTT                                                           00054700
          K1 = II                                                               00054800
          CALL CHECK                                                            00054900
          IF (II-2) 51, 51, 55                                                  00055000
       51 IF (IPRINT) 52, 65, 52                                                00055100
       52 WRITE (NO,018)                                                        00055200
          IO = 1                                                                00055300
          WRITE (NO,019) (IO, J, X(IO,J), J= BEG,M)                             00055400
       55 IF (IPRINT) 56, 65, 56                                                00055500
       56 WRITE (NO,019) (II, J, X(II,J), J= BEG,M)                             00055600
       65 CONTINUE                                                              00055700
          GO TO 69                                                              00055800
C               ENTER HERE IF THE USER HAS PROVIDED X VALUES FOR 1 THROUGH K    00055900
C               CALL CONST TO CALCULATE OTHER X VALUES & GET READY TO CALL FUNC00056000
       61 CONTINUE                                                              00056100
          IF(IBASE.EQ.1) GO TO 63                                               00056200
C         READ THE K POINTS FROM DISK, UNIT 16.                                 00056300
          DO 62 IKK=1,K                                                         00056400
       62 READ(12' IKK)  (X(IKK,L),L=1,M)                                       00056500
          WRITE(6,17)                                                           00056600
       63 CONTINUE                                                              00056700
          WRITE (NO,018)                                                        00056800
          DO  64  I=1,K                                                         00056900
          CALL CONSTT                                                           00057000
          K1=I                                                                  00057100
          CALL CHECK                                                            00057200
          WRITE (NO,019) (I , J, X(I ,J), J= BEG,END)                           00057300
       64 CONTINUE                                                              00057400
       69 K1 = K                                                                00057500
          DO 70 I=1,K                                                           00057600
          CALL OBJT                                                             00057700
       70 CONTINUE                                                              00057800
          KOUNT = 1                                                             00057900
          IA = 0                                                                0-0058000
          IF (IPRINT) 72, 80, 72                                                00058100
       72 WRITE (NO,021)                                                        00058200
          DO 7000 I= BEG,K                                                      00058300
          WRITE(NO,7001)  (I,J7=1,30)                                           00058400
     7001 FORMAT('0',30A4)                                                      00058500
          WRITE(NO,7002)    I,F(I)                                              00058600
     7002 FORMAT('0',2HF(,I3,4H) = ,F20.6)                                      00058700
          DO 8000 J3=1,7                                                        00058800
          WRITE(NO,7003) (J4,N800(J3),GH1(I,J4,J3),J4=1,4)                      00058900
     7003 FORMAT('0',4(2X,2HC(,I2,1H,,I3,4H) = ,F12.4))                         00059000
     8000 CONTINUE                                                              00059100
          WRITE(NO,7005) (J8,GH1(I ,J8,10),J8=1,4)                              00059200
     7005 FORMAT('0',4(2X,2HP(,I2,4H) = ,F10.3))                                00059300
          WRITE(NO,7004) (I,J5,X(I,J5),J5=BEG,END)                              00059400
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00000000011111111112222222222333333333344444444445555555555666666666677777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
CARD
      IF(X(I,J)- G(J)) 320,320,330                                      00054100
  320 X(I,J) = G(J) + DELTA                                             00054200
      GO TO 350                                                         00054300
  330 IF( H(J)-X(I,J)) 340,340,350                                      00054400
  340 X(I,J) = H(J)- DELTA                                              00054500
  350 CONTINUE                                                          00054600
      CALL CONSTT                                                       00054700
      K1 = II                                                           00054800
      CALL CHECK                                                        00054900
      IF (II-2) 51, 51, 55                                              00055000
   51 IF (IPRINT) 52, 65, 52                                            00055100
   52 WRITE (NO,018)                                                    00055200
      IO = 1                                                            00055300
      WRITE (NO,019) (IO, J, X(IO,J), J= BEG,M)                         00055400
   55 IF (IPRINT) 56, 65, 56                                            00055500
   56 WRITE (NO,019) (II, J, X(II,J), J= BEG,M)                         00055600
   65 CONTINUE                                                          00055700
      GO TO 69                                                          00055800
C           ENTER HERE IF THE USER HAS PROVIDED X VALUES FOR 1 THROUGH K00055900
C           CALL CONST TO CALCULATE OTHER X VALUES & GET READY TO CALL FUNC00056000
   61 CONTINUE                                                          00056100
      IF(IBASE.EQ.1) GO TO 63                                           00056200
C     READ THE K POINTS FROM DISK, UNIT 16.                             00056300
      DO 62 IKK=1,K                                                     00056400
   62 READ(12' IKK)  (X(IKK,L),L=1,M)                                   00056500
      WRITE(6,17)                                                       00056600
   63 CONTINUE                                                          00056700
      WRITE (NO,018)                                                    00056800
      DO  64  I=1,K                                                     00056900
      CALL CONSTT                                                       00057000
      K1=I                                                              00057100
      CALL CHECK                                                        00057200
      WRITE (NO,019) (I , J, X(I ,J), J= BEG,END)                       00057300
   64 CONTINUE                                                          00057400
   69 K1 = K                                                            00057500
      DO 70 I=1,K                                                       00057600
      CALL OBJT                                                         00057700
   70 CONTINUE                                                          00057800
      KOUNT = 1                                                         00057900
      IA = 0                                                            00058000
      IF (IPRINT) 72, 80, 72                                            00058100
   72 WRITE (NO,021)                                                    00058200
      DO 7000 I= BEG,K                                                  00058300
      WRITE(NO,7001)  (I,J7=1,30)                                       00058400
 7001 FORMAT('0',30A4)                                                  00058500
      WRITE(NO,7002)    I,F(I)                                          00058600
 7002 FORMAT('0',2HF(,I3,4H) = ,F20.6)                                  00058700
      DO 8000 J3=1,7                                                    00058800
      WRITE(NO,7003) (J4,N800(J3),GH1(I,J4,J3),J4=1,4)                  00058900
 7003 FORMAT('0',4(2X,2HC(,I2,1H,,I3,4H) = ,F12.4))                     00059000
 8000 CONTINUE                                                          00059100
      WRITE(NO,7005) (J8,GH1(I ,J8,10),J8=1,4)                          00059200
 7005 FORMAT('0',4(2X,2HP(,I2,4H) = ,F10.3))                            00059300
      WRITE(NO,7004) (I,J5,X(I,J5),J5=BEG,END)                          00059400
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         00000000011111111112222222222333333333344444444445555555555666666666677777777778
         12345678901234567890123456789012345678901234567890123456789012345678901234567890
              1NESTOR,KING,NPRDM,IDROP,IFLAG,NFSTST,NSANDY,NSUZY,IHOLD1,NSANDI   00070300
              3,NRPB,INDXX                                                       00070400
               COMMON /BLK9/ NC,N,NZZ2,IVAL                                      00070500
               INTEGER DIVAC,TARGET,FREMKT                                       00070600
               COMMON /BLK10/ DIVAC,TARGET,FREMKT,LOAN,IAJSET,JA73,JLRPOL,NSUPFG,00070700
              1JSUPCO,JSUPWH,JSUPSU,IAJLOT,IAPART                                00070800
               COMMON /BLK11/ I,J,NOBS,NOB,NSHOOT,NOEX,NERD                      00070900
               COMMON /BLK12/ DUMP1(14,7),DUMP2(14,7),DUMP5(14,7),DUMP6(14,7)    00071000
               DOUBLE PRECISION DUMP1,DUMP2,DUMP5,DUMP6                          00071100
               COMMON /BLK13/ KROP(7,14),J37                                     00071200
               COMMON /BLK14/ IDATA(4,350),CDATA(14,100),INTER,NTER              00071300
               COMMON /BLK25/ ITMAX,IQ,NQ,GAMMA,IBASE,KODE,IPRINT,IC,BEG,END,    00071400
              1BEG2,M,K,IEV1,IEV2,K1,N2,M2,N22(20),M22(20)                       00071500
               INTEGER GAMMA,REG,END,BEG2                                        00071600
               COMMON /BLK26/ R1(60,60),X(60,150),F(60),G(150),H(150),XC(100),   00071700
              1GL(99),HL(99),H1(12,12),A(12),GH1(60,4,10),ALPHA,BETA,DELTA       00071800
               DOUBLE PRECISION R1,X,F,G,H,GL,HL,H1,A,ALPHA,BETA,DELTA           00071900
               EXOG(I,137)=EXOG(I,136)                                           00072000
               EXOG(I,139)=EXOG(I,136)                                           00072100
         C     CALL TO CROPQ,TO RETURN EXPECTED PRODUCTION                       00072200
               CALL AJLOAN                                                       00072300
               CALL CROPQ                                                        00072400
         C     COMPUTE PROGRAM ALLOCATION FACTORS                                00072500
