MACROECONOMIC IMPACTS ON UNITED STATES AGRICULTURE: A SIMULATION ANALYSIS

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MACROECONOMIC IMPACTS ON UNITED STATES

AGRICULTURE: A SIMULATION

ANALYSIS

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NOMENCLATURE

DEFINITIONS FOR THE ENDOGENOUS VARIABLES

DDNA - domestic absorption of all nonagricultural products in millions of 1972 dollars. SCB, NIPA

DDA - domestic absorption of agricultural products in millions of 1972 dollars. SCB, NIPA

DXDA - net exports of agricultural products in millions of 1972 dollars. BS

DIDNA - net imports of nonagricultural products in millions of 1972 dollars. BS

DSKA - change in the level of inventories of agricultural products in millions of 1972 dollars. SCB, NIPA

DSA - production of agricultural products in millions of 1972 dollars. AS

PCPNA - percentage change in price index of nonagricultural products. BS

PCW - percentage change in index of wages in manufacturing (1977=100). Supp. to SCB

AED - aggregate expenditures in the U.S. economy in millions of 1972 dollars. SCB, NIPA

RPR - real prime rate of interest on short-term loans. FRB

ERA - index of the real exchange rate of U.S. dollars adjusted for inflation by the implicit price deflator of GNP for the U.S. and trade weighted CPI for the G-10 currencies (G-10 classification). FRB

DKD - net capital outflow of capital for the U.S. economy in millions of 1972 dollars. SCB, NIPA

PNAD - producer price index for all nonagricultural products (1977=100). BS

PAD - producer price index for all agricultural products (1977=100). BS

YD - national income of the U.S. economy in millions of 1972 dollars. BS

HPMS - supply of high powered money (M1-B) in millions of 1972 dollars. FRB

BOPD - balance of payments for the U.S. economy in millions of 1972 dollars. BS

DEFINITIONS FOR THE EXOGENOUS VARIABLES

POP - population of the U.S. (millions). SCB, NIPA

YF - foreign income indicator in million of 1972 dollars (US). FRB

PPF - price index of prices paid by farmers (1910-14 =100). AS

PCPIDNA - percentage change in the price of nonagricultural imports (1977=100). SCB, NIPA

PCHPMS - percentage change in the supply of money. FRB

U - percentage rate of unemployment. SCB, NIPA

GPDID - gross private domestic investment in millions of 1972 dollars. SCB, NIPA

FGSDD - federal government budget (surplus) in millions of 1972 dollars. SCB, NIPA

PRDD - change in the prime rate of interest on short-term loans. FRB

DPRF - difference between foreign and domestic interest rates. FRB

FRDL - foreign reserves of U.S. lagged in millions of 1972 dollars. SCB, NIPA

NDAD - net domestic money asset for the U.S. in millions of 1972 dollars. SCB, NIPA

All variables ending in "L" are lagged values of the indicated variable.

Sources: SCB, NIPA - Survey of Current Business (National Income and Product Accounts Supplements) (USDC).

BS - Business Statistics (USDC).

AS - Agricultural Statistics (USDA).

FRB - Federal Reserve Bulletin

CHAPTER I

BACKGROUND

The farm economy has been dramatically changed in the last 15 years. Before the 1970's U.S. agriculture produced food primarily for the domestic market. Today it is an export based industry with considerable world market share. Table I reveals an increase in world and U.S. agricultural export volume. The commodities listed are those that makeup a major share of world agricultural trade. In the 1972-73 through 1981-82 period the U.S. exported approximatly 57 percent of world exports in the commodities listed. Exports from the U.S. began to decline after 1981-82 and the market share of the U.S. is projected to fall to 43 percent by 1985-86. World exports are also projected to decline but the decrease in U.S. exports represents a larger percentage decrease.

