THE INTERMEDIATE UNITED STATES FOOD AND AGRICULTURE MODEL OF THE IIASA/FAP BASIC LINKED SYSTEM: SUMMARY DOCUMENTATION AND USER'S GUIDE

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FOREWORD

Understanding the nature and dimensions of the world food problem and the policies available to alleviate it has been the focal point of IIASA's Food and Agriculture Program (FAP) since it began in 1977.

National food systems are highly interdependent, and yet the major policy options exist at the national level. Therefore, to explore these options, it is necessary both to develop policy models for national economies and to link them together by trade and capital transfers. Over the years FAP has, with the help of a network of collaborating institutions, developed and linked national policy models of twenty countries, which together account for nearly 80 percent of important agricultural attributes such as area, production, population, exports, imports and so on. The remaining countries are represented by 14 somewhat simpler models of groups of countries.

Since the United States is a major actor on the world market, a special food and agriculture model of the United States was developed by the Michigan State University (MSU) and the U.S. Department of Agriculture (USDA) in collaboration with FAP to serve as the basic U.S. model in the IIASA/FAP basic linked system.

In this document Mike Abkin provides a summary description of the U.S. intermediate model and guidelines for implementing the model's computer program, as of its August 1984 version, and interpreting its results. It is intended to assist analysts in using this model for policy analysis as a part of the basic linked system.

This working paper is one of a series of Working Papers documenting the work that went into developing the various models of FAP's system of linked models.

Kirit S. Parikh
Program Leader
Food and Agriculture Program.

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THE INTERMEDIATE UNITED STATES FOOD AND AGRICULTURE MODEL OF THE IIASA/FAP BASIC LINKED SYSTEM: SUMMARY DOCUMENTATION AND USER'S GUIDE

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Chapter 1

INTRODUCTION AND OVERVIEW

The intermediate food and agriculture model of the United States has been developed by Michigan State University (MSU) and the U.S. Department of Agriculture (USDA) in collaboration with the Food and Agriculture Program of the International Institute for Applied Systems Analysis (IIASA/FAP) to serve as the basic U.S. model in the IIASA/FAP basic linked system. The mission of FAP is elaborated elsewhere (Rabar 1979; Parikh, 1981), as are the theoretical and mathematical derivations of the global trade and national exchange models and the domestic and internal equilibrium algorithms which link them (Keyzer, 1981).

This document provides a summary description of the U.S. intermediate model (USINT) and guidelines for implementing the model's computer program, *as of its August 1984 version*, and interpreting its results. It is intended to assist analysts in using USINT for policy analysis as part of the basic linked system. A more complete guide to the Fortran program of the basic linked system (including USINT) and the detailed U.S. model (also developed by MSU and USDA) as they are installed on the IBM 3033 computer at the USDA in Washington – including the structure of subroutines and COMMON blocks, input-output files, and run control parameters – is published in Abkin (1983). Other national models of the Basic Linked System are described in Fischer and Frohberg (1980).

Commodities and Units

The thirty commodities of supply in USINT are aggregated to twenty commodities for utilization purposes, and these are further aggregated to IIASA's ten commodities for the international linkage. Table 1.1 shows the commodity correspondences and units used in the model. There remain a few relatively minor inconsistencies between the commodity definitions of this version of the U.S. basic model and those of the international system. These will be resolved as the international commodity list for the basic system is expanded to the 19 commodities of the detailed model system in order to conduct analyses using both basic and detailed models. The current inconsistencies are:

Table.1.1. Commodities and units of U.S. intermediate model

International		Domestic Utilization		Domestic Supply	
Commodity[1]	Unit[3]	Commodity[1]	Unit[3]	Commodity[2]	Unit[3]
1. Wheat	th.MT (grain)	1. Wheat	th.MT (grain)	1. Wheat	th.bu
2. Rice	th.MT (polished)	2. Rice	th.MT (polished)	2. Rice	th.cwt. (rough)
3. Coarse grain	th.MT (grain)	3. Coarse grain	th.MT (grain)	3. Corn	th.bu
				4. Sorghum	th.bu
				5. Barley	th.bu
				6. Oats	th.bu
4. Beef, sheep	th.MT (carcass)	12. Beef	th.MT (carcass)	7. Fed beef	mi.lbs. (live)
				8. Nonfed beef	mi.lbs. (live)
		13. Lamb, mutton	th.MT (carcass)	9. Sheep & lambs	th.lbs. (live)
5. Dairy	th.MT (milk)	17. Dairy	th.MT (milk)	10. Milk	mi.lbs.
6. Other animal	th.MT (protein)	14. Pork	th.MT (carcass)	11. Pork	mi.lbs. (live)
		15. Poultry	th.MT (RTC)	12. Turkey	mi.lbs. (RTC)
				13. Chicken	mi.lbs. (RTC)
		16. Eggs	th.MT (fresh)	14. Eggs	mi.dozen
		18. Fish	th.MT (fresh)	15. Fish	mi.lbs. (fresh)
7. Protein feeds	th.MT (protein)	19. Protein feeds	th.MT (meal)	16. Soybeans	th.bu
				17. Cottonseed	th.tons
				18. Peanuts	th.lbs. (farm wt.)
				19. Flaxseed	th.bu
8. Other foods[4]	mi.$ (1970)	4. Potatoes	th.MT	20. Potatoes	th.cwt.
		5. Vegetables	th.MT	21. Vegetables	th.tons
		6. Dry beans	th.MT	22. Dry beans	th.cwt.
		7. Fruits, nuts	th.MT	23. Fruits, nuts	th.tons
				18. Peanuts	th.lbs. (farm wt.)
		9. Fats & oils	th.MT (oil)	11. Pork	mi.lbs. (live)
				16. Soybeans	th.bu
				18. Peanuts	th.lbs. (farm wt.)
				19. Flaxseed	th.bu
				24. Cottonseed oil	mi.lbs. (oil)
		10. Sugar[4]	th.MT (refined)	25. Cane sugar	th.tons (raw)
				26. Sugarbeets	th.tons (beets)
		11. Coffee,tea,cocoa[4]	th.MT (beans)	none	
9. Nonfood agriculture	mi.$ (1970)	8. Tobacco	th.MT (farm wt.)	27. Tobacco	th.lbs.(farm wt.)
		20. Nonagriculture	mi.$ (1967)	28. Cotton	th.bales
				29. Wool	th.lbs.
10. Nonagriculture	mi.$ (1970)	20. Nonagriculture	mi.$ (1967)	30. Nonagriculture	mi.$ (1967)

Notes:

[1]Includes processed products in fresh equivalents.

[2]Additional commodities modeled on the supply side, but not on the demand side, are beef cows (th.head), dairy heifers (th.head), sows (th.head), corn silage (th.tons), and sorghum silage (th.tons).

[3]Unit symbols: th=thousand; mi=million; MT=metric tons; $ =U.S. dollars; RTC =ready to cook; bu = bushels; cwt=hundred weight (100 pounds); lbs=pounds; tons=short tons (2000 pounds)

[4]See the text for discussion of inconsistencies in commodity definition

1. alcoholic beverage consumption should be included in the "other foods" category, whereas the model currently includes it in aggregate consumption of the primary ingredients (e.g. wheat, coarse grains, fruits, etc.);
2. use of sweeteners derived from corn should be included with sugar in "other foods" instead of its current accounting in "coarse grains";
3. "coffee, tea, cocoa" currently includes only coffee; and
4. a few miscellaneous items, such as flowers and hides and skins, are not yet accounted for in "nonfood agriculture"; likewise for miscellaneous crops, such as rye.

Model Structure and Chapter Outline

Figure 1.1 is a simplified schematic flow diagram of USINT, indicating the principal components and linkages of the system. The exchange side of the model (enclosed by the dotted line in the diagram) determines equilibrium prices and quantities simultaneously, as shown by the two-way arrows. All components within the exchange, except feed demand, are described in Chapter 4.

On the supply side, production is based on lagged prices. The livestock and crop production components are described in Chapters 2 and 3, including feed demand, the land resource subcomponent and the model of the government's commodity programs. The demography and general economy model and the nonagricultural production component are touched on briefly in Chapter 7. Domestic supply is simply the sum of production and beginning stocks.

Chapters 5 and 6 are intended to be of direct assistance in using USINT for policy analysis in that they describe, respectively, how policy assumptions and scenarios may be manipulated in the model and the information and formats generated by USINT's report writer. Chapter 7, then, recommends priority areas for both updating the model and further developing it. Finally, Appendix A defines the numbered endogenous and exogenous variables of the model; and Appendix B describes the call sequence of the Fortran subroutines and the functions of the subroutines and their relationship to the components shown in Figure 1.1.

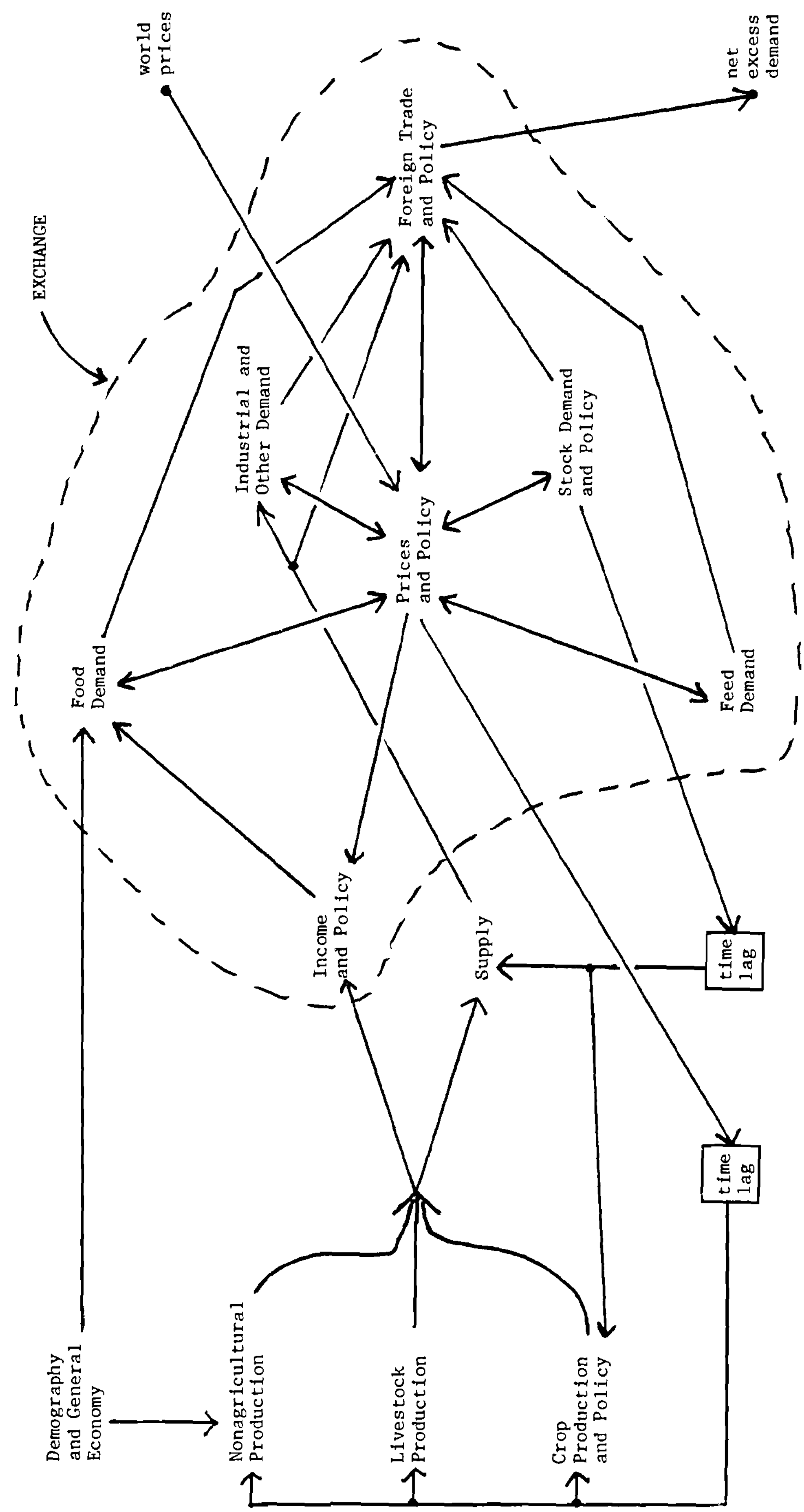

Figure 1.1
Flow Diagram of the U.S. Intermediate Model

Chapter 2

A DESCRIPTION OF THE SUPPLY, POLICY AND FEED DEMAND COMPONENTS OF THE U.S. INTERMEDIATE AGRICULTURAL MODEL

by
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Thomas Christensen

Introduction

The U.S. intermediate model (USINT) is a synthesis of contributions from various sources. The U.S. crop and livestock supply, government policy and feed demand components of the U.S. model have resulted from the adaptation of the MSU Agriculture Model, an agricultural forecasting model developed at Michigan State University. The development and refinement of the MSU Agricultural Model has involved many individuals; however, the portions used in USINT are primarily the work of Eric Wailes. Major contributions were made by John Ferris, Donald O. Mitchell, Thomas H. Christensen and J. Roy Black. Descriptions of the MSU Agricultural Model are available in Wailes (1981), Mitchell (1979) and Christensen (1979). Only those portions of the MSU Agriculture Model that have been incorporated into USINT are described in this chapter.

The U.S. agricultural supply model is an econometrically based annual model. It is a national supply model of production, consumption, exports, stocks and prices of grains, oilseeds, livestock and a number of minor agricultural products. The model does not include detailed resource use or factors of production information; it does have a detailed component which deals with government agricultural policy.

The U.S. supply model is designed to be an intermediate term (5- to 15-year) forecasting model. With the land resource component (Chapter 3), the model has limited application to longer-run issues of cropland availability and utilization. However, it should not be expected to project long-term structural adjustments in U.S. agriculture due to resource reallocation. Nor should it be used to answer questions related to resource quality, environmental impacts or input utilization in agriculture. The model is especially well equipped to address questions related to producer responses to price changes and to government policy changes. Table 2.1 shows the commodities included in the U.S. supply model.

Table 2.1 Commodities, units and year definitions of the supply module of the U.S. intermediate agricultural model

	Commodity		Unit*	Year Definition
1.	Wheat		th.bu.	July 1-June 30
2.	Rice (rough basis)		th.cwt.	Jan. 1-Dec. 31
3.	Corn	grain	th.bu.	Oct. 1-Sept. 30
		silage	th.tons	
4.	Sorghum	grain	th.bu.	Oct. 1-Sept. 30
		silage	th.tons	
5.	Barley		th.bu.	July 1-June 30
6.	Oats		th.bu.	" "
7.	Beef	fed (live basis)	mi.lbs.	Jan. 1-Dec. 31
		nonfeed (live basis)	mi.lbs.	
8.	Sheep and lambs, meat (live basis)		th.lbs.	" "
		wool	th.lbs.	
9.	Milk		mi.lbs.	" "
10.	Pork (live basis)		mi.lbs.	" "
11.	Turkey (ready-to-cook-basis)		mi.lbs.	" "
12.	Chicken (ready-to-cook-basis)		mi.lbs.	" "
13.	Eggs		mi.doz.	" "
14.	Fish (fresh basis)		mi.lbs.	" "
15.	Soybeans	beans	th.bu.	Oct. 1-Sept. 30
		meal	th.tons	
		oil	mi.lbs.	
16.	Cotton	fiber	th.bales	Aug. 1-July 31
		cottonseed	th.tons	
		meal	th.tons	
		oil	mi.lbs.	
17.	Peanuts (farm weight basis)		th.lbs.	Aug. 1-July 31
18.	Flaxseed		th.bu.	July 1-June 30
19.	Potatoes		th.cwt.	Oct. 1-Sept. 30
20.	Vegetables		th.tons	July 1-June 30
21.	Dry beans		th.cwt.	" "
22.	Fruits and nuts		th.tons	" "
23.	Cane Sugar (raw basis)		th.tons	Jan. 1-Dec. 31
24.	Sugarbeets		th.tons	" "
25.	Tobacco (farm weight basis)		th.lbs.	" "

*Unit Symbols: th. = thousand; mi. = million; bu. = bushel; bale = 480 lbs.; cwt. = hundred weight (100 lbs.); lbs. = pounds; tons = short tons (2000 lbs.).