               EXOG(I,123)=(EXOG(I,063)*EXOG(I,068))/(C(I,215)*C(I,219))         00072600
               EXOG(I,124)=(EXOG(I,064)*EXOG(I,069))/(C(I,216)*C(I,220))         00072700
               EXOG(I,126)=(EXOG(I,065)*EXOG(I,070))/(C(I,218)*C(I,222))         00072800
               EXOG(I,125)=(EXOG(I,147)*EXOG(I,131))/(C(I,217)*C(I,221))         00072900
               EXOG(I,094)=(EXOG(I,066)*EXOG(I,049))/(C(I,002)*C(I,006))         00073000
               EXOG(I,095)=(EXOG(I,067)*EXOG(I,050))/(C(I,004)*C(I,008))/480.0   00073100
               DO 400 J1=123,126                                                 00073200
               IF(EXOG(I,J1).LT.0.80) EXOG(I,J1)=0.80                            00073300
               IF(EXOG(I,J1).GT.1.00) EXOG(I,J1)=1.00                            00073400
           400 CONTINUE                                                          00073500
               IF(EXOG(I,094).LT.0.80) EXOG(I,094)=0.80                          00073600
               IF(EXOG(I,094).GT.1.00) EXOG(I,094)=1.00                          00073700
               IF(EXOG(I,095).GT.1.00) EXOG(I,095)=1.00                          00073800
         C     REDUCE YIELDS FOR COST CALCULATION                                00073900
               IF(EXOG(I,136).NE.0.0)                                            00074000
              1C(I,219)=C(I,219)/(1.0+EXOG(I,222))                               00074100
               IF(EXOG(I,003).NE.0.0)                                            00074200
              1C(I,006)=C(I,006)/(1.0+EXOG(I,223))                               00074300
               IF(EXOG(I,006).NE.0.0)                                            00074400
              1C(I,008)=C(I,008)/(1.0+EXOG(I,224))                               00074500
         C     COMPUTE CORN                                                      00074600
               IF(EXOG(I,51).GT.C(J,102).AND.EXOG(I,136).NE.0.0)                 00074700
              1C(I,352)= (EXOG(I,136)*C(I,223)*(C(J,102)-(C(I,254)/C(I,219)))-   00074800
              2(EXOG(I,51)-C(J,102))*EXOG(I,68)*EXOG(I,63)*EXOG(I,123))/(        00074900
              3 EXOG(I,136)*C(I,223))                                            00075000
               IF(EXOG(I,51).LE.C(J,102))                                        00075100
              1C(I,352)= C(J,102)- (C(I,254)/C(I,219))                           00075200
               EXOG(I,152)=.50                                                   00075300
               IF(C(I,352).LE.0.0)    C(I,352)=0.0                               00075400
               EXOG(I,133)= (EXOG(I,152) /.60)*C(I,352)                          00075500
               EXOG(I,210)=EXOG(I,136)*EXOG(I,152)                               00075600
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C       COMPUTE WHEAT                                                   00075700
         IF(EXOG(I,52).GT.C(J,026).AND.EXOG(I,003).NE.0.0)              00075800
        1C(I,353)=(EXOG(I,03)*C(I,010)*(C(J,26)-(C(I,014)/C(I,006)))-   00075900
        2(EXOG(I,52)-C(J,026))*EXOG(I,063)*EXOG(I,69)*EXOG(I,123))/(    00076000
        3 EXOG(I,003)*C(I,010))                                         00076100
         IF(EXOG(I,52).LE.C(J,026))                                     00076200
        1 C(I,353)=C(J,26)-(C(I,014)/C(I,006))                          00076300
         EXOG(I,087)=.60                                                00076400
         IF(C(I,353).LE.0.0)    C(I,353)=0.0                            00076500
         EXOG(I,76)=(EXOG(I,087)/.60)*C(I,353)                          00076600
         EXOG(I,211)=EXOG(I,003)*EXOG(I,087)                            00076700
C       COMPUTE COTTON                                                  00076800
         IF(EXOG(I,53).GT.C(J,28).AND.EXOG(I,006).NE.0.0)               00076900
        1C(I,354)=(EXOG(I,006)*C(I,012)*480.0*(C(J,028)-(C(I,016)/(C(I,008)00077000
        2*480.0))) -(EXOG(I,53)-C(I,028))*EXOG(I,50)*EXOG(I,67)*EXOG(I,094)00077100
        3 )/ (EXOG(I,006)*C(I,012)*480.0)                               00077200
         IF(EXOG(I,53).LE.C(J,102))                                     00077300
        1 C(I,354)=C(J,028)-(C(I,016)/(C(I,008)*480.0))                 00077400
         EXOG(I,088)=.90                                                00077500
         IF(C(I,354).LE.0.0)    C(I,354)=0.0                            00077600
         EXOG(I,77)=(EXOG(I,088)/.80)*C(I,354)                          00077700
         EXOG(I,212)= EXOG(I,006)*EXOG(I,088)                           00077800
C       COMPUTE GRAIN SORGHUM                                           00077900
         IF(EXOG(I,059).GT.C(J,103).AND.EXOG(I,137).NE.0.0)             00078000
        1C(I,355)=(EXOG(I,137)*C(I,244)*(C(J,103)-(C(I,255)/C(I,220))) -  00078100
        2 (EXOG(I,59)-C(J,103))*EXOG(I,069)*EXOG(I,64)*EXOG(I,124)) /   00078200
        3 (EXOG(I,137)*C(I,224))                                        00078300
         IF(EXOG(I,059).LE.C(J,103))                                    00078400
        1 C(I,355)=C(J,103)-(C(I,255)/C(I,220))                         00078500
         EXOG(I,153)=.50                                                00078600
         IF(C(I,355).LE.0.0)    C(I,355)=0.0                            00078700
         EXOG(I,134)=(EXOG(I,153)/.60)*C(I,355)                         00078800
         EXOG(I,213)=EXOG(I,137)*EXOG(I,153)                            00078900
C       COMPUTE BARLEY                                                  00079000
         IF(EXOG(I,060).GT.C(J,104).AND.EXOG(I,139).NE.0.0)             00079100
        1C(I,356)=(EXOG(I,139)*C(I,226)*(C(J,104)-(C(I,257)/C(I,222))) -  00079200
        2(EXOG(I,60)-C(J,104))*EXOG(I,70)*EXOG(I,65)*EXOG(I,126) ) /    00079300
        3 (EXOG(I,139)*C(I,226))                                        00079400
         IF(EXOG(I,060).LE.C(J,104))                                    00079500
        1 C(I,356)=C(J,104)-(C(I,257)/C(I,222))                         00079600
         EXOG(I,155)=.50                                                00079700
         IF(C(I,356).LE.0.0)    C(I,356)=0.0                            00079800
         EXOG(I,140)=(EXOG(I,155)/.60)*C(I,356)                         00079900
         EXOG(I,214)=EXOG(I,155)*EXOG(I,139)                            00080000
         RETURN                                                         00080100
         END                                                            00080200
         SUBROUTINE FUNC                                                00080300
         COMMON /BLK1/ C(14,360),B(14,350),C1(14,50),R(14,350),EXOG(14,240)00080400
        1,OLDEXO(14,240),NGAUSS(14,3),NF1(40),NBAR(7)                   00080500
         DOUBLE PRECISION C,B,C1,R,EXOG,OLDEXO                          00080600
         COMMON /BLK2/ E(275),ADJ(100),CONST(120),EE(275),DM(7,9),PM(7,9) 00080700
         COMMON /BLK3/ ACRE(14,30),YIELD(16,7),DUM(14,7)                00080800
         DOUBLE PRECISION ACRE                                          00080900
         COMMON /BLK4/ KPAR(350),KRAY(350),KGR(200),KDR(200),INDE1(200)  00081000
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     1,INDE2(200),INDE3(200),INDE4(200),INDE5(350),INDE6(350),NYEAR(10) 00081100
      INTEGER US(33,20),SIMNAM(20)                                      00081200
      COMMON /BLK5/ US,SIMNAM                                           00081300
      INTEGER SUMFIL(160),SUMTAB(160,6),SUMF(160)                       00081400
      COMMON /BLK6/ SUMFIL,SUMTAB,SUMF,NAAA                             00081500
      COMMON /BLK7/ NB1(34),NB2(06),NB3(13),NB4(07),NB5(07)             00081600
      COMMON/BLK8/  LFM,NPRB,IEN,IFSTYP,ISIMND,IMONTH,IDAY,IBASYR,NPRE, 00081700
     1NESTOR,KING,NPRDM,IDRUP,IFLAG,NFSTST,NSANDY,NSUZY,IHOLD1,NSANDI   00081800
     3,NRPB,INDXX                                                       00081900
      COMMON /BLK9/ NC,N,NZZ2,IVAL                                      00082000
      INTEGER DIVAC,TARGET,FREMKT                                       00082100
      COMMON /BLK10/ DIVAC,TARGET,FREMKT,LOAN,IAJSET,JA73,JLRPOL,NSUPFG,00082200
     1JSUPCO,JSUPWH,JSUPSO,IAJLOT,IAPART                                00082300
      COMMON /BLK11/ I,J,NOBS,NOB,NSHOOT,NOEX,NERD                      00082400
      COMMON /BLK12/ DUMP1(14,7),DUMP2(14,7),DUMP5(14,7),DUMP6(14,7)    00082500
      DOUBLE PRECISION DUMP1,DUMP2,DUMP5,DUMP6                          00082600
      COMMON /BLK13/ KROP(7,14),J37                                     00082700
      COMMON /BLK14/ IDATA(4,350),CDATA(14,100),INTER,NTER              00082800
      COMMON /BLK20/ AE(7,8),BE(7,8),NG(160)                            00082900
      DO 1000 I= 3   ,NOBS                                              00083000
      J=I-1                                                             00083100
      CALL EVALUT                                                       00083200
      CALL AJLOAN                                                       00083300
      CALL SETUP                                                        00083400
      CALL LVSK                                                         00083500
      IVAL=4                                                            00083600
      CALL INIT                                                         00083700
      CALL CRUPQQ                                                       00083800
      CALL SBDD                                                         00083900
      CALL LOANRP                                                       00084000
      CALL FGWTD                                                        00084100
      IF(I.EQ.4.AND.LOAN.NE.0) CALL CHECKR                              00084200
      CALL LOANRP                                                       00084300
      CALL SUPPRT                                                       00084400
      CALL COTDD                                                        00084500
      CALL LOANRP                                                       00084600
      CALL RECPTS                                                       00084700
      CALL FEEDAG                                                       00084800
      CALL FEED                                                         00084900
      CALL FED2                                                         00085000
      CALL INDEX                                                        00085100
      CALL GOVP                                                         00085200
      CALL TOTALS                                                       00085300
 1000 CONTINUE                                                          00085400
      RETURN                                                            00085500
      END                                                               00085600
     1,OLDEXO(14,240),NGAUSS(14,3),NF1(40),NBAR(7)                      00085700
      DOUBLE PRECISION C,B,C1,R,EXOG,OLDEXO                             00085800