The increases shown in Table I suggest that the U.S. has been the chief beneficiary of an expansion in world agricultural markets during the past 15 years. Agricultural producers have increased output and taken advantage of expanding world agricultural trade. The benefit to the rest of the U.S. economy is in the form of increased foreign

TABLE I

EXPORT VOLUME 1972-86

	United States				World			
	Wheat	Coarse grains	Soy-beans	Total	Wheat	Coarse grains	Soy-beans	Total
	Million Metric Tons							
72/73	31.8	35.6	15.7	83.1	67.4	59.4	87.7	145.5
73/75	31.1	44.5	18.4	94.0	62.6	70.8	22.9	156.3
74/75	28.0	34.3	21.0	83.3	63.8	63.7	28.2	155.7
75/76	31.5	46.5	16.3	94.3	66.3	76.5	25.6	168.4
76/77	26.1	50.6	20.9	97.6	63.3	82.7	31.1	177.1
77/78	31.5	52.1	20.5	104.1	72.8	84.0	32.8	189.6
78/79	32.3	56.9	27.6	116.8	72.0	90.2	38.7	200.9
79/80	37.2	71.6	32.8	141.6	86.0	100.9	44.1	231.0
80/81	41.9	72.4	27.4	141.7	94.3	105.5	43.7	243.5
81/82	49.1	61.4	33.2	143.7	101.9	103.7	47.4	253.0
82/83	45.0	61.5	35.0	141.5	100.3	98.8	50.2	249.0
83/84	38.9	55.7	26.3	120.9	102.9	91.9	47.0	241.8
84/85*	38.7	56.0	21.9	116.6	107.2	101.0	46.2	254.4
85/86*	27.2	48.9	24.6	100.7	90.9	93.8	47.6	232.3

* Projected

Source: U.S. Department of Agriculture, _Agricultural Outlook_, Economic Research Service, Jan-Feb. 1972-86.

exchange to purchase imports. Agricultural exports account for about 20 percent of total U.S. merchandise exports.

The agricultural trade dilemma of the U.S. economy during the past five years is not fully reflected by volume only. In Table II domestic and export prices are contrasted. Domestic agricultural prices decreased 30 percent from 1980 to 1985. Export prices declined 11 percent in the same period. Although export prices have dampened, they have not decreased enough to reverse the downward trend in export volume.

Export value of agricultural products has declined along with export volume. From 1980 to 1986 the value of agricultural exports fell from $41.2 billion to a forecasted $29.0 billion representing a 29 percent decrease. The decline in exports seems to be associated with a sharp rise in the value of the U.S. dollar. Between 1980 and 1985 the exchange value of the dollar, relative to a weighted average of the currencies of our 10 largest trading partners, increased 61 percent. The index value of the dollar (1972=100) increased from approximatly 87 to 140.

A rise in the value of the U.S. dollar increases real export prices to importers of U.S. agricultural products. On the other hand, imports to the U.S. economy become relatively cheaper, other things being equal. The rise in the value of the dollar has contributed to the narrowing of the U.S. agricultural trade balance. In Table III U.S. agricultural exports and imports are reported with the

TABLE II

AGRICULTURAL PRICE INDEXES (1972=100)

	Producer Price Index for all Agricultural Goods	Implicit Price Deflator of Agricultural Exports
1972	100	100
1973	108	148
1974	144	202
1975	143	197
1976	134	185
1977	136	188
1978	133	195
1979	143	221
1980	148	245
1981	143	234
1982	126	217
1983	111	226
1984	105	224
1985	103	218

Source: U.S. Department of Commerce, Bureau of Economic Analysis (USDC). Business Statistics. Washington, D.C., 1972-85.

TABLE III

U.S. AGRICULTURAL TRADE BALANCE

	Agricultural Exports	Agricultural Imports	Trade Balance
	---------Billions of U.S. Dollars---------		
1972	9.4	6.7	2.7
1973	17.6	8.5	9.1
1974	21.9	10.4	11.5
1975	23.4	9.6	13.8
1976	22.9	11.2	11.7
1977	23.6	13.5	10.1
1978	29.4	14.9	13.5
1979	34.7	16.9	17.8
1980	41.2	17.5	23.7
1981	43.8	17.2	26.6
1982	39.1	15.4	23.7
1983	34.8	16.4	18.4
1984	38.0	18.9	19.1
1985	31.2	19.7	11.5
1986*	29.0	20.0	9.0

Source: U.S. Department of Agriculture (USDA). Agricultural Statistics. Washington, D.C., 1972-86.

agricultural trade balance. From 1981 to 1985 the trade balance was reduced by 57 percent. The USDA predicts that the trade balance will fall even further in 1986 to approximately $9.0 billion which would be a 66 percent decrease from 1981 levels.