Model Specification Procedures

The primary emphasis in developing the U.S. model was specification of the structural relationships within and between sectors. To accomplish this objective, close interaction between model researchers and commodity experts was maintained. This procedure was followed from the initial stages of model development through the testing and validation of the entire system. Numerous cross checks, balance sheets and measures of sector alignment were built into the model to aid the researchers in evaluating the entire system.

Intersector "balance" was explicitly tested for during the specification and respecification. Intersector balance refers to the relationship of each sector to all other sectors. This phase of model development requires close working relationships between commodity experts and modelers. The approach represents a modeling philosophy used throughout this project.

Following this same philosophy, model forecasts include the same scrutiny as did the model development. Structural changes which cannot be estimated from historical data are introduced in the model in a systematic way. For example, the increase in energy costs which occurred in the late 1970's have introduced a structural change into the acreage allocation component of the model. Since corn and soybean profitability are not equally affected by an increase in this input, a new relationship will develop between these two crops. Before the change in input costs, farmers based their acreage decision on the expected relative prices. This change cannot be observed from the historical data, so the researcher must attempt to estimate the extent of structural adjustment and impose these changes on the model. This change was introduced into the model by adjusting the acreage equations' estimated coefficients to reflect the shift in profitability.

Characteristics of U.S. Demand for Grain and Soybeans

The U.S. agricultural grain and soybean sectors center around two primary sources of demand: exports and livestock feed. Approximately 87 percent of all grain produced is used for these two purposes. An additional 2 percent of production is used as seed and 11 percent are consumed directly by humans. Table 2.2 shows the utilization of wheat, soybeans and feedgrains for 1978.

These sources of demand result in several unique problems. Export demand is highly variable, depending in the short run on production in the rest of the world. Long-run growth in export demand is a function of income, population and productivity growth. Additionally, meat utilization is relatively price and income responsive, varying with general economic activity. Together these characteristics result in the U.S. agricultural economy being very sensitive to fluctuations in demand.

Most countries experience stable demand due to the relatively inelastic response of direct human grain consumption to either price or income changes. In contrast, the U.S. has both fluctuating supply and fluctuating demand. In years of low demand and high supply levels, it is possible to build enormous surpluses, while, in years of high demand and low supply levels, very high prices can result. This price volatility problem has led to a series of government policies which are directed at simultaneously dampening both extremes.

Model Capabilities

The model is especially well suited to the analysis of government policies related to food and feed to grains. Policies related to both supply restrictions and grain stock management are endogenous to the policy framework. Income maintenance and price support policies can also be handled by the policy framework.

Table 2.2 Utilization of Wheat, Soybeans and Feed Grains in 1978 in million bushels

Commodity	Feed	Export	Seed	Other	Total Use
Wheat	180.1	1190.5	87.0	595.2	2052.8
Soybeans*a	757.7	1011.3	76.0	13.0	1858
Feed Grains*b	5235.0	2369.5	54.7	723.6	8382.8
Corn	4187.0	2130.0	18.0	557	6902
Barley	200.0	26.0	16.6	159.4	402.0
Oats	533.0	12.7	35.8	42.5	624.0
Sorghum	572.0	200.0	2.0	5.7	779.7

*a Based on a 60-pound bean equivalent bushel.

*b Sum of Corn, Oats, Barley and Sorghum based on a 56-pound equivalent bushel.

Since government policies have historically related to the grain sector rather than to livestock production, no policy framework exists for the livestock sector.

In order to a provide a general framework for policy analysis, several policy variables were defined and then included as explanatory variables in the decision process of the producer. For example, acreage allocation policies are expressed in two variables, even though many variations have existed through the years. All policies have related to price support or acreage diversion. Price supports encourage production while acreage diversion discourages production. Within these two variables are seven specific policy tools which may be varied independently. Since it is impossible to separate the effect of each policy tool independently, an expected value of each policy tool is included in the general policy variable. This results in a very flexible and manageable way of incorporating government policy into the decision process.

The model is not well suited to analyzing questions related to long-run resource requirements, input usage, technological change, investment or environment. The linkage between the resource base and production is not well developed. The only inputs explicitly considered are land (see Chapter 3), fertilizer and short-term capital. No distinction between land quality is made, nor is land productivity directly related to the amount of land cultivated. Land productivity is directly tied to government diversion and set-aside programs. Water quality or quantity is not considered either, and the number of acres of cropland irrigated is not identified.

Crop Supply

Crop production is calculated as the product of separately estimated harvested acres and yield per acre. Harvested acres are estimated as a function of planted acres, with some price and time responsiveness. Planted acres are estimated as a function of lagged planted acres, lagged relative crop prices and current government policy variables. Planted acres are then constrained from above by the available extensive and intensive cropland base. This two-step procedure for obtaining planted acres is shown in Figure 2.1. Total cropland under cultivation in a given year is shown by the area of the circle. The allocation of this area is shown by the portion of the cropland devoted to each crop.

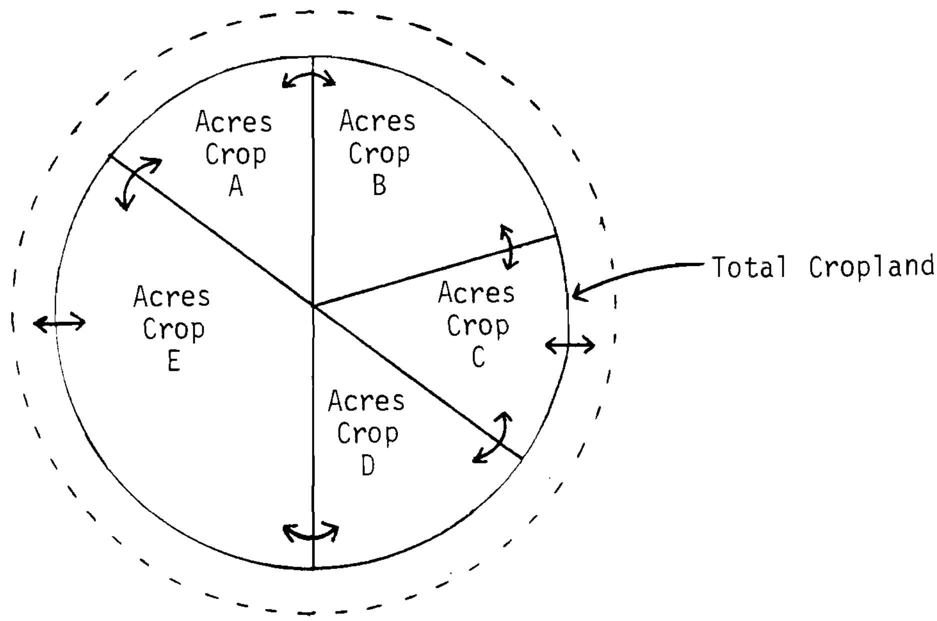


Figure 2.1 Cropland Allocation Model

A four-step procedure is used for estimating planted and harvested area. First, the land available for crops (total and intensive) in year t, CLB_t, is estimated in the land resource component (Chapter 3). Then this land is allocated to the various crops, as shown in equation (1).

(1) Acreage Allocation Equations

$$\underline{AP}_{it} = f(AP_{i,t-1}, P_{i,t-1}, P_{j,t-1}, GPV_t) \tag{1}$$

where $\underline{AP}_{it}$ is the desired acres planted to crop i in year t, $P_{i,t-1}$ is the exponential average of past prices of crop i, $P_{j,t-1}$ is the exponential average of past prices of crop j, and GPV_t is the government policy variable(s) in year t.

Equation (2) shows the constraint which limits the estimated planted acres for each commodity, AP_{it}, to the total land available in year t. This constraint is applied first to the subset of intensive crops, then to total cropland planted.

$$AP_{it} = \min[\underline{AP}_{it}, \frac{\underline{AP}_{it}}{\Sigma_j \underline{AP}_{jt}} * CLB_t] . \tag{2}$$

Acres harvested for each commodity, AH_{it}, are then estimated as a fixed proportion of area planted.

Crop yields, CY_{it}, are estimated strictly as functions of a time trend. Production then becomes the product of area harvested and yield:

$$P_{it} = AH_{it} * CY_{it} \, . \tag{3}$$

Government Policy Related to Cropland Area

U.S. government policy variables related to the cropland area are designed to shift acreage between uses or to withdraw acreage from cropland. This is done through a number of programs of voluntary participation in response to income supplements and price guarantees. The components of the government program include: target prices, deficiency payments and nonrecourse commodity loans. These components can be combined in a number of ways to achieve a desired objective. A brief description of each government policy component and related variables is shown in Table 2.3.

The oldest of the presently implemented government programs is the commodity loan program, called the nonrecourse commodity loan program. Nonrecourse loans are made available to producers who in turn pledge a quantity of their crop equal to the amount of the loan divided by the loan rate. These loans, made at a rate of interest which is typically below prevailing market rates, may either be redeemed or allowed to lapse, in which case the USDA-CCC (Commodity Credit Corporation) assumes the title of the grain originally tendered as collateral. The loan rate acts as a price floor while allowing for more orderly marketing of grains by providing needed cash flow during times when market prices are depressed. In order to be eligible for the loan rate program, the producer must be in compliance with the set-aside and diversion programs. The set-aside program requires a participant to refrain from planting a specified percentage of the acreage normally devoted to a particular crop or set of crops. This set-aside land may be planted to any other crop not specified within that program. Diversion of cropland involves the retirement of acreage from the production of "intensive" crops. Diverted land is therefore relegated to less intensive use, while set-aside land may be planted to a larger group of relatively intensive crops (e.g., set-aside corn land has often been planted to soybeans).

As an additional incentive to participate in the set-aside and diversion programs, a producer may also receive a direct diversion payment for lands not planted to "intensive crops"* and a deficiency payment for grain marketed at prices below the announced target price. The deficiency payment is equal to the positive difference between the target price and the price received by the producer for his grain times a program allocation factor. This program allocation factor is determined by the ratio of National Program Acreage to the level of acres harvested in that crop year. A producer who voluntarily reduces harvested acreage from his previous year's harvest by the percentage announced by the Secretary of Agriculture will receive the full deficiency payments on all harvested grains. Otherwise, the program participant will receive payments equal to the difference between the target and market price multiplied by the program allocation factor.

The producer makes his planting decision based upon his price expectations as modified by the policy instruments described above. To reflect the impact of

*The crops which are defined as nonintensive are announced by the USDA along with the specific details of other policy instruments.

Table 2.3 Government policy variables related to acreage allocation and diversion

Policy Variable	Description	Purpose
Acreage Allot- ment	Acreage eligible for deficiency and other government payments	Limit production eligible for government payments and thereby encourage producers to partici- pate in the program
Defi- ciency Payment	Payments made to farmers when the average market price is below the target price. The payment is equal to the target price minus the larger of market price or the loan rate times the program allocation factor	Provides direct income subsidy to farmers when crop prices are below the cost of production
Direct Diversion Payments	Payments to producers who comply with supply control or set-aside programs	Encourage participation in government supply management programs
National Program Acreage	The number of harvested acres needed to meet domestic, export and carryover needs. The level is set each year by the Secretary of Agriculture	Establishes the desired acres needed to meet current year needs
Non- recourse Loan	Commodity Credit Corporation loans at below market interest rates. The producer tenders his crop as collateral and if the loan is allowed to lapse, the full payment of the loan is required	A loan from the USDA's Commodity Credit Corporation to provide operating capital to the producer while the producer retains con- trol and marketing discretion over his crop
Program Alloca- tion Factor	The ratio of the national harvested acres to the national program acreage	Used to reduce government payments to producers when they plant more than the projected needs
Set- Aside	The percent of planted acres which is not planted to the specified commodity	Reduce supply of a particular commodity
Target Price	Price of each commodity established by the USDA to represent the cost of production	Provides a basis for making income support payments to farmers

these policy instruments on the price expectations of farmers, methodology was developed from the work of J. Houck and associates† and J. McKeon (1974). An effective loan rate variable (ELR) is defined as the nominal loan rate (LR) discounted by the factor by which set-asides (SA) impose upon program participation plus deficiency payments (DP), defined as the difference between target price (TP) and loan rate, discounted by the national program allocation factor (PAF) (see Wailes 1979). The formula for the effective loan rate is:

$$ELR = LR * (1.0 - SA) \tag{4}$$

The formula for the effective deficiency payment (EDP) is:

$$EDP = (TP - LR) * PAF \tag{5}$$

The effective support rate (PV1) is the first composite policy variable which is introduced as a measure of the impact of loan and deficiency payments upon producer planting decisions. This policy variable is defined as the sum of the effective loan rate and effective deficiency payments, or:

$$PV1 = ELR + EDP \tag{6}$$

The direct diversion payment described above will create some degree of incentive for the farmer to participate in the diversion program. Additional incentive is provided by a payment beyond the effective deficiency payment in years when the program allocation factor is below 1.0 (this factor may legally vary from 0.8 to 1.0). If the producer reduces plantings of all crops below the level of the previous year's set-aside and cropland of all crops in accordance with the percentage recommended for voluntary diversion (the recommended voluntary diversion rate), the producer will receive the maximum possible deficiency payments on 100 percent of the acreage harvested, regardless of the program allocation factor. The benefit to a producer complying with the recommended voluntary diversion equals:

$$\text{Benefit} = (1 - PAF) * DP \tag{7}$$

A less exact measure of this additional deficiency payment is simply the recommended voluntary diversion percentage times the deficiency payment. The composite variable measuring the incentive to divert land (PV2) is the effective diversion payment which is equal to the direct diversion payment (DDP) plus the deficiency payment (DP) times the recommended voluntary diversion percentage (RVD). The formula for the composite diversion variable (PV2) is:

$$PV2 = DDP + (DP * RVD) \tag{8}$$

or decomposing the deficiency payment to the target price (TP) and loan rate (LR) elements:

$$PV2 = DDP + (TP - LR) * RVD \tag{9}$$

This second composite variable, PV2, is used to capture the incentive offered farmers to withdraw land from production beyond the incentives measured in the first composite policy variable, PV1.

†Their work is published in several monographs, of which the most complete article is "Analyzing the Impact of Government Programs on Crop Acreage," USDA ERS Technical Bulletin No. 1548. August 1976.

Producer-Held Reserve Program

Farm policy directed at the moderation of demand in the U.S. is accomplished through the management of grain stocks by the U.S. government. The management of grain stocks is conducted in order to dampen oscillations in U.S. grain prices. For years government control of grain stocks was accomplished by direct ownership of stocks by the Commodity Credit Corporation (CCC). In the aftermath of the huge Soviet grain purchases in 1973, U.S. growers expressed the desire for a more active role in the management of grain stocks owned by the U.S. government. In response to this producer lobby, the U.S. Congress included enabling legislation for a Farmer-Owned Grain Reserve program (FOR) in the 1977 Food and Agriculture Act. As a result of creation of the FOR program, total U.S. grain stocks are now of three distinct types: 1) stocks held by the private trade, 2) stocks held by the producers under the FOR program, and 3) stocks acquired and held by the CCC from price support programs and direct acquisition. At certain times in recent years, the combined size of the CCC and FOR stocks has been as large as that of the stocks held by the private trade.