      COMMON /BLK3/ ACRE(14,30),YIELD(16,7),DUM(14,7)                   00085900
      DOUBLE PRECISION ACRE                                             00086000
      INTEGER DIVAC,TARGET,FREMKT                                       00086100
      COMMON /BLK10/ DIVAC,TARGET,FREMKT,LOAN,IAJSET,JA73,JLRPOL,NSUPFG,00086200
     1JSUPCO,JSUPWH,JSUPSO,IAJLOT,IAPART                                00086300
      COMMON /BLK11/ I,J,NOBS,NOB,NSHOOT,NOEX,NERD                      00086400
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CARD
      DIMENSION NZERO(25),NZERO1(58),NZERO2(21)                         00086500
      DIMENSION I7(5),I8(5),I9(5),I10(5)                                00086600
      DATA I7/102,103,104,105,26/                                       00086700
      DATA I8/54,61,62,117,55/                                          00086800
      DATA I9/206,207,208,209,205/                                      00086900
      DATA I10/331,332,334,333,335/                                     00087000
      DATA NZERO/112,113,114,278,109,110,331,332,333,334,335,336,337,11100087100
     1,108,338,162,163,164,318,274,275,276,277,096/                     00087200
      DATA NZERO1/33,203,76,34,77,175,143,133,199,144,134,200,145,135,  00087300
     1201,146,140,202,13,177,14,204,32,123,63,68,124,64,69,126,65,70,12500087400
     2,147,131,94,67,66,49,50,54,51,152,61,59,153,62,60,155,117,146,154,00087500
     355,52,87,56,53,88/                                                00087600
      DATA NZERO2/33,203,76,34,77,175,143,133,199,144,134,200,145,135,  00087700
     1201,146,140,202,13,177,14/                                        00087800
      WRITE(8,12345)                                                    00087900
12345 FORMAT('0',' SUBROUTINE GOVP ENTERED')                            00088000
      IF(FREMKT.NE.0) GO TO 207                                         00088100
      IF(TARGET.EQ.0) GO TO 470                                         00088200
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC00088300
C                                                                       00088400
C                                                                       00088500
CC    CALCULATE PROGRAM ALLOCATION FACTORS                              00088600
C                                                                       00088700
C                                                                       00088800
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC00088900
      EXOG(I,123)=(EXOG(I,063)*EXOG(I,068))/(C(I,215)*C(I,219))         00089000
      EXOG(I,124)=(EXOG(I,064)*EXOG(I,069))/(C(I,216)*C(I,220))         00089100
      EXOG(I,126)=(EXOG(I,065)*EXOG(I,070))/(C(I,218)*C(I,222))         00089200
      EXOG(I,125)=(EXOG(I,147)*EXOG(I,131))/(C(I,217)*C(I,221))         00089300
      EXOG(I,094)=(EXOG(I,066)*EXOG(I,049))/(C(I,002)*C(I,006))         00089400
      EXOG(I,095)=(EXOG(I,067)*EXOG(I,050))/(C(I,004)*C(I,008))/480.0   00089500
      DO 400 J1=123,126                                                 00089600
      IF(EXOG(I,J1).LT.0.80) EXOG(I,J1)=0.80                            00089700
      IF(EXOG(I,J1).GT.1.00) EXOG(I,J1)=1.00                            00089800
  400 CONTINUE                                                          00089900
      IF(EXOG(I,094).LT.0.80) EXOG(I,094)=0.80                          00090000
      IF(EXOG(I,094).GT.1.00) EXOG(I,094)=1.00                          00090100
      IF(EXOG(I,095).GT.1.00) EXOG(I,095)=1.00                          00090200
  420 CONTINUE                                                          00090300
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC00090400
C                                                                       00090500
CC    CALCULATE DIFICIENCY PAYMENTS                                     00090600
C                                                                       00090700
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC00090800
C     CORN DIFICIENCY PAYMENTS                                          00090900
      IF (EXOG(I,54).GE.EXOG(I,51)) GO TO 451                           00091000
      IF (C(I,102) .GE. EXOG(I,51)) GO TO 451                           00091100
      IF (C(I,102) .LT. EXOG(I,54)) CORNDF = EXOG(I,51) - EXOG(I,54)    00091200
      IF (C(I,102) .GE. EXOG(I,54)) CORNDF = EXOG(I,51) - C(I,102)      00091300
      C(I,112)=CORNDF *EXOG(I,152)*EXOG(I,063)*EXOG(I,68)*EXOG(I,123)   00091400
  451 CONTINUE                                                          00091500
C     GRAIN SORGHUM DIFICIENCY PAYMENT                                  00091600
      IF (EXOG(I,61).GE.EXOG(I,59)) GO TO 456                           00091700
      IF (C(I,103) .GE. EXOG(I,59)) GO TO 456                           00091800
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CARD
               IF (C(I,103) .LT. EXOG(I,61)) GSOGDF = EXOG(I,59) - EXOG(I,61)      00091900
               IF (C(I,103) .GE. EXOG(I,61)) GSOGDF = EXOG(I,59) - C(I,103)        00092000
               C(I,113)=GSOGDF*EXOG(I,153)*EXOG(I,064)*EXOG(I,69)*EXOG(I,124)      00092100
           456 CONTINUE                                                            00092200
         C     BARLEY DIFICIENCY PAYMENT                                           00092300
               IF (EXOG(I,62).GE.EXOG(I,60)) GO TO 461                             00092400
               IF (C(I,104) .GE. EXOG(I,60)) GO TO 461                             00092500
               IF (C(I,104) .LT. EXOG(I,62)) BARDIF = EXOG(I,60) - EXOG(I,62)      00092600
               IF (C(I,104) .GE. EXOG(I,62)) BARDIF = EXOG(I,60) - C(I,104)        00092700
               C(I,114)=BARDIF*EXOG(I,155)*EXOG(I,065)*EXOG(I,070)*EXOG(I,126)     00092800
           461 CONTINUE                                                            00092900
         C     OAT DEFICIENCY PAYMENT                                              00093000
               IF(EXOG(I,117).GE.EXOG(I,146)) GO TO 466                            00093100
               IF(C(I,105).GE.EXOG(I,146)) GO TO 466                               00093200
               IF(C(I,105).LT.EXOG(I,117)) OATDIF=EXOG(I,146)-EXOG(I,117)          00093300
               IF(C(I,105).GE.EXOG(I,117)) OATDIF=EXOG(I,146)-C(I,105)             00093400
               C(I,278)=OATDIF*EXOG(I,154)*EXOG(I,131)*EXOG(I,147)*EXOG(I,125)     00093500
           466 CONTINUE                                                            00093600
         C     WHEAT DIFIIENCY PAYMENT                                             00093700
               IF (EXOG(I,55).GE.EXOG(I,52)) GO TO 465                             00093800
               IF (C(I,26)  .GE. EXOG(I,52)) GO TO 465                             00093900
               IF (C(I,26)  .LT. EXOG(I,55)) WHDIF  = EXOG(I,52) - EXOG(I,55)      00094000
               IF (C(I,26)  .GE. EXOG(I,55)) WHDIF  = EXOG(I,52) - C(I,26)         00094100
               C(I,109)=WHDIF    * EXOG(I,87) * EXOG(I,66) * EXOG(I,49)*EXOG(I,94)00094200
           465 CONTINUE                                                            00094300
         C     COTTON DIFICIENCY PAYMENTS                                          00094400
               IF (EXOG(I,56).GE.EXOG(I,53)) GO TO 470                             00094500
               IF (C(I,28)  .GE. EXOG(I,53)) GO TO 470                             00094600
               IF (C(I,28)  .LT. EXOG(I,56)) COTDIF = EXOG(I,53) - EXOG(I,56)      00094700
               IF (C(I,28)  .GE. EXOG(I,56)) COTDIF = EXOG(I,53) - C(I,28)         00094800
               C(I,110)=COTDIF  * EXOG(I,88) * EXOG(I,67) * EXOG(I,50)*EXOG(I,95)00094900
           470 CONTINUE                                                            00095000
         CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC00095100
         C                                                                         00095200
         C                                                                         00095300
         C                                                                         00095400
         CC    COMPUTE DIVERSION PAYMENTS                                          00095500
         C                                                                         00095600
         C                                                                         00095700
         C                                                                         00095800
         CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC00095900
         C     WHEAT DIVERSION PAYMENTS                                            00096000
               IF(DIVAC.EQ.0) GO TO 206                                            00096100
               IF(DUM(I,2).NE.0.0) GO TO 200                                       00096200
               EXOG(I,033)=C(I,010)*EXOG(I,211)*EXOG(I,076)                        00096300
         C     COTTON DIVERSION PAYMENTS                                           00096400
           200 IF(DUM(I,3).NE.0.0) GO TO 201                                       00096500
               EXOG(I,034)=C(I,012)*480.0*EXOG(I,212)*EXOG(I,77)                   00096600
         C     CORN DIVERSION PAYMENTS                                             00096700
           201 IF(DUM(I,1).NE.0.0) GO TO 202                                       00096800
               EXOG(I,143)=C(I,223)*EXOG(I,210)*EXOG(I,133)                        00096900
         C     GRAIN SORGHUM DIVERSION PAYMENTS                                    00097000
           202 IF(DUM(I,4).NE.0.0) GO TO 203                                       00097100
               EXOG(I,144)=C(I,224)*EXOG(I,213)*EXOG(I,134)                        00097200
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 C      OAT DIVERSION PAYMENTS
    203 IF(DUM(I,5).NE.0.0) GO TO 204
        EXOG(I,145)=EXOG(I,135)*EXOG(I,201)
 C      BARLEY DIVERSION PAYMENTS
    204 IF(DUM(I,6).NE.0.0) GO TO 205
        EXOG(I,146)=C(I,226)*EXOG(I,214)*EXOG(I,140)
    205 CONTINUE
        IF(DUM(I,7).NE.0.0) GO TO 206
 C      SOYBEAN DIVERSION PAYMENTS
        EXOG(I,013)=EXOG(I,177)*EXOG(I,014)
    206 CONTINUE
        IF(DIVAC.NE.0) GO TO 207
        DO 208 J900=1,21
    208 EXOG(I,NZERO2(J900))=0.0
    207 CONTINUE
 C      COMPUTE TOTAL DIVERSION PAYMENTS ALL CROPS
        EXOG(I,204)=EXOG(I,033)+EXOG(I,013)+EXOG(I,034)+EXOG(I,143)+
       1EXOG(I,144)+EXOG(I,145)+EXOG(I,146)
 C      COMPUTE TOTAL DIVERSION PAYMENTS FOR FEED GRAINS
        EXOG(I,032)=EXOG(I,143)+EXOG(I,144)+EXOG(I,145)+EXOG(I,146)
 C      COMPUTE TOTAL FEED GRAIN DIVERSION ACREAGE
        EXOG(I,193)=EXOG(I,199)+EXOG(I,200)+EXOG(I,201)+EXOG(I,202)
 C      COMPUTE DIVERSION PAYMENTS PER ACRE DIVERTED
        IF(EXOG(I,193).EQ.0.0) GO TO 15040
        EXOG(I,075)=EXOG(I,032)/EXOG(I,193)
  15040 CONTINUE
 C
 CC     COMPUTE GOVP PAYMENTS ON FARMER HELD GRAIN RESERVES.PAYMENTS ARE
 CC     COMPUTED AS THE PRODUCT OF THE AMOUNT OF RESERVES TIMES THE PAY-
 CC     MENT RATE.