The value of the U.S. dollar in foreign exchange markets reflect a strong demand for and weak supply of dollars. Monetary and fiscal policies of the federal government influence the value of the dollar. Tight monetary policy has contributed to the weak supply of dollars. Strong demand for dollars is the result of high real interest rates in the U.S. relative to the rest of the world. When foreign investors move capital in to the U.S. to take advantage of the high real rates of interest they must first convert their currencies to dollars. As large amounts of currency are converted , the increased demand for dollars is reflected in the U.S. exchange rate.

High real interest rates are associated with a strong demand for investment and credit. Table IV compares demand for and supplies of capital for the U.S. economy. Although the demand for investment in the U.S. has been relatively strong since 1980, the growth in public borrowing increased more rapidly because of increasing federal deficits. Foreign investment has become increasingly important in recent years because the U.S. savings rate is low compared to other developed economies.

TABLE IV

DOMESTIC INVESTMENT GAP vs.
FOREIGN CAPITAL INFLOWS

Fiscal Year	1980	1981	1982	1983	1984	1985
	(Billions of U.S. Dollars)					
Gross Savings	403	466	445	402	534	555
Gross Investment	403	467	441	431	631	646
Difference	0	-1	4	-29	-79	-91
U.S. Budget Deficit	60	57	111	195	175	210
Foreign Capital Inflows	-2	-6	8	41	102	140

Source: U.S. Department of Commerce, Bureau of Economic Analysis (USDC). Business Statistics. Washington, D.C., 1981-85.

Blaming the high value of the dollar on high interest rates is not altogether correct. More correctly, both should be viewed as a simultaneous responses to the underlying discrepancy between the demand for and supply of credit. Were it not for the high value of the dollar and investment by foreigners in dollar-denominated assets, real interest rates in the U.S. would be even higher than they are now. Adjustment costs in response to the difference between demands for credit and domestic savings is carried by a highly-valued dollar. The burden is borne by export and import-competing industries. To the extent that adjustment is carried by high real interest rates, the burden is borne by industries using capital intensively. Agriculture suffers on both counts because it is a capital intensive export based industry.

Research Objectives

The purpose of this work is to identify and quantify the factors which have led to smaller U.S. agricultural trade balances. Factors hypothesized to affect the trade balance are the federal deficit, real interest rates, real exchange rates, and foreign income. The specific objectives of this study are:

1. Identify how U.S. governmental policies impact factors which affect the U.S. farm economy.

2. Specify a general equilibrium econometric model relating U.S. and international macroeconomic factors to the U.S. farm economy.
3. Estimate the impact of the factors which affect the U.S. farm economy with emphasis on net exports of agricultural products.
4. Simulate the general equilibrium econometric model into the future under certain experimental conditions that reflect different governmental policies than those which exist at the present time.

Research Hypotheses

The fulfillment of the objectives make it possible to empirically test the following hypotheses, other things equal.

1. A decrease in the federal deficit decreases the real interest rate.
2. A decrease in the real interest rate decreases the real value of the U.S. dollar in foreign exchange markets.
3. A decrease in the real value of the U.S. dollar increases net exports of farm products.
4. An increase in the U.S. money supply does not influence real interest rates or exchange rates except in the short-run.
5. An increase in foreign income increases net exports of agricultural products.

Some of these hypotheses are tested directly from the estimated coefficients in the econometric model. Other tests are made on informal judgments based on trends in predicted variables because the hypotheses are outcomes of several interacting and complex structural relationships not suited for testing statistically from and one coefficient.