The Farmer-Owned Reserve program is open to producers in compliance with the set-aside program provisions. A FOR program participant enters the program via a commodity loan agreement with the CCC. The loan agreement applies to a specific portion of the producer's crop and is equal to the quantity of grain entered into the program times the loan rate (typically equal to the support rate). The CCC offers several program benefits (i.e., storage payments, storage facility loans, low-interest rates or possibly a waiver on interest, etc.) "in return placing strict limits on the market price range over which the grower can market the grain" (see Wailes 1979). This range is a function of the prevailing loan rate and is between 140 (release) to 175-185 (call) percent on feed grains. The USDA has discretion over these release and call prices, both via the establishment of the loan rate and to a lesser extent the relationship of call and release prices to this loan rate. In addition, the program management has discretion over:

(1) the period during which the program is open;

(2) the eligibility of crops for each period;

(3) the desired level of stocks for each crop;

(4) the level of program incentives to achieve the desired stock level, i.e.,

  (a) storage cost payments,

  (b) rate of interest (or waive) on the CCC loan,

  (c) availability of loans for new or repaired storage facilities, and

  (d) extension of CCC loan period; and

(5) production controls that must be complied with to be eligible for the FOR program.

The policy component of the MSU Agriculture Model which is currently incorporated into the U.S. intermediate model is designed to simulate existing government stock acquisition programs based on the program rules. The specification of this component of the policy process is a literal expression of the reserve program rules. Unfortunately, while program rules and parameters can be identified, the behavioral content, in terms of producer response, has little history by which to be identified. The behavior of the farmer in a particular short-run market situation may be contrary to a simplistic market price-stock level function, but longer-term adjustments to price are basically consistent. USINT's model of this behavior is described in Chapter 4.

Livestock Model

Four categories of livestock are modeled in the U.S. supply model: beef, dairy, pork and poultry. Separate models are estimated for each category and outputs are aggregated after production. Some interaction between sectors is incorporated, such as the number of dairy cows held based in part on the price of beef, but interaction between livestock types is very small.

The number of animals produced and the yield per animal are separately estimated. For beef and pork, yield is measured as pounds of meat produced per animal. The dairy sector produces both milk and beef, so milk produced per cow is estimated and pounds of meat per animal slaughtered is also estimated. Poultry meat production is estimated as an aggregate rather than per bird basis. Yield estimates are based on profitability measures such as grain and meat or milk prices.

Beef

The beef model is developed from two types of relationships: producer decision variables and physical response variables. Producer decision variables include decisions about the number of animals to sell, the weight at which an animal is slaughtered and the rate of herd expansion or contraction. Physical response variables are determined by primarily biological factors beyond the control of a producer. Examples of these physical relationships include death rates, birth rates and calving rates.

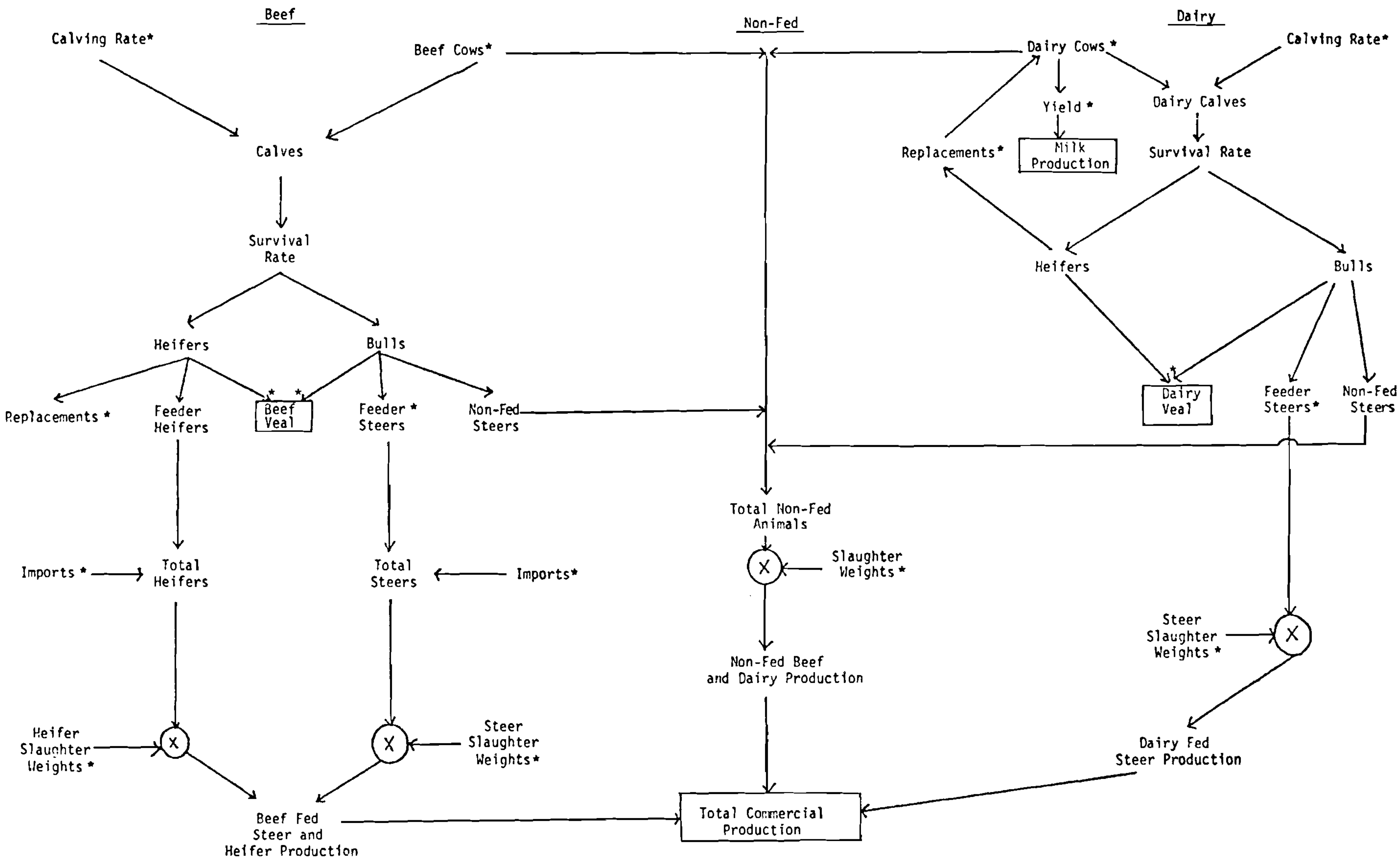
Producer decision variables are econometrically estimated on the basis of economic factors, while the biological factors are obtained from historical records. Some factors which are primarily biological can still be altered by producer decisions. Calving survival rates, for example, are influenced by the stage of the cattle cycle which is determined by producer decisions. If cow numbers are expanding rapidly, the calf survival rate will drop because the proportion of both young cows and old cows will increase, and these animals tend to have lower calf survival rates. Variables of this type are estimated based on herd change factors even though they are primarily biological variables.

Figure 2.2 shows the linkages in the beef and dairy sector. Estimated relationships are denoted with an * and biological linkages have the * omitted. Individual estimated equations are included for calving rates, breed-feed-slaughter decisions, and the slaughter weights of the finished animal. Separate slaughter weight estimates are made for steers and heifers. Survival rates, the distribution of calves between bulls and heifers, and the meat yield per carcass are all treated as biological parameters which are independent of producer decisions.

Beef cow numbers are estimated as the sum of the cow herd and replacements minus the number of culls and deaths. Cull cows and non-fed steers both become part of the non-fed beef category. Non-fed beef production is determined from the number of animals in this category times the slaughter weight per animal. The slaughter weight for non-fed beef is estimated for all non-fed beef and makes no distinction between cows and steers. Dairy cow culls and non-fed dairy steers are also included in the non-fed category. Total commercial meat production is the sum of fed beef steer and heifer production, non-fed beef and dairy production, and diary fed steer production.

Dairy

Dairy cow numbers are estimated from herd size, replacements, culls and death loss. Heifer replacements are estimated on the basis of milk production profitability and cow slaughter prices. The milk production profitability measure is



*Estimated.

Figure 2.2 Beef and Dairy Sector

proxied by a gross margin which includes milk prices, feed costs, labor costs and technological production shifts over time. The gross margin specification allows many variables to be included in an estimated equation without requiring the statistical degrees of freedom which would be associated with separately entered variables. The gross margin specification does have the disadvantage of imposing an equal supply response for all variables included in the gross margin variable.

Milk production is estimated as the product of cow numbers and milk production per cow. Milk production per cow is estimated as a function of feed price, the price of milk and previous year milk yields.

Dairy heifers not used for replacements are slaughtered as veal. Bull calves are either slaughtered as veal, fed or slaughtered as non-fed steer beef. Fed steers and non-fed steers go into total commercial meat production.

Pork

Pork production is determined by the size of the pig crop and the weights of the slaughtered animals. Separate equations are used to represent fall farrowings and spring farrowings. Fixed rates are used to obtain litter size per sow, and pork production is then the product of slaughter weights and hogs slaughtered.

The specification of the spring sows farrowing equation is based on the previous year's inventory of sows, the competitive opportunities afforded by beef feeding and a profitability measure associated with pork production. Fed beef price is an important variable reflecting the opportunities for feeding beef rather than hogs. This is consistent with the tendency of hog producers to also be beef producers. Fall sow farrowings are determined by largely the same variables as spring farrowings; however, feed prices are identified separately from the gross margin profitability variable to emphasize the most recent feed price changes which are associated with the fall crop harvest.

Slaughter weights are estimated from the hog/corn price ratio, which is intended to capture the incentive to feed to lighter or heavier slaughter weights. No distinction is made between different aged animals in estimating slaughter weights, nor is the changing size of the animal over time considered.

Poultry

The poultry sector identifies separate turkey, broiler and egg production. The complexity and rapid structural change which has occurred in the poultry sector in the last two decades is not captured by the model. The primary reason for including poultry in the model is to identify feed consumption by this sector. Additional refinements would be useful for this sector, although the current specification appears reasonably good at identifying feed demand based on the current characteristics of the industry.

Livestock Feed Consumption

Feed consumption is estimated for coarse grains, soymeal and wheat. The procedure for estimating coarse grain and soymeal fed is based on grain or meal consumed per standardized animal unit, while wheat fed is estimated directly.

Numbers of livestock in each category are used as a basis for determining the number of grain consuming animal units, which is a weighted sum of livestock units designed to standardize numbers on the basis of feed consumption. The weights used to obtain estimates of grain consuming animal units are obtained from USDA sources. Grain consumption per animal unit is estimated from livestock and feed prices. Total feed grain consumption is then obtained as the product of feed grain consumed per grain consuming animal unit and the number of grain consuming animal units.

Soymeal consumption is obtained in a similar way. An index of high protein grain consuming animal units is developed to reflect a standardized animal unit based on high protein consumption. Soymeal consumption per high protein grain consuming animal unit is then estimated based on soymeal, corn and livestock prices. The product of these two factors provides the level of consumption of soymeal.

Wheat fed to livestock is directly estimated rather than estimated on a per animal unit basis. Wheat comprises a relatively small share of livestock feed in the United States, and the amount of wheat fed depends primarily on availability and the price relationship between wheat and coarse grains. Wheat is preferred to coarse grains as a livestock feed because it has a higher protein content than corn, which is the primary coarse grain fed in the U.S. However, the margin between wheat and coarse grain prices usually does not favor wheat feeding. The second reason for feeding wheat is due to availability. An abundance of wheat in a given area of the U.S. relative to coarse grain will encourage wheat feeding due to convenience. The wheat fed relationship is very sensitive, so small changes in the wheat/corn price ratio within the critical range of values which makes wheat favorably priced as a feed. However, the amount of wheat fed is very unresponsive to price changes in the wheat/corn price ratio outside of the critical range. A second component of wheat feeding is linked to the availability factor and is largely unresponsive to price changes between wheat and coarse grains.

Chapter 3

THE LAND RESOURCE COMPONENT OF CROP SUPPLY IN USINT

There has been occasion to use USINT in conjunction with the basic linked system to examine the long-run (to 2030) demand for agricultural land in the United States arising from alternative export demand scenarios for food and feed commodities and whether and when land availability constraints in the U.S. are likely to become effective over that horizon. In order to accommodate such longer-run analyses, therefore, the national-level version of the resource development component of the detailed U.S. model was adapted for use in USINT as well. This component, including the theory, specification, and estimation of both its national and regional versions, is described fully in Johnson and Quinby (1983). A brief summary of the model structure is provided here.

The outputs of the land resource component are an upper-bound constraint on total cropland planted and an upper-bound constraint on land planted to intensive crops.

The constraint on total acres planted begins with an estimated benchmark of 900 million acres of potentially cropable land in 1977. This includes land currently cropped, in fallow, and in cropland pasture; rangeland, forests, and farmsteads in Class I-IV land; and an allowance for potential increases in the intensity of land use approaching that observed in the Far East and Western Europe. An identity equation, then, determines the cropland potential each year by adjusting this 1977 figure for prior or subsequent (1) population changes, assuming .22 acres per capita going to nonfarm uses; and (2) an exogenous projection of irreversible soil erosion.

In order to determine the constraint on total cropland planted, the model uses an econometrically estimated equation for its complement, i.e., unused cropland potential. The explanatory variables here are (1) the amount of land set aside and diverted, and (2) a technology index reflecting technical change allowing the farming of more fragile land. Both of these variables are currently projected exogenously in USINT. Set-asides and diversions are taken into account in the acres planted equations of crop supply (see Chapter 2), but only implicitly. The actual number of acres involved, as required by the unused cropland potential equation, cannot be explicitly computed from the information currently in the model.

A third factor influencing unused potential is public and private land development investments to bring additional land into production. The accumulation of such developments over time, less the disinvestments which allow land to revert to an unused or undeveloped status, reduces the unused potential, thus relaxing the cropland planted constraint.

The cropland planted constraint, then, is defined each year as the cropland potential, minus the unused potential, plus five percent of the unused potential (as the maximum amount of new land that can be developed in any one year).

It is the land development behavior that provides the principal economic feedback to this component. The cropland potential equation, the unused potential equation, and the intensity constraint equation (discussed below) all depend on technical and institutional variables. It is the acres planted equations in crop supply, responding to domestic and world prices through the international trade linkage, that in sum determine whether any or all of the allowable land development will take place. Any such development accumulates over time to ease the constraint on total cropland planted in future years.

Finally, an intensity constraint places an upper bound on the area that can be planted to intensive crops. In the national-level version of the model, all crops except hay, oats, flax, barley, and rye are considered to be "intensive". The constraint is based on an econometrically estimated logit function of (1) an index of mechanization and (2) acreage set aside and diverted. The mechanization index, which is exogenously projected in the model, represents three technological factors which permit increases in cropping intensity: the use of tractor horsepower, yield-increasing technologies, and technologies which permit the farming of more fragile soils. Two standard errors are added to the estimated logit value to produce the actual constraint applied in a given year.