 C
 C      CORN FARMER HELD GRAIN RESERVE STORAGE PAYMENTS
        C(I,331)=C(I,282)*EXOG(I,194)
 C      GRAIN SORGHUM FARMER HELD GRAIN RESERVE STORAGE PAYMENTS
        C(I,332)=C(I,285)*EXOG(I,195)
 C      OAT FARMER HELD GRAIN RESERVE STORAGE PAYMENTS
        C(I,333)=C(I,288)*EXOG(I,196)
 C      BARLEY FARMER HELD GRAIN RESERVE STORAGE PAYMENTS
        C(I,334)=C(I,291)*EXOG(I,197)
 C      WHEAT FARMER HELD GRAIN RESERVE STORAGE PAYMENTS
        C(I,335)=C(I,294)*EXOG(I,198)
 C      COMPUTE TOTAL STORAGE PAYMENTS ALL CROPS
        DO 100 J1=1,5
        IF(C(I,I7(J1)).GT.(EXOG(I,I8(J1))*EXOG(I,I9(J1))))
      1 C(I,I10(J1))=0.0
    100 CONTINUE
        C(I,336)=C(I,331)+C(I,332)+C(I,333)+C(I,334)+C(I,335)
 C      COMPUTE TOTAL STORAGE PAYMENTS FOR FEED GRAINS
        C(I,337)=C(I,336)-C(I,335)
 C      COMPUTE TOTAL DEFICIENCY PAYMENTS FOR ALL CROPS
        C(I,111)=C(I,109)+C(I,110)+C(I,112)+C(I,113)+C(I,114)+C(I,278)
 C      COMPUTE TOTAL FEED GRAIN DEFICIENCY PAYMENT
        C(I,108)=C(I,112)+C(I,113)+C(I,114)+C(I,278)
 C      COMPUTE TOTAL GOVT PAYMENTS(MODEL),THESE PAYMENTS ARE 1.DEFICIENCY
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CARD
      C      2.DIVERSION 3.STORAGE PAYMENTS ON FARMER HELD RESERVES                 00102700
             C(I,338)=EXOG(I,204)+C(I,336)+C(I,111)                                 00102800
      C      COMPUTE TOTAL GOVT PAYMENTS TO FEEDGRAINS(MODEL)                        00102900
             C(I,162)=C(I,337)+EXOG(I,032)+C(I,108)                                 00103000
      C      COMPUTE TOTAL GOVT PAYMENTS(MODEL) TO WHEAT                            00103100
             C(I,163)=C(I,335)+EXOG(I,033)+C(I,109)                                 00103200
      C      COMPUTE TOTAL GOVT PAYMENTS(MODEL) TO COTTON                           00103300
             C(I,164)=C(I,110)+EXOG(I,034)                                          00103400
      C      COMPUTE TOTAL GOVT PAYMENTA(MODEL) TO SOYBEANS                         00103500
             C(I,318)=EXOG(I,014)                                                   00103600
      C      COMPUTE TOTAL GOVT PAYMENTS(MODEL) TO CORN                             00103700
             C(I,274)=C(I,112)+EXOG(I,143)+C(I,331)                                 00103800
      C      COMPUTE TOTAL GOVT PAYMENTS (MODEL) TO GRAIN SORGHUM                   00103900
             C(I,275)=C(I,113)+EXOG(I,144)+C(I,332)                                 00104000
      C      COMPUTE TOTAL GOVT PAYMENTS(MODEL) TO OATS                             00104100
             C(I,276)=C(I,278)+EXOG(I,145)+C(I,333)                                 00104200
      C      COMPUTE TOTAL GOVT PAYMENTS(MODEL) TO BARLEY                           00104300
             C(I,277)=C(I,114)+EXOG(I,146)+C(I,334)                                 00104400
      C      COMPUTE TOTAL MODEL GOVT PAYMENTS (MODEL AND NON-MODEL)                00104500
             C(I,096)=C(I,338)+EXOG(I,035)                                          00104600
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC00104700
      C                                                                             00104800
      CC     ZERO OUT ALL GOVERMENT PAYMENT VARIABLES AND POLICY VARIABLES          00104900
      CC     IF A FREE MARKET IS BEING SIMULATED.                                   00105000
      C                                                                             00105100
      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC00105200
             IF (FREMKT.EQ.0) GO TO 490                                             00105300
             DO 475 K=1,25                                                          00105400
         475 C(I,NZERO(K))=0.0                                                      00105500
             DO 480 K=1,58                                                          00105600
         480 EXOG(I,NZERO1(K))=0.0                                                  00105700
             DO  495 K=32,34                                                        00105800
         495 EXOG(I,K)=0.0                                                          00105900
         490 CONTINUE                                                               00106000
         550 CONTINUE                                                               00106100
      C      REDEFINE ACREAGES TO BASELINE VALUES                                   00106200
             B(I,215)=ACRE(I,17)                                                    00106300
             B(I,216)=ACRE(I,18)                                                    00106400
             B(I,217)=ACRE(I,19)                                                    00106500
             B(I,218)=ACRE(I,20)                                                    00106600
             B(I,2) = ACRE(I,2)                                                     00106700
             B(I,3) = ACRE(I,3)                                                     00106800
             B(I,4) = ACRE(I,4)                                                     00106900
             B(I,1) = B(I,215) + B(I,216) + B(I,217) + B(I,218)                     00107000
             RETURN                                                                 00107100
             END                                                                    00107200
             SUBROUTINE OBJT                                                        00107300
             COMMON /BLK1/ C(14,360),B(14,350),C1(14,50),R(14,350),EXOG(14,240)00107400
            1,OLDEXO(14,240),NGAUSS(14,3),NF1(40),NBAR(7)                           00107500
             DOUBLE PRECISION C,B,C1,R,EXOG,OLDEXO                                  00107600
             COMMON /BLK2/ E(275),ADJ(100),CONST(120),EE(275),DM(7,9),PM(7,9)       00107700
             COMMON /BLK3/ ACRE(14,30),YIELD(16,7),DUM(14,7)                        00107800
             DOUBLE PRECISION ACRE                                                  00107900
             COMMON /BLK4/ KPAR(350),KRAY(350),KGR(200),KDR(200),INDE1(200)         00108000
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     1,INDF2(200),INDE3(200),INDE4(200),INDE5(350),INDE6(350),NYEAR(10) 00108100
      INTEGER US(33,20),SIMNAM(20)                                      00108200
      COMMON /BLK5/ US,SIMNAM                                           00108300
      INTEGER SUMFIL(160),SUMTAB(160,6),SUMF(160)                       00108400
      COMMON /BLK6/ SUMFIL,SUMTAB,SUMF,NAAA                             00108500
      COMMON /BLK7/ NB1(34),NB2(06),NB3(13),NB4(07),NB5(07)             00108600
      COMMON/BLK8/  LFM,NPRB,IEN,IFSTYR,ISIMND,IMONTH,IDAY,IBASYR,NPRE, 00108700
     1NESTOR,KING,NPRDM,IDRUP,IFLAG,NFSTST,NSANDY,NSUZY,IHOLD1,NSANDI   00108800
     3,NRPB,INDXX                                                       00108900
      COMMON /BLK9/ NC,N,N7Z2,IVAL                                      00109000
      INTEGER DIVAC,TARGET,FREMKT                                       00109100
      COMMON /BLK10/ DIVAC,TARGET,FREMKT,LOAN,IAJSET,JA73,JLRPOL,NSUPFG,00109200
     1JSUPCU,JSUPWH,JSUPSO,IAJLOT,IAPART                                00109300
      COMMON /BLK11/ I,J,NOBS,NOB,NSHOOT,NOEX,NERD                      00109400
      COMMON /BLK12/ DUMP1(14,7),DUMP2(14,7),DUMP5(14,7),DUMP6(14,7)    00109500
      DOUBLE PRECISION DUMP1,DUMP2,DUMP5,DUMP6                          00109600
      COMMON /BLK13/ KRUP(7,14),J37                                     00109700
      COMMON /BLK14/ IDATA(4,350),CDATA(14,100),INTER,NTER              00109800
      COMMON /BLK20/ AE(7,8),BE(7,8),NG(160)                            00109900
      COMMON /BLK25/ ITMAX,IO,NO,GAMMA,IBASE,KODE,IPRINT,IC,BEG,END,    00110000
     1BEG2,M,K,IEV1,IEV2,K1,N2,M2,N22(20),M22(20)                       00110100
      INTEGER GAMMA,BEG,END,BEG2                                        00110200
      COMMON /BLK26/ R1(60,60),X(60,150),F(60),G(150),H(150),XC(100),   00110300
     1GL(99),HL(99),H1(12,12),A(12),GH1(60,4,10),ALPHA,BETA,DELTA       00110400
      DOUBLE PRECISION R1,X,F,G,H,GL,HL,H1,A,ALPHA,BETA,DELTA           00110500
      DIMENSION N800(7)                                                 00110600
      DOUBLE PRECISION Y                                                00110700
      DATA N800/93,351,96,102,282,26,294/                               00110800
      IB=I                                                              00110900
      DO 6000 J1=1,N2                                                   00111000
      DO 6000 J2=3,NOBS                                                 00111100
      J3=J2-2 +(J1-1)*NOB                                               00111200
      EXOG(J2,N22(J1))=X(IB,J3)                                         00111300
 6000 CONTINUE                                                          00111400
      CALL FUNC                                                         00111500
      DO 170 J1=1,7                                                     00111600
      DO 170 J2=3,NOBS                                                  00111700
      GH1(IB,J2-2,J1)=C(J2,N800(J1))                                    00111800
  170 CONTINUE                                                          00111900
      Y=0.0D0                                                           00112000
      DO 100 J1=1,M2                                                    00112100
      DO 100 J2=3,NOBS                                                  00112200
      J3=J2-2+(J1-1)*NOB                                                00112300
      Y=Y+(C(J2,M22(J1))-A(J3))*(C(J2,M22(J1))-A(J3))*H1(J3,J3)         00112400
  100 CONTINUE                                                          00112500
      F(IB)=-Y                                                          00112600
      I=IB                                                              00112700
      DO 7000 J1=3,NOBS                                                 00112800
      DO 7000 J2=1,360                                                  00112900
 7000 C(J1,J2)=0.0D0                                                    00113000
      RETURN                                                            00113100
      END                                                               00113200
      SUBROUTINE SETUP                                                  00113300
      COMMON /BLK1/ C(14,360),B(14,350),C1(14,50),R(14,350),EXOG(14,240)00113400
```

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00000000011111111112222222222333333333344444444445555555555666666666677777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
     1,OLDEXO(14,240),NGAUSS(14,3),NF1(40),NBAR(7)                      00113500
      DOUBLE PRECISION C,B,C1,R,EXOG,OLDEXO                             00113600
      COMMON /BLK3/ ACRE(14,30),YIELD(16,7),DUM(14,7)                   00113700
      DOUBLE PRECISION ACRE                                             00113800
      INTEGER DIVAC,TARGET,FREMKT                                       00113900
      COMMON /BLK10/ DIVAC,TARGET,FREMKT,LOAN,IAJSET,JA73,JLRPOL,NSUPFG,00114000
     1JSUPCO,JSUPWH,JSUPSO,IAJLOT,IAPART                                00114100
      COMMON /BLK11/ I,J,NOBS,NOB,NSHOOT,NOEX,NERD                      00114200
      DIMENSION MI(7),MJ(7)                                             00114300
      DIMENSION P(7)                                                    00114400
      DIMENSION  Z2(6),NY1(6),NY2(6),NY3(6)                             00114500
      DATA MI/3,5,136,137,138,139,6/                                    00114600
      DATA MJ/2,3,215,216,217,218,4/                                    00114700
      DATA Z2/.10,.15,.10,0.0,.30,.15/                                  00114800
      DATA NY3/136,3,137,138,139,6/                                     00114900
      DATA NY2/152,87,153,154,155,88/                                   00115000
      DATA NY1/68,49,69,147,70,50/                                      00115100
      WRITE(8,12345)                                                    00115200
12345 FORMAT('0',' THE SUBROUTINE SETUP ENTERED')                       00115300
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC00115400
C     CONVERT SLIPPAGE TO 1-SLIPPAGE                                    00115500
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC00115600
      DO 340 LJK=82,85                                                  00115700
  340 EXOG(I,LJK)=1.0- EXOG(I,LJK)                                      00115800
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC00115900
C                                                                       00116000
C     ADJUST SETASIDE IF DESIRED                                        00116100
C                                                                       00116200
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC00116300
      IF(IAJSET.EQ.0) GO TO 10                                          00116400
C     COMPUTE DESIRED LEVEL OF STOCKS                                   00116500
C     WHEAT                                                             00116600
      P(1)=B(I,042)-(EXOG(I,003)*EXOG(I,083)*B(I,006))                  00116700
C     SOYBEANS                                                          00116800
      P(2)=B(I,043)-(EXOG(I,005)*EXOG(I,084)*B(I,007))                  00116900
C     CORN                                                              00117000
      P(3)=B(I,227)-(EXOG(I,136)*EXOG(I,082)*B(I,219))                  00117100
C     GRAIN SORGHUM                                                     00117200
      P(4)=B(I,228)-(EXOG(I,137)*EXOG(I,082)*B(I,220))                  00117300
C     OATS                                                              00117400
      P(5)=B(I,229)-(EXOG(I,138)*EXOG(I,082)*B(I,221))                  00117500
C     BARLEY                                                            00117600
      P(6)=B(I,230)-(EXOG(I,139)*EXOG(I,082)*B(I,222))                  00117700
C     COTTON                                                            00117800
      P(7)=B(I,044)-(EXOG(I,006)*EXOG(I,085)*(B(I,008)/480.0))          00117900
      WRITE(8,150) (P(J40),J40=1,7)                                     00118000
  150 FORMAT('0',8F10.3)                                                00118100
C     WHEAT                                                             00118200
      EXOG(I,003)=((B(I,010)+EXOG(I,004)+C(J,042)-B(I,034)-B(I,038)-    00118300
     1P(1) )/B(I,006))/EXOG(I,083)                                      00118400
C     SOYBEANS                                                          00118500
      EXOG(I,005)=((B(I,011)+EXOG(I,122)+C(J,043)-B(I,035)-B(I,039)-    00118600
     1P(2) )/B(I,007))/EXOG(I,084)                                      00118700
C     CORN                                                              00118800
```

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00000000011111111112222222222333333333344444444445555555555666666666677777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
      EXOG(I,136)=((B(I,223)+EXOG(I,118)+C(J,227)-B(I,265)-B(I,239)-    00118900
     1P(3)  )/B(I,219))/EXOG(I,082)                                     00119000
C     GRAIN SORGHUM                                                     00119100
      EXOG(I,137)=((B(I,224)+EXOG(I,119)+C(J,228)-B(I,266)-B(I,243)-    00119200
     1P(4) )/B(I,220))/EXOG(I,082)                                      00119300
C     OATS                                                              00119400
      EXOG(I,138)=((B(I,225)+EXOG(I,120)+C(J,229)-B(I,267)-B(I,247)-    00119500
     1P(5) )/B(I,221))/EXOG(I,082)                                      00119600
C     BARLEY                                                            00119700
      EXOG(I,139)=((B(I,226)+EXOG(I,121)+C(J,230)-B(I,268)-B(I,251)-    00119800
     1P(6) )/B(I,222))/EXOG(I,082)                                      00119900
C     COTTON                                                            00120000
      EXOG(I,006)=((B(I,012)+EXOG(I,007)+C(J,044)-B(I,032)-B(I,040)-    00120100
     1P(7))/(B(I,008)/480.0))/EXOG(I,85)                                00120200
      DO 41 J19=1,7                                                     00120300
   41 IF(EXOG(I,MI(J19)).LT.0.0) EXOG(I,MI(J19))=0.0                    00120400
      DO 42 J19=1,7                                                     00120500
   42 IF(EXOG(I,MI(J19)).GE.(.28*B(I,MJ(J19)))) EXOG(I,MI(J19))=.28*    00120600
     1B(I,MJ(J19))                                                      00120700
   10 CONTINUE                                                          00120800
      IF(IAJLOT.EQ.0) GO TO 20                                          00120900
C     COMPUTE DESIRED LEVEL OF STOCKS                                   00121000
C     WHEAT                                                             00121100
      P(1)=B(I,042)-(B(I,006)*EXOG(I,049))                              00121200
C     CORN                                                              00121300
      P(3)=B(I,227)-(B(I,219)*EXOG(I,068))                              00121400
C     GRAIN SORGHUM                                                     00121500
      P(4)=B(I,228)-(B(I,220)*EXOG(I,069))                              00121600
C     OATS                                                              00121700
      P(5)=B(I,229)-(B(I,221)*EXOG(I,147))                              00121800
C     BARLEY                                                            00121900
      P(6)=B(I,230)-(B(I,222)*EXOG(I,070))                              00122000
C     COTTON                                                            00122100
      P(7)=B(I,044)-((B(I,008)/480.0)*EXOG(I,050))                      00122200
C     WHEAT                                                             00122300
      EXOG(I,049)= (B(I,010)+EXOG(I,004)+C(J,042)-B(I,034)-B(I,038)-    00122400
     1P(1) )/B(I,006)                                                   00122500
C     CORN                                                              00122600
      EXOG(I,068)= (B(I,223)+EXOG(I,118)+C(J,227)-B(I,265)-B(I,239)-    00122700
     1P(3)  )/B(I,219)                                                  00122800
C     GRAIN SORGHUM                                                     00122900
      EXOG(I,069)= (B(I,224)+EXOG(I,119)+C(J,228)-B(I,266)-B(I,243)-    00123000
     1P(4) )/B(I,220)                                                   00123100
C     OATS                                                              00123200
      EXOG(I,147)= (B(I,225)+EXOG(I,120)+C(J,229)-B(I,267)-B(I,247)-    00123300
     1P(5) )/B(I,221)                                                   00123400
C     BARLEY                                                            00123500
      EXOG(I,070)= (B(I,226)+EXOG(I,121)+C(J,230)-B(I,268)-B(I,251)-    00123600
     1P(6) )/B(I,222)                                                   00123700
C     COTTON                                                            00123800
      EXOG(I,050)= (B(I,012)+EXOG(I,007)+C(J,044)-B(I,032)-B(I,040)-    00123900
     1P(7))/(B(I,008)/480.0)                                            00124000
      DO 35 J395=1,6                                                    00124100
   35 IF(EXOG(I,NY1(J395)).LT.0.0)  EXOG(I,NY1(J395))=0.0               00124200
```

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00000000011111111112222222222333333333344444444445555555555666666666677777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
   20 CONTINUE                                                          00124300
      IF(IAPART.EQ.0) GO TO 30                                          00124400
C     COMPUTE  NEW PARTICIPATION RATES                                  00124500
C     CORN                                                              00124600
      DO 31 J394=1,6                                                    00124700
      IF(Z2(J394)*EXOG(I,NY1(J394)).EQ.0.0)  GO TO 31                   00124800
      EXOG(I,NY2(J394))=EXOG(I,NY3(J394))/(Z2(J394)*EXOG(I,NY1(J394)))  00124900
      IF(EXOG(I,NY2(J394)).EQ.0.0) EXOG(I,NY2(J394))=OLDEXO(I,NY2(J394))00125000
      IF(EXOG(I,NY2(J394)).GT.1.0) EXOG(I,NY2(J394))=1.0                00125100
      WRITE(8,39) NY2(J394),EXOG(I,NY2(J394)),OLDEXO(I,NY2(J394))       00125200
   39 FORMAT('0',I4,2X,F9.3,3X,F9.3)                                    00125300