The concept of intensity as defined here, i.e., crops considered to be intensively cultivated, is only really meaningful at a regional level. In particular, a specific crop may be considered intensive in one region and nonintensive in another, depending on the soil and water conditions and cultivation practices applied. Furthermore, crops grown, land planted in crops, and land potentially cropable vary greatly by region. Thus, the total cropland planted constraint would also be more meaningful at a regional level of disaggregation.

Therefore, a regional version of this component has been developed for the detailed U.S. model (Johnson and Quinby 1983). Additional extensions which may be considered in the future include (1) distinguishing between irrigated and nonirrigated land, (2) developing decision functions to explicitly model the investment necessary to bring potentially cropable land into actual production, and (3) modeling measures of land and water quality, effectively endogenizing the currently exogenous soil erosion.

Chapter 4

THE DOMESTIC UTILIZATION AND PRICE COMPONENTS OF USINT

Total utilization of each commodity includes exports, if any, and several components of domestic disappearance. Exports (actually net imports) are determined, in the simultaneous national-international exchange algorithm of IIASA's linked system, as a residual of domestic supply over demand consistent with world prices; domestic price, quota and stock policies; and assumed international agreements. Domestic utilization includes seed, losses, feed, nonfood industrial uses, government consumption, stocks and human consumption. Feed demand is discussed in Chapter 2; prices and the other components of demand are described here.

Seed and Losses, and Industrial and Government Consumption

Seed rates per acre are assumed for wheat, rice, the four coarse grains, potatoes, dry beans, soybeans (accounted to fats and oils, and protein feeds) and cotton (accounted to protein feeds). Losses due to waste, spoilage, insects, etc., in farm and market storage, processing and distribution activities are modeled as proportions of annual production. In addition, milk fed to calves, as a proportion of milk production, is considered a feed use of milk, and eggs used for hatching are considered a seed use of eggs.

A general Cobb-Douglas functional form is postulated for the nonfood industrial consumption of each food commodity

$$\mathrm{DEMIND}_i(t) = \alpha_i\left(\frac{\mathrm{CPRICE}_i(t)}{\mathrm{CPRICE}_{20}(t)}\right)^{\beta_i}\left(\frac{\mathrm{DOMSUP}_{20}(t)}{1000}\right)^{\sigma_i} \qquad (1)$$

where

DEMIND_i	= industrial demand for commodity i (thousand MT)
CPRICE_i	= retail-level price of commodity i
CPRICE_{20}	= nonagricultural price index (1967 = 1.00)
DUMSUP_{20}	= nonagricultural production (million 1967 dollars)
$\alpha_i, \beta_i, \sigma_i$	= parameters of the function

A preliminary data search for this version of the model yielded data on nonfood use of only two food commodities: fats and oils, and fish. The use of corn for methanol production is determined based on endogenous investments in distillation capacity and relative fuel-corn prices. Government incentive policies are included, and the contribution of the high-protein by-product to protein feed supply is accounted for. Zero industrial consumption is assumed for the other food commodities; further research will be necessary to determine whether this is a reasonable assumption (e.g., potatoes and sugar for starch, medicinal alcohol, etc.).

Industrial demand for the nonagricultural commodity, in million 1967 dollars, is interpreted as demand for intermediate inputs and is computed using the same two-sector input-output model used to determine gross nonagricultural production.

$$DEMIND_{20}(t) = AIO_{21} \cdot VA67(t) + AIO_{22} \cdot VN67(t) \qquad (2)$$

where

AIO_{21} = dollars of nonagricultural input per dollar of agricultural output

VA67 = value of agricultural production at 1967 prices

VN67 = value of nonagricultural production at 1967 prices

Total government consumption expenditures (e.g. for the military, institutions, etc.) are assumed to be a fixed proportion (namely, 21 percent) of GNP. This total is modified in order to achieve the exogenously-specified national trade balance (necessary for consistency within the global system) if that balance cannot be otherwise achieved at equilibrium prices given quota and tax rate constraints.

This total public expenditure is then allocated to the individual commodities by first assuming that a proportion goes to the nonagricultural commodity, and then distributing the rest to the food commodities in the same proportion as lagged private consumption expenditures. The data for food consumption used to calibrate the human food consumption functions described below were derived as a residual in food balance sheet calculations, with no distinction between public and private consumers. Therefore, until other data are compiled which explicitly identify government consumption of food commodities, all government consumption is assumed to be of the nonagricultural commodity.

Demand for Ending Stocks

Stocks are considered in the model for wheat, coarse grains, milk, soybeans and peanuts. The oil and cake equivalents of soybean and peanut stocks are allocated to fats and oils and protein feeds, respectively. Milk stocks include the fresh milk equivalents of milk products stocks. Coarse grain stocks are modeled as an aggregate of corn, sorghum, barley and oat stocks.

The modeling of wheat, coarse grains, and soybean stocks is more complicated than that of the other commodities, because stocks of these commodities are closely related to price control policies. Specifically, the government will act as a buyer (or stockpiler) of last resort, if necessary, in order to maintain a minimum farm price (or "loan rate"). At the other end, if farm price is rising above an upper target (the "call price"), the government will call in loans, essentially requiring farmers to sell the stocks they hold as part of government programs. (See Chapter 2 for a fuller discussion of the producer-held reserve program.) It should be mentioned here that this version of the model does not distinguish different types of stocks, such as on-farm stocks, government buffer stocks, market stocks, etc. Rather, total national ending stocks are modeled in the aggregate.

Since wheat, coarse grains, and soybean stocks are modeled identically, the following discussion applies to all these commodities. The basic hypothesis is that stocks build up as prices fall and are depleted as prices rise. A negative exponential function is assumed to represent this behavior over most of the relevant price range (curve II in Figure 4.1). For the function to be homogeneous of degree zero, the independent variable is the price P of the commodity relative to nonagricultural prices P_n. At the call price PC, stocks are assumed to have fallen to a minimum pipeline level, XL, below which they will not go even if the relative price is higher than PC (curve III in Figure 4.1).

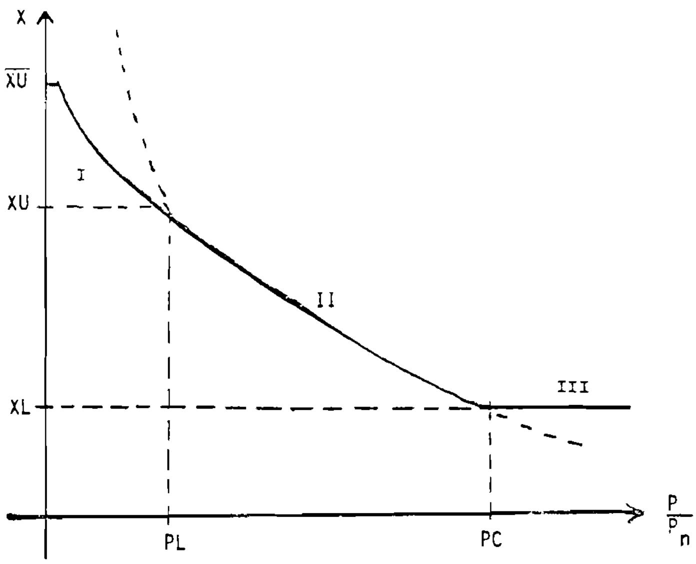


Figure 4.1 Carry-out stocks function: wheat, coarse grains, and soybeans

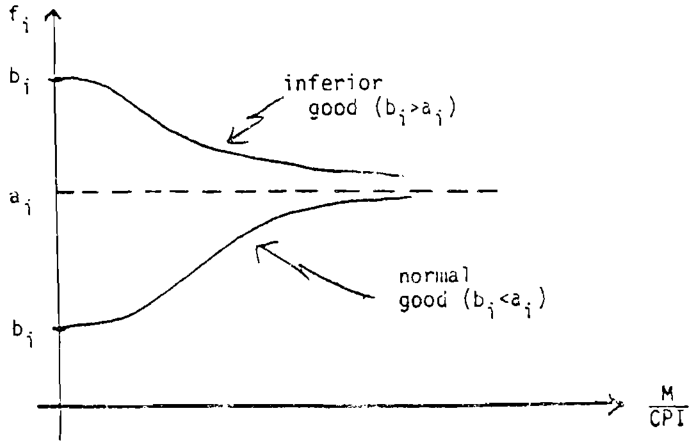


Figure 4.2 The income factor of per capita consumption

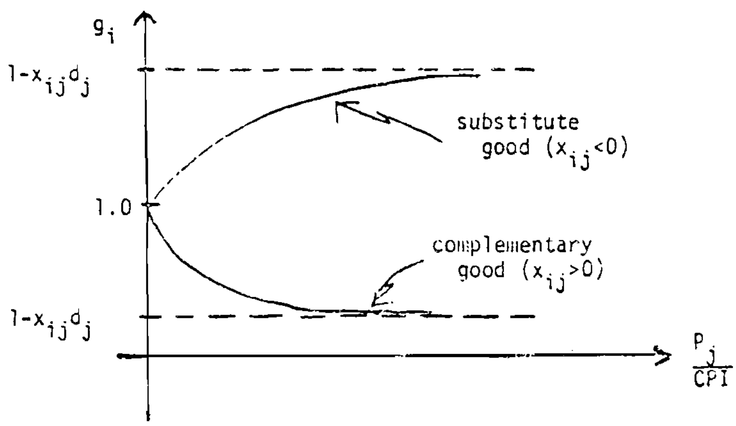


Figure 4.3 The price factor of per capita consumption

Since the government is assumed to be the stockpiler of last resort, the price will not fall below the loan rate PL. (Given the U.S. role in the world market for these commodities, this implies supporting the world price as well.) This would imply a vertical, perfectly elastic segment of the stock demand curve at PL. In order for stocks to be a *function* of price, however, as required by the overall model, a negatively-sloped linear segment (curve I in Figure 4.1) is modeled between PL and zero.

At PL, stocks are assumed to be at their "normal" maximum XU and at zero their "logical" maximum $\overline{XU}$. The logical maximum $\overline{XU}$ is defined somewhat arbitrarily as 110 % of XU. At PL, the normal maximum XU is defined to be

$$XU(t) = \lambda Q(t) \tag{3}$$

where

Q = total production (thousand MT)

λ = maximum stock as a proportion of production.

At and above the call price PC, pipeline stocks XL are defined to be

$$XL(t) = \mu Q(t) \tag{4}$$

where μ is again a proportion of production Q.

The negative exponential curve II has the form, for stock level X,

$$X(t) = \alpha e^{-\beta (P(t)/P_n(t))} \tag{5}$$

Two points on this curve are assumed to be known, namely, (PL, XU) and (PC, XL). Therefore, the parameters α and β can be determined as

$$\alpha = XU(t)e^{\beta PL(t)} \tag{6}$$

and

$$\beta = \frac{\ln(XU(t)/XL(t))}{PC(t) - PL(t)} \tag{7}$$

Thus, the curve is completely specified by the parameters λ and μ, and by the price policies PC and PL. It is interesting to note that, with α and β defined as in (6) and (7), the stock demand functions reduce to the Cobb-Douglas form, i.e.

$$X = (XU)^{\gamma}(XL)^{\delta} \tag{8}$$

whose exponents, which add to unity, are

$$\gamma = \frac{PC - (P/P_n)}{PC - PL} \quad \text{and} \quad \delta = \frac{(P/P_n) - PL}{PC - PL} \quad . \tag{9}$$

For this version of the model, peanut stocks are projected exogenously, while milk stocks are modeled with the following econometrically estimated equation:

$$MLKSTK(t) = A_0 + A_1 \cdot MKSUPP(t) + A_2 \cdot DOMSUP_{17}(t) + A_3 \cdot GNPPC(t) \tag{10}$$

where

MLKSTK = milk stocks (thousand MT)

MKSUPP = milk support price ($/kg)

$DOMSUP_{17}$ = milk supply (production plus beginning stocks)(thousand MT)

GNPPC = per capita GNP (thousand $/person)

Human Consumption

A rather complicated nonlinear function is used to model the per capita consumption of each food commodity (in pounds per person per year) in order to exhibit a hypothesized mode of consumption behavior with respect to income, prices and time. Specifically, per capita consumption PCC is the product of three functions representing an income factor, a price factor and a time factor, respectively. For each food commodity i,

$$PCC_i(t) = f_i(M(t),P(t)) \cdot g_i(P(t)) \cdot h_i(t) \tag{11}$$

where M is current nominal per capita disposable income (\$/person-year), P is a vector of nominal consumer prices (\$/pound), and t is time, and where

$$f_i(M,P) = a_i + (b_i - a_i)e^{-c_i(M/CPI)^2} \tag{12}$$

$$g_i(P) = \prod_j [1 - x_{ij}d_j(1 - e^{-\sigma_j(P_j/CPI)})] \tag{13}$$

$$h_i(t) = \alpha_i + (\beta_i - \alpha_i)e^{-\delta_i(t-t_o)^2} \tag{14}$$

and where the consumer price index CPI is

$$CPI(t) = \sum_i \omega_i \frac{P_i(t)}{P_i(1967)} \tag{15}$$

Personal income is defined as a proportion of gross domestic product, which in turn is defined as the value of production (at producer prices) less intermediate consumption. The income tax rate resulting from the equilibrium solution is applied to income to arrive at disposable income.

As shown in Figures 4.2 and 4.3,* the income factor f and its parameters a and b have units of per capita consumption and are the major determinants of PCC, while g and h serve as multipliers. The price factor g is nominally unity when all prices are zero, and the time factor h is unity (with $\alpha=\beta=1$) for commodities with no time trend assumed.

Indeed, there are only four commodities (wheat, coarse grains, tobacco and milk) for which time trends are assumed to reflect changes in per capita consumption not reasonably attributable to price, income or other endogenous model variables. For example, a sharp decline in tobacco consumption per capita has been observed, beginning in about 1964 when the first Surgeon-General's report was issued on the health hazards of cigarette smoking. Zero food consumption of "protein feeds" is assumed ($a_{19}=b_{19}=0$), although this restriction may have to be relaxed if food use of soybeans can be expected to become significant in the U.S.

The asymptotic behavior of f_i has advantages over a constant income elasticity model, particularly in long-run analysis as real income increases, in that consumption will remain within reasonable physical and nutritional ranges. Indeed, the set of values for the a_is may be specified according to what could be considered to be a realistic or plausible dietary and nutritional mix in the limit "as real income goes to infinity." Note in Figure 4.2 that setting $b_i > a_i$ implies an inferior good, while $b_i < a_i$ indicates a normal good.

Cross-price effects in the price factor g_i, i.e. the impacts of the price of commodity j on consumption of commodity i, are reflected in the matrix $[x_{ij}]$. For the own-price effect (i = j), $x_{ij} = 1.0$, for complementary goods $x_{ij} > 0$, and for

*A figure is not given for the time factor h; it would look exactly the same as Figure 4.2, with α and β in place of a and b, and $(t-t_0)$ in place of (M/CPI).

substitute commodities $x_{ij} < 0$. $x_{ij} = 0$ implies no cross-price effect. From this point of view, a commodity is a perfect complement to itself, i.e., one always eats rice with rice.

Note in equation (13) and Figure 4.3 that x_{ij} is a proportion of d_j. That is, the effect of commodity j's price on consumption of commodity i is proportional to its effect on own consumption, i.e., the consumption of commodity j. The d_j represents the maximum proportional deviation of commodity j consumption as the real price of j increases without limit. Thus, $d_j = 1$ implies consumption goes to zero "as real price goes to infinity", while $d_j = 0$ indicates no price response.

In order to maintain a consumption expenditure budget constraint, per capita consumption of the nonagricultural commodity PCC_{20} (in 1967 $/person) is computed as a residual, where the total budget is taken to be disposable income M, implying savings as a component of PCC_{20}.

Econometric estimation of the parameters - a_i, b_i, c_i, d_i, x_{ij}, α_i, β_i, σ_i, δ_i for i and j = 1, 2,...,18 - has not been attempted. Preliminary judgemental estimates were made and then further refined in "manually tuning" the model to track PCC for the 1970-1976 period using actual historical values for M and P over that period. Although elasticities as such are not used in the model, as a check on model performance with these parameter values, Table 4.1 shows elasticities computed from the partial derivatives of PCC in equation (11) with respect to prices and income. Indeed, the "estimation" of the parameters was guided somewhat by the elasticity value in an attempt to arrive at elasticities generally consistent with those found in other studies.

Prices

Prices are the major feedback from the simultaneous national-international exchange system to the national model. Domestic consumer prices are determined based on world prices and national price policies. A "target" (or "desired" or "normal") price for each commodity PD_i is defined to be proportional to the retail-level world price PWD_i.

$$PD_i = DPD_i \cdot PWD_i \tag{16}$$

where DPD can be interpreted to embody not only tariff policies, for instance, but also quality and other differences between the domestic commodity and the world commodity, transportation costs, etc. The retail-level world price PWD_i is defined as the world price PW_i plus a domestic marketing/processing margin PRM_i representing a quantity of the nonagricultural good (commodity n) times the price of that good. PRM_i is also used as the margin between domestic farm and consumer prices.

$$PWD_i = PW_i + PRM_i \cdot PW_n \tag{17}$$

The price PD_i will be the equilibrium price P_i unless a specified minimum or maximum demand constraint is effective, where these can be interpreted as export and import quotas, respectively. These quotas are defined each year in the model based on minimum and maximum self-sufficiency rates and minimum and maximum year-to-year changes in consumption for each commodity. If one of these constraints is effective, the equilibrium price P_i will be below or above PD_i, respectively, unless buffer stock behavior is modeled. In that case (as for wheat, coarse grains, milk and protein feeds discussed above), equilibrium ending stocks will deviate above or below a target level, respectively, where the target stocks are those determined in equations (5) and (10) above. Maximum and minimum stocks are also specified, and if the stock adjustment is such as to make a stock constraint

Table 4.1. Price and Income Elasticities of Demand in 1970.

Price / Quant.	Price Elasticities										
	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	P_{10}	P_{11}
1	-0.346	0.041	0.021	0.024	0.016	0.019	0.011	0.003	0.001	0.003	0.001
2	0.078	-0.291	0.040	0.043	0.038	0.034	-0.008	-0.010	-0.003	-0.010	-0.003
3	0.035	0.019	-0.299	-0.003	-0.012	-0.001	-0.010	-0.013	-0.004	-0.013	-0.004
4	0.081	0.076	-0.000	-0.373	0.066	0.053	-0.005	-0.006	-0.002	-0.007	-0.002
5	-0.095	-0.092	0.001	0.509	-1.017	0.035	0.137	0.012	0.004	0.013	0.004
6	0.064	0.052	0.001	0.057	0.058	-0.245	0.007	0.009	0.003	0.009	0.003
7	-0.001	-0.000	-0.000	-0.000	0.025	-0.000	-0.303	-0.001	-0.000	-0.001	0.019
8	0.002	0.000	0.000	0.001	0.003	0.000	0.002	-0.187	0.001	0.003	0.001
9	-0.015	-0.003	-0.001	-0.004	-0.031	-0.001	-0.014	-0.018	-0.167	-0.019	-0.006
10	0.004	0.001	0.000	0.001	0.004	0.000	0.020	0.004	0.001	-0.317	0.011
11	0.014	0.003	0.001	0.003	0.016	0.001	0.013	0.017	0.005	0.017	-0.201
12	-0.010	-0.002	-0.001	-0.002	-0.012	-0.001	-0.010	-0.012	-0.004	-0.013	-0.004
13	0.029	0.006	0.002	0.007	0.033	0.002	0.027	0.035	0.010	0.036	0.011
14	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
15	-0.016	-0.003	-0.001	-0.004	-0.018	-0.001	-0.015	-0.019	-0.006	-0.019	-0.006
16	0.016	0.003	0.001	0.004	0.018	0.001	0.015	0.019	0.006	0.020	0.006
17	0.006	0.001	0.000	0.001	0.006	0.000	0.005	0.007	0.002	0.007	0.002
18	-0.010	-0.002	-0.001	-0.002	-0.011	-0.001	-0.009	-0.011	-0.003	-0.012	-0.004
19	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
20	-0.003	-0.001	-0.008	-0.004	0.000	-0.001	-0.004	-0.016	-0.004	-0.003	-0.003

210 SUM OVER I OF D(EXP(I))/D(P(J)) = 0

Price / Quant.	P_{12}	P_{13}	P_{14}	P_{15}	P_{16}	P_{17}	P_{18}	P_{19}	P_{20}	Income Elas.	Σ*
1	0.004	0.003	0.002	0.001	0.041	0.005	0.001	0.	0.096	0.055	-0.00
2	-0.014	-0.010	-0.008	-0.004	-0.004	-0.017	-0.003	0.	-0.341	0.491	0.00
3	-0.018	-0.014	-0.011	-0.005	-0.005	-0.024	-0.004	0.	-0.463	0.850	0.00
4	-0.009	-0.007	-0.005	-0.003	-0.003	-0.012	-0.002	0.	-0.228	0.387	0.00
5	0.017	0.013	0.010	0.005	0.005	0.022	0.003	0.	0.436	-0.022	-0.00
6	0.012	0.009	0.007	0.004	0.004	0.016	0.002	0.	0.314	-0.386	-0.00
7	-0.001	-0.001	-0.001	-0.000	-0.000	0.008	-0.000	0.	-0.031	0.289	0.00
8	0.004	0.003	0.002	0.001	0.001	0.005	0.001	0.	0.095	0.062	0.00
9	0.026	-0.020	-0.015	-0.008	-0.007	-0.033	-0.005	0.	-0.649	1.042	0.00
10	0.006	0.004	0.003	0.002	0.002	0.010	0.001	0.	0.147	0.096	0.00
11	0.023	0.018	0.013	0.007	0.007	0.042	0.004	0.	0.586	-0.589	-0.00
12	-0.745	0.109	0.143	0.084	0.022	-0.022	0.099	0.	-0.440	0.820	0.
13	0.080	-0.300	0.044	0.038	0.014	0.063	0.024	0.	1.234	-1.396	0.
14	0.057	0.045	-0.608	0.045	0.009	-0.000	0.053	0.	-0.004	0.405	-0.00
15	0.071	0.014	0.058	-0.364	-0.008	-0.034	0.037	0.	-0.567	1.001	0.00
16	0.027	0.020	0.015	0.008	-0.212	0.035	0.005	0.	0.678	-0.685	-0.00
17	0.009	0.007	0.005	0.003	0.017	-0.340	0.002	0.	0.232	0.028	0.
18	0.044	-0.000	0.022	0.019	-0.005	-0.020	-0.492	0.	-0.401	0.898	0.00
19	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
20	-0.011	-0.006	-0.012	-0.008	-0.005	-0.014	-0.007	0.	-0.985	1.095	-0.00

210 SUM OVER I OF D(EXP(I))/D(P(J)) = 0

*Σ = the sum of income and all cross-price elasticities; it must equal zero for homogeneity.

effective, *then* P_i will deviate from PD_i.

These prices are at the 10-commodity international aggregation and must be disaggregated to the U.S. model's 20-commodity utilization level for consumer prices and the 30-commodity supply level for farm prices (see Table 1-1). The 10-commodity aggregate prices P_i are related to the 20-commodity aggregate prices CP_k by

$$P_i = \left[\sum_k \omega_k \frac{CP_k}{\sigma_k}\right] / \sum_k \omega_k \tag{18}$$

for i = 1, 2, ..., 10 and where the summation is over commodities k belonging to aggregate i. In (18), ω_k is the consumer price index weight of equation (15), and σ_k is a unit conversion factor, e.g., thousand MT of carcass weight to thousand MT of protein equivalent (see Table 1-1).

For commodities with a one-to-one correspondence, i.e. wheat, rice, coarse grains, milk and nonagriculture, the consumer prices are simply

$$CP_k = \sigma_k P_i \tag{19}$$

For the other commodities, each CP_k in a group i is ratioed to reflect the same proportional change as its aggregate P_i, so that (18) holds.

Producer prices PP_k at the 20-commodity level are determined from consumer prices and an assumed farmer share α_k

$$PP_k = \delta_k \alpha_k CP_k \tag{20}$$

where δ_k is a unit conversion, e.g. from \$/pound for consumer prices to \$/bushel for farm prices. The marketing/processing margins PRM_i used in (18) are computed from the farmer shares α_k by

$$PRM_i = \left\{\left[\sum_k \omega_k (1 - \alpha_k) \frac{CP_k}{\sigma_k}\right] / \sum_k \omega_k\right\} / P_n \tag{21}$$

where, again, the summation is over commodities k in group i.

The 20-commodity producer prices are then disaggregated to the 30-commodity level. For example, it is assumed that PP_3 for coarse grains represents the corn price. The farm prices of barley, oats and sorghum ($PPCG_j$) are then related to that of corn and to the share of those commodities in total feed grain production FGQT by equations of the type

$$PPCG_j = \alpha_j + \beta_j PP_3 + \gamma_j \frac{Q_j}{FGQT} \tag{22}$$

Demand-Price Equilibrium

Domestic equilibrium in USINT is determined using the standard complementarity path algorithm used for other FAP national models. This algorithm is designed, however, for generalized linear expenditure demand systems. Therefore, the USINT demand system is transformed into the LES by summing up a Taylor series linear approximation of each of the demand components described above.

Chapter 5

POLICY INSTRUMENTS AND SCENARIOS IN USINT

The usefulness of a model for policy analysis is directly proportional to the degree of flexibility with which the analyst is able to use the model. Dozens of policy parameters and variables are explicitly built into USINT, and the analyst may give values to them as appropriate for particular policy assumptions, as described in this chapter. However, flexibility is enhanced when the analyst is familiar enough with the model and its computer program to be able to change not only data values but also to change, introduce, or delete equations, variables, and structural relationships in customizing the model to meet the needs of a particular analysis. The possibilities here are virtually limitless, bounded only by the imagination and creativity of the analyst. Thus, this chapter also gives general indications of where such changes may be entered within some of the policy areas described.

This discussion is organized in two sections: one for supply-oriented policy assumptions and one for the exchange side of the model. Within each section, two categories of assumption are presented: (1) direct instruments of public policy and (2) scenario projections of other variables, some of which may be indirectly influenced by policy. For each variable, the discussion gives its Fortran and data file names and the names of subroutines where it is defined and used (see Appendix B for subroutine descriptions).

Supply Policies

1. Direct Instruments

The supply policy instruments modeled explicitly include support prices and acreage diversions for the major grains, soybeans, and cotton. In the case of grains and soybeans, these variables are listed in Table 5.1 and described more fully in Chapter 2. They are all used in subroutine FAMUSR in determining the effective loan rates and effective diversion payments, which in turn are explanatory variables for the acreage planted equations, YY(13) through YY(18). See Appendix A for definitions of these variables and associated units of measure.

Direct diversion payments are given values exogenously, in the data file, for the entire simulation period. *It is important to note* that, as for all exogenous variables (called Z) not otherwise computed in the model, subroutine SUP231 keeps Z constant, at the last value given in the data file, for simulated years beyond the one corresponding to that last value.

All the other variables in Table 5.1 are computed endogenously in subroutine FAMUSR according to decision rules specified in the 1977 Farm Bill (see Chapter 2). Loan rates and target prices are functions of the previous year's costs of production Z(72) and Z(73) for corn and wheat, respectively, while the costs of production are, in turn, functions of the exogenous consumer price index. Set asides and national program acreages are functions of lagged and desired stock-to-disappearance ratios, while recommended voluntary diversions depend on the difference in the previous year between the national program acreage and the

Table 5-1

Direct Supply Policy Instruments for Grains and Soybeans
in the U.S. Intermediate Model

Instrument	Names	Wheat	Corn	Barley	Oats	Sorghum	Soybns
loan rate	Data file name	WLR	CLR	BLR	OLR	SLR	SBLR
	Fortran name	Z(9)	Z(34)	Z(18)	Z(24)	Z(41)	Z(40)
target price	Data file name	WTP	CTP	BTP	--	STP	--
	Fortran name	Z(10)	Z(35)	Z(19)	--	Z(42)	--
complement of set aside	Data file name	WSA	CSA	BSA	--	SSA	--
	Fortran name	Z(11)	Z(36)	Z(20)	--	Z(43)	--
direct diversion payment	Data file name	WDDP	CDDP	BDDP	--	SDDP	--
	Fortran name	Z(12)	Z(37)	Z(21)	--	Z(44)	--
recommended voluntary diversion	Data file name	WRVD	CRVD	BRVD	--	SRVD	--
	Fortran name	Z(13)	Z(38)	Z(22)	--	Z(45)	--
national program acreage	Data file name	WNPA	CNPA	BNPA	--	SNPA	--
	Fortran name	Z(14)	Z(39)	Z(23)	--	Z(46)	--

actual acreage harvested. The analyst may change these assumed adjustment rules, for purposes of a particular analysis, by changing the appropriate equations in the computer program.

The commodity programs incorporating the variables discussed above are voluntary, and the historical degree of participation in them is captured through the statistical parameter estimates of the acreage planted equations, YY(13) through YY(18) in subroutine FAMUSR. The analyst has the further option of imposing *mandatory set asides* to force land out of production of these crops. Currently, mandatory set asides are programmed in FAMUSR as part of the minimum export price policy (see the discussion below of exchange policies), were they restrict production if stock-to-disappearance ratios exceed a desired maximum as a result of stock build-ups to support a high minimum export price. The user may reprogram this to consider mandatory limits on acres planted untied to the minimum export price policy and/or to introduce different decision rules for the mandatory set asides.

In the case of cotton, the effective loan rate and effective diversion payment are projected exogenously (and deflated) for the entire simulation period during run initialization in subroutine FAMUSI. These are Fortran variables Z(47) and Z(56), with data file names PV1CTT and PV2CTT, for the cotton loan rate and diversion payment, respectively. They are used in subroutine FAMUSR in the cotton acreage planted equation, YY(35).

2. Scenario Projections

Most of the supply-related variables which are projected exogenously are prices and crop yields. These are shown in Table 5.2 along with their Fortran and data file names and the names of the subroutines where they are given values and used. Note that the peanut producer price, indicated as being given values only in the data file, will be constant at the last value given when simulating beyond the time associated with that value. Also, the fertilizer price is not used in the current version of the model; it would only be used if the estimated crop yield equations, which are currently inactive, are reactivated. In addition, the farm wage rate is only used in the dairy gross margin (GMPHL2) and chicken labor efficiency (CKLEDC) equations in FAMUSR.