   31 CONTINUE                                                          00125400
   30 CONTINUE                                                          00125500
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC00125600
C                                                                       00125700
C     IF FREE MARKET IS ASSUMMED OR NO SETASIDE AND DIVSERSION PROG-    00125800
C     RAM IS ASSUMMED SET SETASIDES AND DIVERSIONS TO ZERO              00125900
C                                                                       00126000
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC00126100
      IF(FREMKT.EQ.1.OR.DIVAC.EQ.0) EXOG(I,3)=0.0                       00126200
      IF(FREMKT.EQ.1.OR.DIVAC.EQ.0) EXOG(I,5)=0.0                       00126300
      IF(FREMKT.EQ.1.OR.DIVAC.EQ.0) EXOG(I,6)=0.0                       00126400
      IF(FREMKT.EQ.1.OR.DIVAC.EQ.0) EXOG(I,136)=0.0                     00126500
      IF(FREMKT.EQ.1.OR.DIVAC.EQ.0) EXOG(I,137)=0.0                     00126600
      IF(FREMKT.EQ.1.OR.DIVAC.EQ.0) EXOG(I,138)=0.0                     00126700
      IF(FREMKT.EQ.1.OR.DIVAC.EQ.0) EXOG(I,139)=0.0                     00126800
      IF(FREMKT.EQ.1.OR.DIVAC.EQ.0)     EXOG(I,199)=0.0                 00126900
      IF(FREMKT.EQ.1.OR.DIVAC.EQ.0)     EXOG(I,200)=0.0                 00127000
      IF(FREMKT.EQ.1.OR.DIVAC.EQ.0)     EXOG(I,201)=0.0                 00127100
      IF(FREMKT.EQ.1.OR.DIVAC.EQ.0)     EXOG(I,203)=0.0                 00127200
      IF(FREMKT.EQ.1.OR.DIVAC.EQ.0)     EXOG(I,177)=0.0                 00127300
      IF(FREMKT.EQ.1.OR.DIVAC.EQ.0)     EXOG(I,175)=0.0                 00127400
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC00127500
C     THE OBJECTIVE OF THE FOLLOWING COMMANDS IS TO MODIFY BASELINE     00127600
C     HARVESTED ACREAGE FOR CHANGES IN USER SUPPLIED  SETASIDES AND     00127700
C     DIVERSIONS.                                                       00127800
C     THE ULTIMATE  EFFECT UPON BASE HARVESTED ACREAGE CAN BE           00127900
C     EXPRESSED AS FOLLOWS :                                            00128000
C       NEW BASE = OLDBASE-(1-SLIPPAGE)*(CHANGE IN SETASIDE + CHANGE    00128100
C         IN DIVERSIONS )                                               00128200
C                                                     GREGG PARVIN      00128300
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC00128400
      CORNAC= ACRE(I,017)+ACRE(I,009)*(ACRE(I,013)+ACRE(I,021))         00128500
      GSAC  = ACRE(I,018)+ACRE(I,009)*(ACRE(I,014)+ACRE(I,022))         00128600
      OATAC = ACRE(I,019)+ACRE(I,009)*(ACRE(I,015)+ACRE(I,023))         00128700
      BARAC = ACRE(I,020)+ACRE(I,009)*(ACRE(I,016)+ACRE(I,024))         00128800
      WHAC  = ACRE(I,002)+ACRE(I,010)*(ACRE(I,006)+ACRE(I,025))         00128900
      SYAC  = ACRE(I,003)+ACRE(I,011)*(ACRE(I,007)+ACRE(I,026))         00129000
      CTAC  = ACRE(I,004)+ACRE(I,012)*(ACRE(I,008)+ACRE(I,027))         00129100
      B(I,217)=OATAC   -(EXOG(I,082)*(EXOG(I,138) + EXOG(I,201)))       00129200
      B(I,003)=SYAC    -(EXOG(I,084)*(EXOG(I,005) + EXOG(I,177)))       00129300
      B(I,215)=ACRE(I,017)*(1.0-EXOG(I,210)) + ACRE(I,017)*EXOG(I,210)  00129400
     1*(1.0-EXOG(I,082))                                                00129500
      B(I,002)=ACRE(I,002)*(1.0-EXOG(I,211)) + ACRE(I,002)*EXOG(I,211)  00129600
```

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     00000000011111111112222222222333333333344444444445555555555666666666677777777778
     12345678901234567890123456789012345678901234567890123456789012345678901234567890
          1*(1.0-EXOG(I,083))                                                   00129700
           B(I,004)=ACRE(I,004)*(1.0-EXOG(I,212)) + ACRE(I,004)*EXOG(I,212)     00129800
          1*(1.0-EXOG(I,085))                                                   00129900
           B(I,216)=ACRE(I,018)*(1.0-EXOG(I,213)) + ACRE(I,018)*EXOG(I,213)     00130000
          1*(1.0-EXOG(I,082))                                                   00130100
           B(I,218)=ACRE(I,020)*(1.0-EXOG(I,214)) + ACRE(I,020)*EXOG(I,214)     00130200
          1 *(1.0-EXOG(I,082))                                                  00130300
     C     CONVERT 1-S TO SLIPPAGE                                              00130400
           DO 341 LJK=82,85                                                     00130500
       341 EXOG(I,LJK)=1.0-EXOG(I,LJK)                                          00130600
           RETURN                                                               00130700
           END                                                                  00130800
```

APPENDIX B

DESCRIPTION OF GAUSS-SEIDEL ITERATIVE TECHNIQUE

The solution technique chosen to be used in POLYSIM was the Gauss-Seidel Iterative. This solution technique was chosen because of its wide use and acceptance, its relative simplicity when compared to other techniques and the ease of modification of this technique to consider different specifications of the crop demand sectors. The Gauss-Seidel iterative technique has been used as the solution techniques in conducting simulations of econometric models such as Holbrook (1976), Chow (1976) and Hein (1973) which involve simultaneous relationships. This solution technique is simply an iterative technique which is explained in the following paragraphs.

Consider the situation of endogenous variables, denoted Y1, ..., Yg, which are related simultaneously and each of which is represented by a normalized equation. Each endogenous variable is assumed to be a function of the other g-1 endogenous variables and k exogenous variables, denoted X1, ..., Xk. This system might be expressed as:

$$Y1 = f1(Y2,...,Yg;X1,...,Xk)$$

$$Y2 = f2(Y1,Y3,...,Yg;X1,...,Xk)$$

$$\vdots$$

$$Yg = fg(Y1,...,Yg-1;X1,...,Xk)$$

Let the initial "guess" of the solution set for the endogenous variables be denoted as the set (Y10,...,Yg0). From these initial "guesses", the first iteration values can

be computed as:

Y11 = f1(Y20,...,Yg0;X1,...,Xk)

Y21 = f2(Y11,...,Yg1;X1,..., Xk)

.

.

.

Yg1 = fg(Y11,...,Yg-11;X1,...,Xk)

The first iteration values can then be used to compute the second iteration values as:

Y12 = f1(Y21,...,Yg1;X1,...,Xk)

Y22 = f2(Y12,...,Yg1;X1,..., Xk)

.

.

.

Yg2 = fg(Y12,...,Yg-12;X1,...,Xk)

This iterative scheme is continued until for some given convergence criterion a specified tolerance level, say, b is reached for all endogenous variables in the system. The convergence criterion and tolerance level are related in the following manner in POLYSIM: |(Yik - Yik-1)| /Yik-1 must be less than or equal to b for all i, where k denotes the iteration number. In POLYSIM the tolerance level (b) is set equal to .0001.

The major problem associated with the use of the

Gauss-Siedel iterative technique is that a solution is not guaranteed. This problem, in general, can be eliminated by careful choice of the variables to normalize upon, the ordering of equations, and the use of dampening factors. The choice of endogenous variables to normalize upon is somewhat fixed in POLYSIM. The simulator has to obtain a solution for a certain set or minimum set of endogenous variables which will adequately describe the crops included in the model.

As can be seen from the above description of the Gauss-Siedel interative technique, this technique computes solutions in a somewhat recursive fashion. If the system being simulated can be ordered, from an equation standpoint, to make it as recursive as possible, convergence is much easier to achieve. The ordering of the equations in POLYSIM which involve simultaneity are shown in Figure 7-9.

A dampening factor is a device used to reduce the magnitude of the oscillations from one iteration to the next. The jth iteration when dampening factors are considered may be defined as

Yjg = W*Yjg+(1-W)*Yig

for all endogenous variables and i is equal to j-1 and W lies in the closed bound 0 to 1.0. A dampening factor when used with a lowered tolerance level for convergence can yield the same solution as a non-dampened solution

Equation \ Variable Name	Soybean Crushing Demand	Soybean Export Demand	Soybean Total Demand	Soybean Price	Soybean Meal Domestic Demand	Soybean Meal Export Demand	Soybean Meal Total Demand	Soybean Meal Price
Soybean Crushing Demand	X			X				X
Soybean Export Demand		X		X				
Soybean Total Demand	X	X	X					
Soybean Price			X	X				
Soybean Meal Domestic Demand					X			X
Soybean Meal Export Demand						X		X
Soybean Meal Total Demand					X	X	X	
Soybean Meal Price							X	X

Figure 7. Simultaneity Flow of Soybean and Soybean Meal Sector

Equation / Variable Name	Corn Feed Demand	Corn Export Demand	Corn Total Demand	Corn Price	Wheat Food Demand	Wheat Export Demand	Wheat Feed Demand	Wheat Total Demand	Wheat Price	Grain Sorghum Feed Demand	Grain Sorghum Export Demand	Grain Sorghum Total Demand	Grain Sorghum Price	Oat Feed Demand	Oat Total Demand	Oat Price	Barley Feed Demand	Barley Total Demand	Barley Price
Corn Feed Demand	X			X															
Corn Export Demand		X		X															
Corn Total Demand	X	X	X																
Corn Price			X	X															
Wheat Food Demand					X				X										
Wheat Export Demand						X			X										
Wheat Feed Demand				X			X		X										
Wheat Total Demand					X	X	X	X	X										
Wheat Price								X	X										
Grain Sorghum Feed Demand				X						X									
Grain Sorghum Export Demand										X			X						
Grain Sorghum Total Demand										X	X	X							
Grain Sorghum Price												X	X						
Oat Feed Demand														X		X			
Oat Total Demand														X	X				
Oat Price															X	X			
Barley Feed Demand				X													X		X
Barley Total Demand																	X	X	
Barley Price																		X	X

Figure 8. Simultaneity Flow of Feed Grain and Wheat Sector

Variable Name	Cotton Domestic Demand	Cotton Export Demand	Cotton Total Demand	Cotton Price
Cotton Domestic Demand	X			X
Cotton Export Demand		X		
Cotton Total Demand	X	X	X	
Cotton Price			X	X

Figure 9. Simultaneity Flow of Cotton Sector

with a higher or less stringent tolerance level for convergence and also substantially reduce the number of iterations necessary to obtain convergence. Dampening factors have been incor- porated in POLYSIM with W set equal to 0.5.

APPENDIX C

OPTIMAL CONTROL VARIABLE VALUES AND SELECTED ENDOGENOUS VARIABLES FOR 0, 30, 50, 70, 100 APPLICATIONS

TABLE XXX

OPTIMAL VALUES OF CONTROL VARIABLES AND SELECTED ENDOGENOUS VARIABLES FOR 0 APPLICATION, 1980-83[1]

Item	Unit	1980	1981	1982	1983
CONTROL VARIABLE					
Loan Rates					
Corn	$/bu.	2.68	2.78	2.78	2.96
Wheat	$/bu.	2.93	3.15	3.19	3.42
Cotton	$/lb.	0.52	0.52	0.52	0.54
Set-Aside Rate					
Corn	%	16.40	22.90	27.80	29.30
Wheat	%	22.30	23.90	24.40	25.90
Cotton	%	18.30	20.80	20.90	24.10
ENDOGENOUS VARIABLES					
Effective Set-Aside Rate					
Corn	%	16.40	22.90	27.80	29.30
Wheat	%	22.30	23.90	24.40	25.90
Cotton	%	18.30	20.80	20.90	24.10
Reduction in Production from Baseline					
Feed Grains in Aggregate	%	16.4	22.9	27.8	29.3
Wheat	%	22.8	28.7	29.2	31.1
Cotton	%	18.9	21.9	14.4	21.7
Harvested Acreage					
Corn	M. ac.	61.4	55.6	49.1	46.7
Wheat	M. ac.	51.8	45.1	42.3	41.6
Cotton	M. ac.	8.9	8.9	10.0	9.8
Feed Grains in Aggregate	M. ac.	92.5	83.3	75.0	71.9
Yield					
Corn	bu./ac.	102.2	104.1	106.8	109.3
Wheat	bu./ac.	32.5	33.9	34.6	35.3
Cotton	lb./ac.	490.2	517.7	555.8	563.1
Feed Grains in Aggregate	tons/ac.	2.3	2.3	2.4	2.4

TABLE XXX (Continued)

Item	Unit	1980	1981	1982	1983
Exports					
Corn	M. bu.	1941.5	1772.9	1646.6	1615.4
Wheat	M. bu.	1041.9	867.0	807.9	786.9
Cotton	M. bales	4.8	3.8	4.2	3.9
Feed Grains in Aggregate	M. tons	218.8	197.9	181.1	173.9
Total Utilization					
Corn	M. bu.	6431.3	5811.8	5327.9	5100.6
Wheat	M. bu.	1810.0	1612.2	1522.0	1470.6
Cotton	M. bales	11.0	9.9	10.2	10.1
Feed Grains in Aggregate	M. tons	218.8	197.9	181.1	173.9
Ending Year Carry-out					
Corn	M. bu.	1655.8	1524.7	1449.6	1453.8
Wheat	M. bu.	853.3	770.9	715.1	715.1
Cotton	M. bales	2.2	1.4	1.4	1.3
Feed Grains in Aggregate	M. tons	56.6	52.6	50.5	50.9
Commodity Prices					
Corn	$/bu.	2.90	3.25	3.40	3.38
Wheat	$/bu.	5.03	5.82	5.88	6.22
Cotton	$/lb.	0.71	0.94	0.91	0.96
Feed Grains in Aggregate	$/ton	90.80	106.40	115.00	117.60
Cattle	$/cwt.	57.00	64.69	65.51	69.49
Hogs	$/cwt.	41.00	61.40	56.78	61.63
Milk	$/cwt.	11.69	13.96	14.70	15.01
Retail Meat Prices					
Choice Beef	$/lb.	2.36	2.78	2.79	2.89
Pork	$/lb.	1.23	1.70	1.78	2.02
Milk	$/1/2 gal.	1.05	1.27	1.35	1.45

[1]See footnote 1 of Table XXI

TABLE XXXI

OPTIMAL VALUES OF CONTROL VARIABLES AND SELECTED ENDOGENOUS VARIABLES FOR 30 APPLICATION, 1980-83[1]

Item	Unit	1980	1981	1982	1983
CONTROL VARIABLE					
Loan Rates					
Corn	$/bu.	2.08	2.09	2.11	2.29
Wheat	$/bu.	2.42	2.62	2.63	2.63
Cotton	$/lb.	0.38	0.38	0.42	0.82
Target Prices					
Corn	$/bu.	3.53	2.28	3.56	3.22
Wheat	$/bu.	4.86	4.28	4.42	4.09
Cotton	$/lb.	0.78	0.72	0.73	0.82
Set-Aside Rate					
Corn	%	16.4	35.0	55.0	58.6
Wheat	%	13.0	22.0	27.0	34.0
Cotton	%	12.8	39.0	54.7	58.3
ENDOGENOUS VARIABLES					
Effective Set-aside Rate					
Corn	%	8.2	17.5	27.4	29.3
Wheat	%	7.8	13.2	15.9	20.2
Cotton	%	11.5	35.1	49.2	52.5
Reduction in Production from Baseline					
Feed Grains in Aggregate	%	4.7	9.9	16.2	17.2
Wheat	%	4.7	3.5	4.5	6.3
Cotton	%	8.1	25.5	31.4	33.0
Harvested Acreage					
Corn	M. ac.	68.6	65.8	60.8	58.9
Wheat	M. ac.	64.2	62.9	60.9	61.3
Cotton	M. ac.	10.9	8.1	7.0	6.8
Feed Grains in Aggregate	M. ac.	102.2	98.7	91.3	89.0

TABLE XXXI (Continued)

Item	Unit	1980	1981	1982	1983
Yield					
Corn	bu./ac.	100.1	100.8	101.7	103.9
Wheat	bu./ac.	32.5	32.9	32.4	32.6
Cotton	lb./ac.	490.2	504.6	551.7	588.7
Feed Grains in Aggregate	ton/ac.	2.3	2.3	2.3	2.3
Exports					
Corn	M. bu.	2107.6	2070.1	1925.3	1898.4
Wheat	M. bu.	1249.8	1258.8	1264.8	1258.9
Cotton	M. bales	11.6	10.0	8.7	8.6
Feed Grains in Aggregate	M. tons	61.3	58.9	55.9	56.7
Set-Aside Payment Rate					
Corn	$/bu.	0.0	0.0	0.0	0.82
Wheat	$/bu.	0.0	1.14	0.94	2.23
Cotton	$/lb.	0.2	0.21	0.54	0.74
Deficiency Payments					
Corn	B. $	3.5	2.1	2.2	1.1
Wheat	B. $	1.2	0.5	0.4	0.0
Cotton	B. $	0.7	0.0	0.0	0.0
Feed Grains in Aggregate	B. $	4.2	2.6	2.8	1.5
Set-Aside Payments					
Corn	B. $	0.0	0.0	0.0	1.5
Wheat	B. $	0.0	0.3	0.3	0.9
Cotton	B. $	0.1	0.3	1.0	1.5
Feed Grains in Aggregate	B. $	0.0	0.0	0.0	1.5

TABLE XXXI (Continued)

Item	Unit	1980	1981	1982	1983
Commodity Prices					
Corn	$/bu.	2.55	2.71	2.97	2.93
Wheat	$/bu.	3.88	3.93	4.09	4.35
Cotton	$/lb.	0.61	0.93	1.13	1.11
Feed Grains in Aggregate	$/ton	86.13	91.50	98.50	102.80
Cattle	$/cwt.	57.00	61.03	62.59	66.50
Hogs	$/cwt.	41.00	52.14	51.36	55.70
Milk	$/cwt.	11.69	13.35	13.82	14.24
Retail Meat Prices					
Choice Beef	$/lb.	2.36	2.64	2.71	2.82
Pork	$/lb.	1.23	1.54	1.68	1.90
Milk	$/1/2 gal.	1.05	1.21	1.29	1.39

[1]See footnote 1 of Table XXI

TABLE XXXII

OPTIMAL VALUES OF CONTROL VARIABLES
AND SELECTED ENDOGENOUS VARIABLES
FOR 50 APPLICATION[1]

Item	Unit	1980	1981	1982	1983
CONTROL VARIABLE					
Loan Rates					
Corn	$/bu.	2.31	2.51	2.61	2.78
Wheat	$/bu.	2.79	3.09	3.51	3.63
Cotton	$/lb.	0.43	0.51	0.51	0.56
Target Prices					
Corn	$/bu.	3.69	3.59	3.88	4.15
Wheat	$/bu.	4.87	4.89	4.58	4.95
Cotton	$/lb.	0.78	0.83	0.80	0.90
Set-Aside Rate					
Corn	%	18.2	36.1	45.0	46.1
Wheat	%	20.8	21.3	32.7	36.8
Cotton	%	26.2	36.8	44.7	45.3
ENDOGENOUS VARIABLES					
Effective Set-aside Rate					
Corn	%	9.1	18.0	22.5	23.1
Wheat	%	12.5	12.8	19.6	22.1
Cotton	%	23.5	33.1	40.2	40.8
Reduction in Production from Baseline					
Feed Grains in Aggregate	%	5.2	10.5	13.3	13.5
Wheat	%	7.4	3.7	5.0	6.1
Cotton	%	16.5	23.7	21.9	29.9
Harvested Acreage					
Corn	M. ac.	68.2	65.4	62.8	62.2
Wheat	M. ac.	62.3	62.5	60.4	61.2
Cotton	M. ac.	9.1	8.1	7.9	7.9
Feed Grains in Aggregate	M. ac.	101.7	98.0	93.9	93.3

TABLE XXXII (Continued)

Item	Unit	1980	1981	1982	1983
Yield					
Corn	bu./ac.	100.1	100.9	101.9	103.2
Wheat	bu./ac.	32.5	33.0	32.5	32.7
Cotton	lb./ac.	490.2	514.5	556.4	574.4
Feed Grains in Aggregate	T./ac.	2.3	2.3	2.3	2.3
Exports					
Corn	M. bu.	2097.3	2057.9	1989.1	1986.5
Wheat	M. bu.	1219.4	1241.1	1253.8	1259.6
Cotton	M. bales	4.9	3.8	3.7	3.6
Feed Grains in Aggregate	M. ton	66.9	65.6	63.2	63.2
Total Utilization					
Corn	M. bu.	6838.6	6653.2	6424.1	6366.3
Wheat	M. bu.	2008.2	2037.5	2048.7	2053.4
Cotton	M. bales	11.2	9.8	9.7	9.6
Feed Grains in Aggregate	M. tons	232.9	226.5	218.2	216.3
Ending Year Carry-out					
Corn	M. bu.	1796.3	1743.4	1724.7	1774.8
Wheat	M. bu.	990.9	1018.6	935.4	885.9
Cotton	M. bales	2.3	2.4	2.6	1.1
Feed Grains in Aggregate	M. tons	60.9	58.9	58.2	60.3
Set-Aside Payment Rate					