Table 5-2

Supply-Related Variables Projected Exogenously in the U.S. Intermediate Model

Variable	Fortran Name	Data File Name	Defined in	Used in
1. Prices				
tobacco producer price	Z(77)	PTOB	FAMUSI	EXSUP
peanut producer price	Z(2)	PGNUT	data file	FAMUSR
sugar import price	Z(81)	NYCSGR	EXSUP	EXSUP
consumer price index	Z(6)	CPIT	FAMUSI	FAMUSI, EXSUP, FAMUSR, SUPEX
2. Yields				
wheat yield	YY(27)	WHTYT	FAMUSR	FAMUSR
soybean yield	YY(28)	SOYBYT	FAMUSR	FAMUSR
sorghum yield	YY(29)	SORHYT	FAMUSR	FAMUSR
barley yield	YY(30)	BARYT	FAMUSR	FAMUSR
oat yield	YY(31)	OATYT	FAMUSR	FAMUSR
corn yield	YY(32)	CORNYT	FAMUSR	FAMUSR
cotton yield	Z(96)	COTYT	FAMUSI	FAMUSR
rice yield	YRICE	--	FAMUSR	FAMUSR
dry bean yield	YDBN	--	FAMUSR	FAMUSR
potato yield	YPOTO	--	FAMUSR	FAMUSR
tobacco yield	YTOB	--	FAMUSR	FAMUSR
vegetable yield	YVEG	--	FAMUSR	FAMUSR

Another group of exogenous variables on the supply side of the model includes four variables of the land resource component (see Chapter 3). All are used in subroutine RESDEV. Two of them are entered in the data file: the farm mechanization index (Fortran name Z(97) and data file name FMECH) and the number of acres diverted and set aside (Fortran name Z(98) and data file name DIVERT). When simulating beyond the time of the last value in the data file, the farm mechanization index is projected exogenously with a time trend during run initialization in subroutine RESDVI, while the number of acres diverted retains its last data file value. The other two exogenous land resource variables, both used in subroutine RESDEV, are the technology index (Fortran name TECH) and the number of acres irreversibly eroded in a year (Fortran name EROSN). TECH and EROSN are both defined in subroutine RESDEV, the former with a table function and the latter with a step function , whose data values are specified in BLOCK DATA RESDAT with the arrays VTECH and VEROSN, respectively.

A final exogenous supply variable is total fish production, entered in the data file with the name MLBSF and with Fortran name Z(7). It is not otherwise computed in the model, and it is used in subroutine FAMUSI.

Exchange Policies

1. Direct Instruments

Exchange policy instruments in USINT can be categorized in three broad classes: trade, price, and demand. While there is a great deal of overlap among these categories, they are useful for the discussion here. Most of these policies are defined and used as in the standard IIASA/FAP national exchange model (Keyzer 1981) and familiarity with this standard model is assumed in the following discussion. In addition, the exchange equilibrium in USINT is solved at the level of the aggregate IIASA/FAP commodities (see Table 1.1), so that the policy bounds and targets (discussed below) defined for the more disaggregated domestic U.S. commodities are aggregated to the IIASA/FAP level for the exchange solution.

Trade Policies

Instruments directly related to trade are the overall trade balance and commodity-specific quotas and tariffs.

The constant-dollar trade balance target, BALTAR, is set equal to BALO at the end of subroutine SUPEX. Prior to that, in subroutine EXSUP, BALO, at the current domestic price level, is initially defined each year from a projection of historical trade balances (Z(83), called TRDBAL in the data file). Then, in SUPEX, BALO is deflated.

BALTAR, determined in this way, is then inflated by the constant sum of world prices in subroutine EX231 and adjusted for international income transfers. No deviation from this target is allowed in USINT, since the proportional deviation parameters BALNC and BALXC are set to zero at the end of SUPEX. Domestic exchange equilibrium, then, is defined as that combination of tax rate, demands, and prices at which this trade balance target is achieved.

The analyst may explore alternative ways of defining the trade balance and, thus, setting the overall level of demand, either exogenously through the data file (variable TRDBAL) or with equations in subroutine SUPEX. One possibility could be to compute it each year as a function of supply and the pre-exchange demand, i.e., the current year's demand curves evaluated at the previous year's prices.

Tariffs are represented in the model as the ratio of domestic to world prices, both converted to retail level. Thus, a ratio of 1.0 means no tariffs. Actually, care must be taken not to interpret this ratio as what is commonly thought of as a tariff policy. Rather, it also incorporates differences (1) in the way IIASA/FAP defines world prices and world prices actually faced by the U.S., and (2) in the components of the commodity aggregates. That is, "other foods" and, hence, its domestic price may refer to a very different basket of goods in the U.S. than that of the world aggregate and, hence, its world price.

With this caveat, the tariff or price ratio — called DPD(I,1) in subroutine SUPEX and PTARC(I,1) in subroutine EX231 — is defined for commodity i in SUPEX based on historically observed ratios. It is used in EX231 to define the target domestic consumer price as a function of the world price. The analyst is free to change this functional form if he wishes in order to meet the needs of a particular analysis, even to the extent of completely unlinking the domestic price from the world price. If a change is made, however, a corresponding change must also be made in the calculation of partial derivatives later in EX231.

Quotas are the final set of trade-related exchange policies in the model. Setting import and export quotas is equivalent to setting maximum and minimum levels of domestic demand, respectively, since domestic supply is predetermined each year. Further, the equilibrium solution is in terms of net excess demand; therefore, a negative import quota means that a minimum level of net exports is to be achieved, and a positive export quota means that a minimum level of net imports is to take place.

Quotas are determined for each of the 20 domestic disappearance commodities (see Table 1.1) in subroutine SUPEX as functions of minimum and maximum self-sufficiency ratios and maximum year-to-year changes in domestic non-stock demand. Export and import quotas are called TRDMIN and TRDMAX, respectively. The policy parameters are:

1. maximum self-sufficiency ratios, called PSLFMX, which are given values in USINT's BLOCK DATA BKDATA;
2. minimum self-sufficiency ratios, called PSLFMN, which are also given values in BKDATA;
3. maximum proportional changes in domestic non-stock demand, called PQIM, which are given values in a DATA statement in SUPEX; and
4. minimum levels of domestic non-stock demand allowed, as proportions of the previous year's demand, called PQEX, which are also given values in a DATA statement in SUPEX.

Alternative specifications for wheat and rice are currently inactive but may be reactivated by the analyst if desired. These define TRDMAX as a minimum level of net exports equal to exogenously specified P.L. 480 concessional food exports — Z(84) for wheat and Z(85) for rice.

Cotton and wool are also handled separately since they are not among the 20 commodities defined above. For cotton, the import quota is defined as a minimum level of net exports (i.e., it is negative) equal to 20% of cotton production, and maximum exports are three times this minimum level. For wool, net imports cannot be greater than 50 thousand metric tons or 60% of production, whichever is greater, and there can be no net exports.

These import and export quotas, TRDMAX and TRDMIN, are then aggregated in SUPEX to the level of the IIASA/FAP commodities, where they are called QIM and QEX, respectively (XMAX and XMIN in subroutine EX231, where they are used).

Demand Policies

The tax rate, public consumption, and stocks are included as policy instruments directly controlling the quantity demanded.

The tax rate, TAXR, is implemented as an income tax reducing disposable income and, hence, the overall level of demand. Its complement, 1.0-TAXR, is called PHI. PHI's equilibrium value is determined in the exchange algorithm's attempt to achieve the target trade balance. Its initial target value, called SCTARC(4,1) and SCTARC(3,1), is set each year in subroutine SUPEX to the previous year's equilibrium value. First- and second-order bounds are also defined in SUPEX. The first set of bounds, SCMINC(4,1) and SCMAXC(4,1), are assumed to be 2% below and above SCTARC(4,1), respectively. If these bounds are hit during the exchange equilibrium algorithm, then PHI is adjusted within the second set of bounds, SCMINC(3,1) and SCMAXC(3,1), which are assumed in SUPEX to deviate 3% from the target value SCTARC(3,1).

If the second set of tax rate bounds also becomes binding, then public consumption of all commodities is adjusted proportionally in order to reach the trade balance target. The total value of public consumption is assumed, in SUPEX, to be a proportion of the nation's income, and, for the present, it is all allocated to the aggregate nonagricultural commodity, GO(N,1). This is discussed more fully in Chapter 4.

Finally, stock demand is also subject to policy control. Policies for wheat, coarse grains, and soybeans stocks are closely associated with price support operations and, so, are discussed in the next section. Those for other commodities are described here.

For peanuts, stock demand is completely exogenous. Values are entered through the data file (Fortran name Z(1) and data file name PNSTK) and used in SUPEX to define YY(89) and STKPN. This is then disaggregated into its oil and meal contents and treated as part of committed demand for "other foods" and "protein feeds", respectively.

Target stocks of milk products, as discussed in Chapter 4, are predetermined in SUPEX as an estimated function of the milk support price, milk supply, and per capita income. The milk support price, Fortran name Z(3) and data file name MKSUPP, is projected exogenously in subroutine FAMUSI. The equilibrium value of milk stocks will deviate from the target if a milk import or export quota is effective.

Stocks for all other commodities are ignored (assumed to be zero).

Price Policies

The major price policies in the model are the use of stocks to support producer prices of wheat, coarse grains, and soybeans. The computation, in subroutine EX231, of target stocks as functions of world prices relative to domestic support prices is described in detail in Chapter 4 (and see Figure 4.1). The parameters of these functions (defined and named in Table 5.3) are computed in subroutine SUPEX as functions of support prices and assumed maximum and minimum stock levels. The parameters of these latter functions are defined in Table 5.4 along with their current values. Their values are set in DATA statements in BLOCK DATA BKDATA and may be changed by the analyst.

Two alternative sets of support prices are used from the stock functions. Normally, wheat, corn, and soybeans loan rates (see Table 5.1) are the minimum prices, i.e., the prices at which stocks are accumulated to maximum levels. The corresponding maximum stock level is a proportion (CESTK(1,i)) of production of each commodity. The prices at which stocks are assumed to fall to a minimum are multiples (PCALLP(i) for wheat and coarse grains, and CESTKW(3,3) for soybeans) of the loan rate. The associated minimum stock level is also a proportion (CESTK(2,i)) of production of the respective commodity.

Alternatively, a minimum export price policy may be instituted for these three commodities, in which the U.S. will restrict exports, and consequently build stocks,

Table 5-3

Parameters of the Price Policy Stock Functions

Name in Subroutine EX231[1]	Name in Subroutine SUPEX[1]	Meaning
XBMAXC(I,1)	DXPMAX(I,1)	maximum stock level, i.e., the level corresponding to price at its minimum, or support, level
XBMINC(I,1)	DXPMIN(I,1)	minimum stock level, i.e., the level below which stocks will not fall even if price is higher
XBTARC(I,2)	XBTARC(I,2)	minimum price, i.e., the support price, at which stocks are at their maximum
XTARC(I,2)	XTARC(I,2)	price at which stocks are at their minimum

[1] I = 1, 3, 7 for wheat, coarse grains, soybeans (as protein feeds), respectively.

if the world price is not above a specified minimum. This policy takes effect at time WTIME if the switch MNXPRI is .TRUE. Both WTIME and MNXPRI are given values in DATA statements in BLOCK DATA BKDATA. As discussed earlier in this chapter, the minimum export price policy is tied to a mandatory set-aside policy in order to prevent stock from becoming astronomical.

The minimum export price for wheat and coarse grains is assumed to be a multiple (CESTKW(1,i)) of the target price (as defined in Table 5.4). Since there is no target price defined for soybeans, a suitable level is assumed to be 2.5 times the corn target price, and the minimum export price for soybeans is CESTKW(4,1) times that. The price at which stocks fall to a minimum is assumed to be CESTKW(2,i) times the minimum export price (CESTKW(5,1) for soybeans). Under this policy, the maximum stock level of each commodity is domestic supply (production plus beginning stocks) minus the previous year's non-stock domestic demand.

2. Scenario Projections

Population growth rates, which are projected exogenously in USINT, influence the overall level of demand in the model. Separate equations, in subroutine FAMUSR, compute metropolitan and nonmetropolitan populations as functions of assumed growth rates for each and migration between them. The proportional growth rates are specified for the whole simulation period through values given in the data file. Thus, as noted earlier, the growth rates are assumed constant after the final year for which a value is specified. For the metropolitan population, the Fortran and data file names are, respectively, Z(5) and AM; for the

Table 5-4

Definitions and Base Values of
Stock Function Policy Parameters

Name	Base Value	Meaning
CESTK(1,I)	.65 .23 .25	maximum stock level, as a proportion of production (I=1,2,3 for wheat, coarse grains, and soybeans, respectively)
CESTK(2,I)	.25 .10 .05	minimum stock level, as a proportion of production (I=1,2,3 for wheat, coarse grains, and soybeans, respectively)
PCALLP(I)	1.85 1.45	price at which stock level is at minimum, as a proportion of support price (I=1,2 for wheat and coarse grains, respectively)
CESTK(3,3)	1.5	price at which soybeans stock level is at a minimum, as a proportion of support price
CESTKW(1,I)	1.25 1.25	ratio of minimum export price to target price (I=1,2 for wheat and coarse grains, respectively)
CESTKW(2,I)	1.10 1.10	ratio of minimum stock price to minimum export price (I=1,2 for wheat and coarse grains, respectively)
CESTKW(4,1)	1.10	ratio of minimum export price to target price for soybeans
CESTKW(5,1)	1.05	ratio of minimum stock price to minimum export price for soybeans

nonmetropolitan population, they are Z(4) and AN.

Chapter 6

DESCRIPTION OF THE OUTPUT OF THE USINT REPORT WRITER

The U.S. intermediate model's report writer (program FAMUSP) is a program, executed following completion of a simulation run, which reads two direct access files containing historical and simulated data and produces tables of times series of results over the period of the simulation run. Three sets of tables are generated. In all tables, the rows represent simulated years; the columns in each of the three sets are described below. A sample of the report writer's output is presented in Figures 6.1 to 6.3.

Numbered Endogenous Variables

The first set of tables (Figure 6.1) has been adapted from the GASSP simultaneous solution package. A table of three columns is given for each of the 185 numbered endogenous variables in the model. The first column reproduces historical and exogenously projected values of the variable. Although these values are based on data read from the model's input data file, many of them either undergo unit transformations or are computed or recomputed during model initialization for internal consistency. Zeros are placed in the table where values do not exist in a projection period. The second column for each variable gives the simulated values as computed by the model, while the third column shows percentage deviations from the historical values.

Appendix Table A.1 defines the 185 numbered endogenous variables tabulated and their units of measure. In general, variables 1-12 and 48-54 are related to the production of livestock products and demand for feed; variables 13-47 and 55-100 are associated with crop areas, yields, production, prices and stocks; variables 101-125 are macroeconomic variables; and variables 126-185 cover net imports, consumer prices, and per capita consumption.

Supply and Utilization

Simulated information on the supply and utilization of each of the 20 commodities of USINT is given in the second set of tables (Figure 6.2). The first column after the year is domestic supply (labeled by the symbolic variable name DOMSUP), i.e. production plus beginning stocks. The second column (labeled AGTRD) is net excess demand, i.e. net imports, where negative values indicate net exports. Columns 3 through 9 are, respectively, losses (QLOSS), seed use (QSEED), feed use (QFEED), industrial consumption (DEMIND), government consumption (DEMGOV), human consumption (CONS), and ending stocks (ENDSTK). The final column, domestic demand (DOMDEM), is the sum of columns 3 through 9. Table 1.1 in Chapter 1 lists the model's 20 commodities of domestic utilization along with their units of measure as shown in the output tables.

Exchange Policies and Results

The final set of tables (Figure 6.3) present simulated price, stock, quota, and government consumption policies and equilibrium results for the U.S. for each of the 10 IIASA/FAP world market commodity aggregates (see Table 1.1 in Chapter 1). The unit of measure for quantity variables for each commodity is shown in the output tables, and price variables are all in terms of million U.S. dollars per that unit. The three price columns are equilibrium world market price (PW) and target and equilibrium domestic consumer retail price (PD and P), respectively. The four buffer stock columns show results for maximum, target, equilibrium, and minimum buffer stocks (XPUMAX, XPUTAR, XPU, and XPUMIN), respectively. The next three columns, headed by QIM, ZN, and QEX, represent maximum, equilibrium, and minimum net excess demand, respectively, where negative values reflect exports. Government consumption results are given in the column labeled XPU1. The final column gives the type of exchange equilibrium solution.

Figure 6.1: Report Writer Output of Numbered Endogenous Variables

I. Numbered Endogenous Variables

	1 BFCOWT			2 DCOWT			3 DHEIFT			4 SOWFST		
1970.0	.367E+05	.367E+05	0.	.121E+05	.121E+05	0.	.388E+04	.388E+04	0.	.711E+04	.711E+04	0.
1971.0	.379E+05	.378E+05	-0.	.119E+05	.118E+05	-1.	.384E+04	.381E+04	-1.	.724E+04	.696E+04	-4.
1972.0	.388E+05	.389E+05	0.	.118E+05	.115E+05	-2.	.383E+04	.377E+04	-1.	.650E+04	.669E+04	3.
1973.0	.409E+05	.399E+05	-3.	.116E+05	.113E+05	-3.	.387E+04	.375E+04	-3.	.644E+04	.650E+04	1.
1974.0	.432E+05	.418E+05	-3.	.113E+05	.111E+05	-1.	.394E+04	.383E+04	-3.	.632E+04	.607E+04	-4.
1975.0	.457E+05	.432E+05	-5.	.112E+05	.110E+05	-2.	.409E+04	.394E+04	-4.	.497E+04	.518E+04	4.

	5 SOWFFT			6 PORKQT			7 FBEFQT			8 MILKQT		
1970.0	.688E+04	.688E+04	0.	.218E+05	.218E+05	0.	.182E+05	.182E+05	0.	.117E+06	.117E+06	0.
1971.0	.634E+04	.595E+04	-6.	.228E+05	.225E+05	-2.	.183E+05	.189E+05	4.	.119E+06	.117E+06	-1.
1972.0	.597E+04	.631E+04	6.	.209E+05	.209E+05	-0.	.189E+05	.195E+05	4.	.120E+06	.118E+06	-2.
1973.0	.587E+04	.543E+04	-8.	.202E+05	.209E+05	4.	.175E+05	.178E+05	1.	.115E+06	.113E+06	-2.
1974.0	.548E+04	.565E+04	3.	.200E+05	.189E+05	-6.	.189E+05	.183E+05	-3.	.116E+06	.115E+06	-1.
1975.0	.495E+04	.463E+04	-6.	.168E+05	.174E+05	3.	.177E+05	.184E+05	4.	.115E+06	.114E+06	-1.

	9 NFBFQT			10 TURKQT			11 CHIKQT			12 EGGQT		
1970.0	.345E+04	.345E+04	0.	.173E+04	.173E+04	0.	.847E+04	.847E+04	0.	.570E+04	.570E+04	0.
1971.0	.362E+04	.363E+04	0.	.177E+04	.189E+04	7.	.852E+04	.862E+04	1.	.581E+04	.568E+04	-2.
1972.0	.352E+04	.380E+04	8.	.191E+04	.208E+04	9.	.889E+04	.905E+04	2.	.574E+04	.568E+04	-1.
1973.0	.371E+04	.382E+04	3.	.193E+04	.226E+04	17.	.876E+04	.894E+04	2.	.550E+04	.556E+04	1.
1974.0	.426E+04	.467E+04	10.	.192E+04	.203E+04	6.	.892E+04	.936E+04	5.	.547E+04	.550E+04	1.
1975.0	.623E+04	.593E+04	-5.	.180E+04	.208E+04	15.	.882E+04	.928E+04	5.	.539E+04	.540E+04	0.

	13 APCT			14 APWT			15 APSBT			16 APOT		
1970.0	.669E+05	.669E+05	0.	.487E+05	.487E+05	0.	.431E+05	.431E+05	0.	.244E+05	.244E+05	0.
1971.0	.742E+05	.760E+05	2.	.538E+05	.574E+05	7.	.435E+05	.429E+05	-1.	.218E+05	.223E+05	2.
1972.0	.671E+05	.690E+05	3.	.542E+05	.579E+05	7.	.469E+05	.484E+05	3.	.200E+05	.207E+05	3.
1973.0	.723E+05	.723E+05	0.	.593E+05	.552E+05	-7.	.565E+05	.538E+05	-5.	.186E+05	.194E+05	4.
1974.0	.779E+05	.789E+05	1.	.710E+05	.701E+05	-1.	.525E+05	.553E+05	5.	.170E+05	.187E+05	10.
1975.0	.786E+05	.787E+05	0.	.748E+05	.780E+05	4.	.546E+05	.520E+05	-5.	.165E+05	.188E+05	14.

	17 APBT			18 APSHT			19 QBSGR			20 ADBN		
1970.0	.105E+05	.105E+05	0.	.170E+05	.170E+05	0.	.264E+05	.264E+05	0.	.150E+04	.150E+04	0.
1971.0	.111E+05	.119E+05	7.	.205E+05	.202E+05	-1.	.271E+05	.257E+05	-5.	.136E+04	.154E+04	13.
1972.0	.106E+05	.988E+04	-6.	.170E+05	.171E+05	0.	.284E+05	.287E+05	1.	.149E+04	.149E+04	0.
1973.0	.110E+05	.117E+05	6.	.190E+05	.186E+05	-2.	.245E+05	.256E+05	5.	.140E+04	.145E+04	4.
1974.0	.871E+04	.896E+04	3.	.176E+05	.174E+05	-1.	.221E+05	.194E+05	-12.	.162E+04	.158E+04	-2.
1975.0	.929E+04	.920E+04	-1.	.181E+05	.199E+05	10.	.297E+05	.291E+05	-2.	.152E+04	.137E+04	-10.

Figure 6.2: Report Writer Output of Supply and Utilization by Domestic U.S. Commodities

II. Supply and Utilization by Domestic U.S. Commodities

WHEAT SUPPLY AND UTILIZATION

UNIT: THOUSAND METRIC TONS

YEAR	DOMSUP(1)	AGTRD(2)	QLOSS	QSEED	QFEED	DEMIND(3)	DEMGOV(4)	CONS	ENDSTK	DOMDEM
1970.	63489.1	-18681.4	1470.5	1591.8	5608.5	0.0	0.0	14022.2	22114.7	44807.6
1971.	69281.6	-18890.4	1886.7	1873.3	3854.0	0.0	0.0	13556.2	29221.0	50391.2
1972.	75121.1	-37039.6	1836.0	1889.9	3091.1	0.0	0.0	14002.8	17261.7	38081.5
1973.	59540.3	-30005.9	1691.1	1801.4	1823.3	0.0	0.0	13648.9	10569.6	29534.4
1974.	57020.8	-27158.4	1858.0	2290.9	952.0	0.0	0.0	13148.7	11612.8	29862.4
1975.	69505.2	-33964.1	2315.7	2547.2	2369.9	0.0	0.0	13835.2	14473.1	35541.1

(1)PRODUCTION AND BEGINNING STOCKS (2)NET IMPORTS
(3)INDUSTRIAL CONSUMPTION (4)GOVERNMENT CONSUMPTION

RICE SUPPLY AND UTILIZATION

UNIT: THOUSAND METRIC TONS

YEAR	DOMSUP(1)	AGTRD(2)	QLOSS	QSEED	QFEED	DEMIND(3)	DEMGOV(4)	CONS	ENDSTK	DOMDEM
1970.	2546.9	-1567.1	229.2	78.8	0.0	0.0	0.0	671.8	0.0	979.8
1971.	2555.5	-1604.7	230.0	80.6	0.0	0.0	0.0	640.2	0.0	950.8
1972.	2624.4	-1625.3	236.2	82.1	0.0	0.0	0.0	680.7	0.0	999.0
1973.	2855.8	-1812.9	257.0	88.7	0.0	0.0	0.0	697.1	0.0	1042.9
1974.	3651.4	-2575.6	328.6	112.7	0.0	0.0	0.0	634.5	0.0	1075.8
1975.	3789.2	-2634.0	341.0	116.2	0.0	0.0	0.0	698.0	0.0	1155.2

(1)PRODUCTION AND BEGINNING STOCKS (2)NET IMPORTS
(3)INDUSTRIAL CONSUMPTION (4)GOVERNMENT CONSUMPTION

COARSE GRAIN SUPPLY AND UTILIZATION

UNIT: THOUSAND METRIC TONS

YEAR	DOMSUP(1)	AGTRD(2)	QLOSS	QSEED	QFEED	DEMIND(3)	DEMGOV(4)	CONS	ENDSTK	DOMDEM
1970.	190696.3	-28896.8	8710.3	1757.1	122724.4	25.4	0.0	8055.5	20526.9	161799.5
1971.	210582.2	-16064.8	11403.3	1796.4	128659.7	25.4	0.0	8900.9	43731.7	194517.4
1972.	228449.2	-54844.3	11083.1	1608.6	133364.5	25.4	0.0	9051.7	18471.8	173604.9
1973.	201707.1	-32191.8	10994.1	1651.7	129611.1	25.4	0.0	8909.4	18323.5	169515.2
1974.	172413.9	-28306.1	9245.4	1561.1	108445.8	25.4	0.0	9421.1	15409.0	144107.8
1975.	199067.7	-40762.9	11019.5	1581.5	115727.3	25.4	0.0	11585.4	18365.9	158304.8

(1)PRODUCTION AND BEGINNING STOCKS (2)NET IMPORTS
(3)INDUSTRIAL CONSUMPTION (4)GOVERNMENT CONSUMPTION

Figure 6.3: Report Writer Output of Policy Targets and Equilibrium Results by IIASA Aggregate Commodity

III. Policy Targets and Equilibrium Results by IIASA Aggregate Commodity

WHEAT (IIASA AGGREGATE)
UNIT:TH MT GRAIN

YEAR	PRICES:MILLION $/UNIT			STOCKS				NET IMPORTS			GOVT CONS	TYPE
	WORLD	CONSUMER										
		TARGET	EQUILIB	MAXIMUM	TARGET	EQUILIB	MINIMUM	MAXIMUM	EQUILIB	MINIMUM		
	PW	PD	P	XPUMAX	XPUTAR	XPU	XPUMIN	QIM	ZN	QEX	XPU1	
1970.	0.0620	0.1896	0.1896	26547.95	22114.69	22114.69	9098.68	- 12228.7	-18642.0	-26669.4	0.0	2.
1971.	0.0640	0.1928	0.1928	34061.57	29221.05	29221.05	11673.80	- 10559.7	-18889.7	-21906.2	0.0	2.
1972.	0.0606	0.1918	0.1918	33146.71	17261.75	17261.75	11360.25	- 30338.1	-37037.7	-40923.2	0.0	2.
1973.	0.0675	0.2433	0.2433	30531.49	10569.64	10569.64	10463.95	- 21905.1	-29993.3	-32314.9	0.0	2.
1974.	0.0894	0.3299	0.3299	33544.69	11612.78	11612.78	11496.65	- 20753.8	-27118.1	-30236.2	0.0	2.
1975.	0.0805	0.3220	0.3220	41807.02	14473.10	14473.10	14328.37	- 31307.6	-33939.8	-40432.4	0.0	2.

RICE (IIASA AGGREGATE)
UNIT:TH MT MILLED

YEAR	PRICES:MILLION $/UNIT			STOCKS				NET IMPORTS			GOVT CONS	TYPE
	WORLD	CONSUMER										
		TARGET	EQUILIB	MAXIMUM	TARGET	EQUILIB	MINIMUM	MAXIMUM	EQUILIB	MINIMUM		
	PW	PD	P	XPUMAX	XPUTAR	XPU	XPUMIN	QIM	ZN	QEX	XPU1	
1970.	0.2430	0.5093	0.5093	0.0	0.0	0.0	0.0	-1130.4	-1563.4	-2492.5	0.0	2.
1971.	0.2260	0.5269	0.5269	0.0	0.0	0.0	0.0	-1281.7	-1604.6	-2506.5	0.0	2.
1972.	0.2548	0.5291	0.5291	0.0	0.0	0.0	0.0	-1388.3	-1625.2	-2576.8	0.0	2.
1973.	0.2069	0.6790	0.6790	0.0	0.0	0.0	0.0	-1557.0	-1811.7	-2805.8	0.0	2.
1974.	0.1846	1.1376	1.1376	0.0	0.0	0.0	0.0	-2295.7	-2572.2	-3599.3	0.0	2.
1975.	0.1900	1.0441	1.0441	0.0	0.0	0.0	0.0	-2390.6	-2631.6	-3735.4	0.0	2.

CRS GRNS (IIASA AGGREGATE)
UNIT:TH MT GRAIN

YEAR	PRICES:MILLION $/UNIT			STOCKS				NET IMPORTS			GOVT CONS	TYPE
	WORLD	CONSUMER										
		TARGET	EQUILIB	MAXIMUM	TARGET	EQUILIB	MINIMUM	MAXIMUM	EQUILIB	MINIMUM		
	PW	PD	P	XPUMAX	XPUTAR	XPU	XPUMIN	QIM	ZN	QEX	XPU1	
1970.	0.0570	0.8726	0.8726	37095.71	20526.87	20526.87	14371.98	22858.7	-28373.9	-73388.5	0.0	2.
1971.	0.0584	0.7086	0.7086	48564.86	43731.73	43731.73	18815.48	16803.7	-14807.7	-53832.5	0.0	2.
1972.	0.0536	1.0301	1.0301	47200.89	18471.75	18471.75	18287.04	-13956.4	-53941.4	-89349.1	0.0	2.
1973.	0.0586	1.6731	1.6731	46822.13	18323.53	18323.53	18140.29	18289.3	-30399.2	-61226.8	0.0	2.
1974.	0.0675	1.9815	1.9815	39374.72	15409.03	15409.03	15254.94	39544.0	-29595.7	-54278.1	0.0	2.
1975.	0.0643	1.6825	1.6825	46930.31	18365.86	18365.86	18182.20	-13393.7	-41731.6	-77742.9	0.0	2.

Chapter 7

RECOMMENDATIONS FOR FURTHER DEVELOPMENT

This final chapter suggests some priority areas for updating and extending the U.S. intermediate model in order to maintain and increase its usefulness for policy analysis as part of the basic linked system.

1. Update Data

The USINT data input file should be updated regularly as new data become available. Some of the historical series contained in it, particularly for per capita food consumption, consumer prices, and producer prices of minor crops, only have data through 1976 or 1977; others go through 1980 or 1981. In addition, the IIASA/FAP world price series currently exist only through 1979. It is useful to keep these series as up to date as possible not only for historical tracking tests of model performance but also to have the capability to initialize the model close to the present for purposes of policy analysis projections.

2. Update Crop Commodity Programs

The commodity programs defined for the major crops, as described in Chapter 2, were modeled in the mid-1970's as part of the MSU Agriculture Model and include features of the 1977 Farm Bill. Therefore, they are now substantially out of date. A major updating is necessary if the model is to remain relevant for analysis of the current and anticipated problems of U.S. agriculture over the next 20 years. Respecification and reestimation of the appropriate supply equations should be carried out, either in cooperation with the MSU Agriculture Model team at Michigan State University or with the FAPSIM team in USDA.

3. Crop Yields

Yields are currently projected in the model as linear time trends. While this may be suitable as a scenario projection, and indeed other such scenarios can easily be implemented, it would be desirable to also have equations in the model which endogenize yields as a base, or standard, mode of operation. It would be particularly useful to relate such equations to input demands and resource allocations, including the quality and quantity of available land, water, labor, capital, and technology.