Corn	$/bu.	0.00	0.00	0.00	0.00
Wheat	$/bu.	0.00	0.00	1.03	0.83
Cotton	$/lb.	0.27	0.30	0.56	0.59
Deficiency Payments					
Corn	B. $	4.0	3.1	3.8	5.0
Wheat	B. $	1.0	1.2	0.6	0.7
Cotton	B. $	0.4	0.0	0.0	0.0
Feed Grains in Aggregate	B. $	4.7	3.8	4.7	6.1

TABLE XXXII, (Continued)

Item	Unit	1980	1981	1982	1983
Set-Aside Payments					
Corn	B. $	0.0	0.0	0.0	0.0
Wheat	B. $	0.0	0.0	0.4	0.4
Cotton	B. $	0.2	0.4	1.0	1.1
Feed Grains in Aggregate	B. $	0.0	0.0	0.0	0.0
Commodity Prices					
Corn	$/bu.	2.57	2.73	2.83	2.78
Wheat	$/bu.	4.05	3.99	4.14	4.33
Cotton	$/lb.	0.69	0.95	1.00	1.02
Feed Grains in Aggregate	$/ton	86.43	92.65	97.13	98.48
Cattle	$/cwt.	57.00	61.26	62.63	65.05
Hogs	$/cwt.	41.00	52.72	51.37	52.38
Milk	$/cwt.	11.69	13.39	13.85	14.01
Retail Meat Prices					
Choice Beef	$/lb.	2.36	2.65	2.71	2.78
Pork	$/lb.	1.23	1.55	1.68	1.82
Milk	$/1/2gal.	1.05	1.22	1.29	1.37

[1]See footnote 1 of Table XXI

TABLE XXXIII

OPTIMAL VALUES OF CONTROL VARIABLES AND SELECTED7ENDOGENOUSIVARIABLES

Item	Unit	1980	1981	1982	1983
CONTROL VARIABLE					
Loan Rates					
Corn	$/bu.	2.26	2.48	2.52	2.53
Wheat	$/bu.	2.85	2.90	3.08	3.11
Cotton	$/lb.	0.45	0.50	0.51	0.51
Target Prices					
Corn	$/bu.	3.50	3.71	4.13	4.61
Wheat	$/bu.	5.01	4.89	5.17	5.39
Cotton	$/lb.	0.89	0.84	0.84	0.88
Set-Aside Rate					
Corn	%	8.6	11.5	21.3	22.1
Wheat	%	8.2	10.1	12.0	15.9
Cotton	%	12.5	16.5	20.7	21.8
ENDOGENOUS VARIABLES					
Effective Set-Aside Rate					
Corn	%	4.3	5.8	10.6	11.0
Wheat	%	4.9	6.1	7.2	9.6
Cotton	%	11.3	14.9	18.6	19.7
Reduction in Production from Baseline					
Feed Grains in Aggregate	%	2.4	3.0	5.5	6.2
Wheat	%	2.9	1.8	2.1	2.6
Cotton	%	7.8	10.6	8.6	10.2
Harvested Acreage					
Corn	M. ac.	70.3	71.4	69.8	69.5
Wheat	M. ac.	65.3	64.2	62.8	64.2
Cotton	M. ac.	9.9	9.7	9.7	9.9
Feed Grains in Aggregate	M. ac.	104.4	106.1	103.4	103.1

TABLE XXXIII (Continued)

Item	Unit	1980	1981	1982	1983
Yield					
Corn	bu./ac.	100.1	100.3	100.3	100.4
Wheat	bu./ac.	32.5	32.8	32.2	32.3
Cotton	lb./ac.	490.2	504.4	528.2	241.6
Feed Grains in Aggregate	ton/ac.	2.3	2.3	2.3	2.3
Exports					
Corn	M. bu.	2152.8	2194.2	2173.2	2149.5
Wheat	M. bu.	1268.6	1288.7	1309.1	1325.5
Cotton	M. bales	5.3	4.9	4.9	9.9
Feed Grains in Aggregate	M.tons	68.7	69.9	69.1	68.5
Total Utilization					
Corn	M. bu.	6985.3	7045.2	6998.4	6939.6
Wheat	M. bu.	2062.7	2088.6	2106.7	2123.9
Cotton	M. bales	11.6	11.1	11.2	11.3
Feed Grains in Aggregate	M.tons	237.6	66.6	66.5	67.8
Ending Year Carry-out					
Corn	M. bu.	1858.4	1980.6	1984.5	2018.6
Wheat	M. bu.	1035.6	1053.6	972.9	927.8
Cotton	M. bales	2.8	2.0	1.8	1.9
Feed Grains in Aggregate	M.tons	62.9	66.6	66.5	67.8
Set-Aside Payment Rate					
Corn	$/bu.	0.00	0.00	0.00	0.00
Wheat	$/bu.	0.00	0.00	0.00	0.00
Cotton	$/lb.	0.18	0.21	0.34	0.36
Deficiency Payments					
Corn	B. $	3.7	4.4	5.9	7.6
Wheat	B. $	1.4	1.4	1.6	1.7
Cotton	B. $	1.1	0.4	0.2	0.4
Feed Grains in Aggregate	B. $	4.4	5.3	6.9	9.0

TABLE XXXIII (Continued)

Item	Unit	1980	1981	1982	1983
Set-Aside Payments					
Corn	B. $	0.0	0.0	0.0	0.0
Wheat	B. $	0.0	0.0	0.0	0.0
Cotton	B. $	0.1	0.2	0.3	0.4
Feed Grains in Aggregate	B. $	0.0	0.0	0.0	0.0
Commodity Prices					
Corn	$/bu.	2.45	2.48	2.52	2.53
Wheat	$/bu.	3.77	3.79	3.89	4.03
Cotton	$/lb.	0.61	0.75	0.79	0.79
Feed Grains in Aggregate	$/ton	84.79	86.83	87.96	88.94
Cattle	$/cwt.	57.00	60.39	60.90	62.83
Hogs	$/cwt.	41.00	49.63	47.72	47.91
Milk	$/cwt.	11.69	13.18	13.43	13.47
Retail Meat Prices					
Choice Beef	$/lb.	2.36	2.62	2.67	2.73
Pork	$/lb.	1.23	1.49	1.61	1.73
Milk	$/1/2gal.	1.05	1.20	1.26	1.32

[1]See footnote 1 of Table XXI

TABLE XXXIV

OPTIMAL VALUES OF CONTROL VARIABLES AND SELECTED ENDOGENOUS VARIABLES FOR 100 APPLICATION[1]

Item	Unit	1980	1981	1982	1983
CONTROL VARIABLE					
Loan Rates					
Corn	$/bu.	2.20	2.32	2.32	2.32
Wheat	$/bu.	2.68	2.73	2.76	2.76
Cotton	$/lb.	0.38	0.39	0.40	0.44
Target Prices					
Corn	$/bu.	3.62	3.99	4.50	5.25
Wheat	$/bu.	5.47	5.17	5.30	5.73
Cotton	$/lb.	0.84	0.91	0.95	0.89
Set-Aside Rate					
Corn	%	2.2	2.6	3.8	4.0
Wheat	%	2.1	3.6	3.8	6.2
Cotton	%	2.2	2.2	4.4	4.7
ENDOGENOUS VARIABLES					
Effective Set aside Rate					
Corn	%	1.1	1.3	1.3	2.0
Wheat	%	1.3	2.2	2.3	3.7
Cotton	%	1.9	1.9	4.0	4.3
Reduction in Production from Baseline					
Feed Grains in Aggregate	%	0.1	0.1	0.1	0.1
Wheat	%	0.7	0.6	0.5	0.8
Cotton	%	1.3	1.4	2.0	2.0
Harvested Acreage					
Corn	M. ac.	71.7	73.6	74.5	74.7
Wheat	M. ac.	66.8	65.3	64.2	65.8
Cotton	M. ac.	10.7	10.8	10.8	11.3
Feed Grains in Aggregate	M. ac.	106.2	109.1	109.5	110.1

TABLE XXXIV (Continued)

Item	Unit	1980	1981	1982	1983
<u>Yield</u>					
Corn	bu./ac.	100.1	99.7	98.9	98.4
Wheat	bu./ac.	32.5	32.7	32.1	32.1
Cotton	lb./ac.	490.2	498.1	508.9	521.5
Feed Grains in Aggregate	ton/ac.	2.3	2.3	2.3	2.3
<u>Exports</u>					
Corn	M. bu.	2188.1	2265.1	2282.8	2276.0
Wheat	M. bu.	1291.9	1314.9	1339.8	1261.5
Cotton	M. bales	5.6	5.6	5.6	5.7
Feed Grains in Aggregate	M.ton	69.8	72.2	72.6	72.5
<u>Total Utilization</u>					
Corn	M. bu.	7078.7	7252.6	7333.3	7355.8
Wheat	M. bu.	2088.2	2116.7	2138.5	2160.9
Cotton	M. bales	11.9	12.0	12.1	12.3
Feed Grains in Aggregate	M. tons	240.6	246.3	248.3	249.2
<u>Ending Year Carry-out</u>					
Corn	M. bu.	1903.0	1990.2	2018.7	2016.7
Wheat	M. bu.	1058.0	1074.5	994.8	951.7
Cotton	M. bales	3.2	2.6	2.2	2.4
Feed Grains in Aggregate	M. tons	64.4	67.1	67.7	67.9
<u>Set-Aside Payment Rate</u>					
Corn	$/bu.	0.00	0.00	0.00	0.00
Wheat	$/bu.	0.00	0.00	0.00	0.00
Cotton	$/lb.	0.14	0.16	0.18	0.22
<u>Deficiency Payments</u>					
Corn	B. $	4.4	5.8	7.9	10.7
Wheat	B. $	2.1	1.9	2.0	2.3
Cotton	B. $	1.1	1.1	1.1	0.8
Feed Grains in Aggregate	B. $	5.2	6.8	9.2	12.5

TABLE XXXIV (Continued)

Item	Unit	1980	1981	1982	1983
Set-Aside Payments					
Corn	B. $	0.00	0.00	0.00	0.00
Wheat	B. $	0.00	0.00	0.00	0.00
Cotton	B. $	0.02	0.02	0.04	0.06
Feed Grains in Aggregate	B. $	0.00	0.00	0.00	0.00
Commodity Prices					
Corn	$/bu.	2.38	2.35	2.33	2.32
Wheat	$/bu.	3.65	3.67	3.75	3.86
Cotton	$/lb.	0.56	0.61	0.67	0.66
Feed Grains in Aggregate	$/ton	83.71	83.36	85.53	82.19
Cattle	$/cwt.	57.00	59.26	60.07	61.29
Hogs	%	41.00	47.66	46.05	44.65
Milk	%	11.69	13.05	13.21	13.14
Retail Meat Prices					
Choice Beef	$/lb.	2.36	2.60	2.65	2.69
Pork	$/lb.	1.23	1.46	1.58	1.66
Milk	$/1/2gal.	1.05	1.18	1.24	1.29

[1]See footnote 1 of Table XXI

VITA[2]

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