4. Farm Accounting

There is currently no accounting of farm income and expenditures in USINT. It would be a straightforward task to modify and adapt the Agricultural Finance component of the U.S. detailed model to USINT. This component computes farm income from crops, livestock, and other sources; investments in machinery and buildings; and expenditures on labor, fertilizers, chemicals, fuels, and other inputs. It then generates tables showing a pro-forma income statement, the sources and uses of funds, a balance sheet for agriculture, and other ratios and indices useful in evaluating the performance of the agricultural sector. In this way, the impact of policy options on the fiscal well-being of U.S. agriculture can be projected.

5. Commodity Definitions

As noted in Chapter 1, there are some minor inconsistencies between the commodity definitions of USINT and those of IIASA/FAP. In addition, the USINT commodities are defined to aggregate to the level of the 10 IIASA/FAP commodities (see Table 1.1). Therefore, any commodity redefinition to be done with USINT should also be consistent with the 19-commodity level of IIASA/FAP in case that version is ever implemented.

6. Macroeconomy Model

Nonagricultural supply is currently determined in USINT based on the total GNP resulting from a simple model of metropolitan and nonmetropolitan population, migration, investment, capital utilization, and consumption (see Edwards and DePass, 1975). At the very least, the equations of this model should be updated. Consideration may also be given as to whether a respecification may be desirable, perhaps along the lines of a scaled-down version of the Macroeconomy component of the U.S. detailed model.

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Appendix A

ENDOGENOUS AND EXOGENOUS VARIABLES OF USINT

The MSU Agriculture Model, which provides the agricultural supply and feed demand components of the U.S. intermediate model (see Chapter 2), is solved with the GASSP simultaneous solution package. Therefore, although USINT is not solved with that package, it does retain some of its features in order to facilitate possible future updates based on later versions of the MSU Agriculture Model. One of these features is the use of Y and Z arrays for storing values of those endogenous and exogenous variables, respectively, which are common to both models as well as some additional ones of the intermediate model. This facilitates the use of the same equations in the two models, for those common to both; data entry using data files in the same format, including some of the same data; and use of the GASSP report writer for part of USINT's output (see Chapter 6).

The Y and Z arrays are dimensioned in the program to allow the use of up to 185 numbered endogenous variables and up to 100 numbered exogenous variables, respectively. The two tables in this appendix list those variables, giving the symbolic names used for them in the data file and output tables, their definitions, and their units of measure.

Table A-1

Numbered Endogenous Variables, Y_i, of the U.S. Intermediate Model[1]

i	Name	Unit[1]	Definition
1	BFCOWT	thousand head	beef cows
2	DCOWT	thousand head	dairy cows
3	DHEIFT	thousand head	dairy heifers
4	SOWFST	thousand head	sows farrowing, spring
5	SOWFFT	thousand head	sows farrowing, fall
6	PORKQT	million pounds, live weight	pork production
7	FBEFQT	million pounds, carcass weight	fed beef production
8	MILKQT	million pounds	milk production
9	NFBFQT	million pounds, carcass weight	nonfed beef production
10	TURKQT	million pounds, ready-to-cook	turkey production
11	CHIKQT	million pounds, ready-to-cook	chicken production
12	EGGQT	million dozen	egg production
13	APCT	thousand acres	corn area planted
14	APWT	thousand acres	wheat area planted
15	APSBT	thousand acres	soybeans area planted
16	APOT	thousand acres	oats area planted
17	APBT	thousand acres	barley area planted
18	APSHT	thousand acres	sorghum area planted
19	QBSGR	thousand tons, beets	sugarbeet production
20	ADBN	thousand acres	dry beans area planted
21	APOTO	thousand acres	potatoes area planted
22	ARICE	thousand acres	rice area planted
23	QGNUT	thousand pounds, unshelled	peanut production
24	AVEG	thousand acres	vegetables area planted
25	ATOB	thousand acres	tobacco area planted
26	QCSGR	thousand tons, raw sugar	sugar cane production
27	WHTYT	bushels/acre	wheat yield
28	SOYBYT	bushels/acre	soybean yield
29	SORHYT	bushels/acre	sorghum yield
30	BARYT	bushels/acre	barley yield
31	OATYT	bushels/acre	oat yield
32	CORNYT	bushels/acre	corn yield
33	CSILYT	tons/acre	corn silage yield
34	SSILYT	tons/acre	sorghum silage yield
35	APCTT	thousand acres	cotton area planted
36	RICEQ	thousand cwt, rough	rice production
37	DBNQ	thousand cwt	dry bean production

Appendix Table A-1, continued . . .

38	COTQT	thousand bales	cotton production
39	COTCRUSHT	thousand tons	cottonseed crushings
40	POTOQ	thousand cwt	potato production
41	TOBQ	thousand pounds, farm-sales-wt	tobacco production
42	COTSTKT	thousand bales	cotton stocks
43	QFLAX	thousand bushels	flaxseed production
44	VEGQ	thousand tons	vegetable production (excl. potatoes)
45	QFRT	thousand tons	fruit production
46	CRUSHT	million bushels	soybean crushings
47	SOILQT	million pounds	soy oil production
48	HPCAUT	million units	protein-consuming animal units
49	LSTKPXT	index (1967=100)	livestock price index
50	GCAUT	million units	grain-consuming animal units
51	SMPERHPCAU	pounds/unit	soymeal per protein-consuming animal unit
52	FGGCAU	tons/unit	feed grains per grain-consuming animal unit
53	FGCONT	million tons	feed grain consumption
54	SOYMQT	thousand tons	soymeal consumption
55	GPFR	1967 $/pound	real fish producer price
56	RICPR	1967 $/cwt	real rice producer price
57	QSHLMB	thousand pounds, live weight	sheep/lamb production
58	PPOTO	1967 $/cwt	real potato producer price
59	PVEG	1967 $/ton	real vegetable producer price
60	PDBN	1967 $/cwt	real dry bean producer price
61	PCSTKT	million bushels	policy corn stocks
62	PWSTKT	million bushels	policy wheat stocks
63	PCOF	1967 $/pound	real coffee producer price
64	PSUG	1967 $/ton, raw	real sugar producer price
65	SBSTKT	million bushels	soybean ending stocks
66	PLMB	1967 $/cwt, live weight	real lamb producer price
67	WHTFDT	million bushels	wheat feed consumption
68	QWL	thousand pounds	wool production
69	PPLTRY	1967 $/cwt, live weight	real poultry producer price
70	PFRT	1967 $/ton	real fruit producer price
71	PPTOB	1967 $/cwt	real tobacco producer price
72	SOILPT	1967 $/cwt	real soy oil price
73	CORNPT	1967 $/bushel	real corn producer price
74	SOYMPT	1967 $/cwt	real soymeal price
75	WHTPT	1967 $/bushel	real wheat producer price
76	PORKPT	1967 $/cwt, live weight	real pork producer price
77	FBEFPT	1967 $/cwt, live weight	real fed beef producer price
78	BFCOWP	1967 $/cwt, live weight	real nonfed beef producer price
79	MILKPT	1967 $/cwt	real milk producer price
80	CHIKPT	1967 $/cwt, live weight	real chicken producer price

Appendix Table A-1, continued . . .

81	TURKPT	1967 $/cwt, live weight	real turkey producer price
82	EGGPT	1967 $/100 dozen	real egg producer price
83	QFSH	million pounds	fish production
84	PBEEF	1967 $/cwt, live weight	real beef producer price
85	FGSTKT	million tons	feed grain ending stocks
86	PWCSGR	1967 $/cwt, raw	real New York CIF sugar price
87	SOYBPT	1967 $/bushel	real soybean producer price
88	MLKSTK	million pounds, fresh milk	milk ending stocks
89	GNUTST	thousand pounds, shelled weight	peanut ending stocks
90	DPCIT	1967 $/person	real per capita disposable income
91	COTPT	1967 $/cwt	real cotton producer price
92	WHTQT	thousand bushels	wheat production
93	SOYBQT	thousand bushels	soybean production
94	SORHQT	thousand bushels	sorghum production
95	BARQT	thousand bushels	barley production
96	OATQT	thousand bushels	oat production
97	CORNQT	thousand bushels	corn production
98	CSILQT	thousand tons	corn silage production
99	SSILQT	thousand tons	sorghum silage production
100	WHTSTK	million bushels	wheat ending stocks
101	PM	million people	metropolitan population
102	PN	million people	nonmetropolitan population
103	LFM	million people	metro labor force
104	LFN	million people	nonmetro labor force
105	EMPM	million people	metro employment
106	EMPN	million people	nonmetro employment
107	MT	million people	nonmetro-metro migration
108	GRINCM	billion dollars	metro income
109	GRINCN	billion dollars	nonmetro income
110	PINCM	billion dollars	metro production
111	PINCN	billion dollars	nonmetro production
112	KSM	billion dollars	metro capital stock
113	KSN	billion dollars	nonmetro capital stock
114	KM	billion dollars	metro capital utilization
115	KN	billion dollars	nonmetro capital utilization
116	EXM	billion dollars	nonmetro-metro income transfers
117	EXN	billion dollars	metro-nonmetro income transfers
118	CONM	billion dollars	metro consumption
119	CONN	billion dollars	nonmetro consumption
120	INVM	billion dollars	metro investment
121	INVN	billion dollars	nonmetro investment
122	GNP	billion dollars	gross national product
123	POPT	million people	population
124	BALPMT	million dollars	current trade deficit
125	TAXR	proportion	national tax burden
126-144	WHNTIM-PFNTIM	thousand metric tons[2]	net imports, commodities wheat through protein feeds
145	AONTIM	million dollars	net imports, nonagriculture

Appendix Table A-1, continued . . .

146- 164	CPWHT- CPPF	\$/pound	nominal retail prices, commodities wheat through protein feed
165	CPAOGS	index (1967=1.0)	nominal retail price, nonagric.
166- 184	PCCWHT- PCCPF	pounds/person	per capita consump., commodities wheat through protein feed
185	PCCAO	dollars/person	per capita consump., nonagric.

Notes: 1. Unit definitions: cwt = hundredweight = 100 pounds
ton = 2000 pounds
2. See Table 4-1, Chapter 4, for specific commodity definitions and units.

Table A-2

Numbered Exogenous Variables, Z_i, of the U.S. Intermediate Model[1]

i	Name	Unit[1]	Definition
1	PNSTK	thousand pounds, shelled	peanut stocks
2	PGNUT	$/cwt, unshelled	peanut producer price
3	MKSUPP	$/cwt	milk support price
4	AN	proportion/year	natural population growth rate, nonmetropolitan areas
5	AM	proportion/year	natural population growth rate, metropolitan areas
6	CPIT	index (1967=1.0)	consumer price index
7	MLBSF	million pounds	fish production
8	PFERTT	index (1967=100)	fertilizer price
9	WLR	$/bushel	wheat loan rate
10	WTP	$/bushel	wheat target price
11	WSA	proportion	complement of wheat set-aside
12	WDDP	$/bushel	wheat direct diversion payment
13	WRVD	proportion	wheat recommended voluntary diversion
14	WNPA	thousand acres	wheat national program acreage
15	CHIKLE	hours	labor efficiency in chicken production
16	--	--	unused
17	--	--	unused
18	BLR	$/bushel	barley loan rate
19	BTP	$/bushel	barley target price
20	BSA	proportion	complement of barley set-aside
21	BDDP	$/bushel	barley direct diversion payment
22	BRVD	proportion	barley recommended voluntary diversion
23	BNPA	thousand acres	barley national program acreage
24	OLR	$/bushel	oat loan rate
25	DRATP	1967 $/cwt	real dairy ration price
26	DCONC	pounds of feed / cwt of milk	dairy concentrates use
27	CLABT	hours	dairy labor use
28	--	--	unused
29	--	--	unused
30	--	--	unused
31	BFCALFP	1967 $/cwt, live weight	real feeder calf price
32	BFCOWPU	1967 $/cwt, live weight	real utility cow price
33	NHAYPRA	1967 $/ton	real hay price
34	CLR	$/bushel	corn loan rate
35	CTP	$/bushel	corn target price
36	CSA	proportion	complement of corn set-aside
37	CDDP	$/bushel	corn direct diversion payment

Appendix Table A-2, continued . . .

38	CRVD	proportion	corn recommended voluntary diversion
39	CNPA	thousand acres	corn national program acreage
40	SBLR	$/bushel	soybean loan rate
41	SLR	$/cwt	sorghum loan rate
42	STP	$/cwt	sorghum target price
43	SSA	proportion	complement of sorghum set-aside
44	SDDP	$/cwt	sorgh. direct diversion payment
45	SRVD	proportion	sorghum recommended voluntary diversion
46	SNPA	thousand acres	sorgh. national program acreage
47	PV1CTT	1967 $/pound	real cotton effective loan rate
48	--	--	unused
49	--	--	unused
50	--	--	unused
51	--	--	unused
52	--	--	unused
53	--	--	unused
54	--	--	unused
55	--	--	unused
56	PV2CTT	1967 $/pound	real cotton effective diversion payment
57	QGASHOL	million bushels	corn used for gasohol
58	VGASHOL	1967 $/gallon	gasohol profitability
59	GASCAP	million bushels	gasohol production capacity
60	PORKCON	percent	pork production concentration in farms with over 1000 head
61	MLKYLDL	thousand pounds/ head	lagged milk yield of dairy cows
62	COTLR	1967 $/bale	cotton loan rate
63	CCCS	million bushels	government corn stocks (endog.)
64	USFGES	--	unused
65	BFHEFRPL	thousand head	beef heifer replacements
66	--	--	unused
67	CLBUS	--	unused
68	STSW	pounds/head	steer slaughter weight
69	HFSW	pounds/head	heifer slaughter weight
70	--	--	unused
71	DDG	thousand tons	dry distiller's grain
72	CCOSTPRO	$/bushel	corn production cost
73	WCOSTPRO	$/bushel	wheat production cost
74	CCC	million bushels	governmt. wheat stocks (endog.)
75	PSTK	--	unused
76	PWOOL	$/cwt	wool producer price
77	PTOB	$/cwt	tobacco producer price
78	TOBCP	$/pound	tobacco retain price
79	FWAGET	1967 $/hour	real farm wage rate
80	RICSP	$/cwt	rice support price
81	NYCSGR	$/cwt	New York CIF raw sugar price
82	COFIMP	$/pound	coffee import price
83	TRDBAL	million dollars	trade deficit
84	PL480W	million bushels	PL480 wheat exports
85	PL480R	million cwt	PL480 rice exports
86	BTSUGP	$/ton	beet sugar price

Appendix Table A-2, continued . . .

87	CNSUGP	$/ton	cane sugar price
88	CSTKT	million bushels	corn beginning stocks
89	OSTKT	million bushels	oat beginning stocks
90	BSTKT	million bushels	barley beginning stocks
91	SHSTKT	million bushels	sorghum beginning stocks
92	GWSTKT	million bushels	government wheat stocks (act.)
93	PVWSTKT	million bushels	private wheat stocks (act.)
94	SMSTKT	thousand tons	soymeal beginning stocks
95	SMEXT	thousand tons	soymeal exports
96	COTYT	pounds/acre	cotton yield
97	FMECH	index (1967=100)	farm mechanization index
98	DIVERT	million acres	acreage diversions
99	--	--	unused
100	--	--	unused

Notes: 1. Unit definitions: cwt = hundredweight = 100 pounds
ton = 2000 pounds