Organization

Chapter II contains a review of the relevant literature. In that section different approaches to trade analysis are reviewed in detail. Chapter III develops the theoretical interrelationships to be used in this work. Here the different natures and assumptions concerning the agricultural trade models will be discussed.

Chapter IV contains the econometric procedures, estimated parameters and results concerning the stated hypotheses. It also details assumptions concerning the functional form of the equations that were estimated. Chapter V will contain simulations of the "base" model compared to simulations with exogenous changes representing policy changes. The base model will be simulated based on current economic conditions. The experimental simulation will cover the same time period but with the expected results of a particular policy change. The experiment should reveal how the economy will adjust to the policy change.

Finally Chapter VI summarizes the results. It discusses the context in which the results can be interpreted and the limitations pertaining to the inferences. The final part of this chapter contains conclusions about the nature of the economic relationships and their relevance to economic policy decisions. The appendix provides tables for some of the more detailed results which may be of interest, but are better examined outside the main text.

CHAPTER II

REVIEW OF LITERATURE

Several previous studies of the relationship between agricultural exports and macroeconomic conditions were undertaken to help explain the domestic price and export expansion of the early 1970's. These studies help explain the interrelationships between the exchange rate, monetary policy, devaluations and agricultural exports. More recently investigators have made a connection between fiscal policy, namely the U.S. budget deficit, the real interest rate, and the exchange rate. Of the many agricultural trade studies, only those that are representative of a class of approaches will be reviewed.

Many countries command a share of world exports which is so small that any change in quantity exported does not affect on world price. The U.S. is in a different position. Its share of world agricultural trade is large enough to affect world prices. For example, the U.S. has about 62 percent of total world trade in coarse grains and approximately 42 percent of the total trade in wheat according to Dunmore and Longmire (1984). Although the U.S. holds considerable world market share in major agricultural commodities traded, its ability to utilize it to influence world prices is limited. The political repercussions from such actions would be prohibitive for the U.S.. More importantly though, most countries maintain a minimal level of food production for security concerns and close substitutes are available for particular commodities (Orden).

To understand the economic behavior of U.S. agricultural exports, the elasticity of foreign demand is a very important parameter. An original estimate of the elasticity of foreign demand was contributed by Tweeten (1967). In his study of aggregate agricultural trade, the author found the parameter to be elastic in the short-run and highly elastic in the long run. These estimates were controversial and some found reasons to dispute them. Johnson for example disputed the analytical basis of the calculation of the elasticity. He recalculated the elasticity but concluded that "Tweeten's estimates are in the right ballpark".

In a related study Bredahl, Meyers and Collins investigated the importance of the price transmission elasticity. This elasticity is important because it measures the extent to which foreign price changes are transmited to domestic prices. If the price transmission elasticity is equal to one (perfect price transmission) then a change in real exchange rate between the countries will be apparent in commodity price changes. They conclude that restrictive trade policies have reduced price transmission elasticities to less than one and hence have reduced export demand elasticities.

Other authors have studied the export elasticity question for a variety of agricultural commodities. But there is little agreement as to the exact value that should be used in trade models. There is also a question concerning the model specification used to calculate the elasticity. Some argue that the exchange rate of the U.S. dollar should be included as an explanatory variable to avoid biased parameters. This school of thought developed in the 1970's as a result of the simultaneous devaluation of the U.S. dollar and the agricultural export increases of that period.

One of the first articles examining the relationship between devaluation and agriculture was by Schuh (1974). Schuh connected the devaluations of the early 1970's to agricultural price increases through the exchange rate. He hypothesized that the devaluations lowered the value of the dollar in foreign markets which lowered the newly floating exchange rate. Lower exchange rates of the U.S. dollar for foreign currency effectively cut the price of agricultural exports. This decrease in the real export price gave U.S. producers a comparitive advantage in world agricultural markets. Devaluation effectively shifted the export demand function to the right. Considering the nature of export supply (very inelastic) this shift was thought by Schuh to result in higher prices. Support for Schuh's reasoning was produced by Soe Lin for Canadian agricultural and Barnett, Bessler, and Thompson (1981a) for the U.S..

Devaluations as described by Schuh were needed because of money supply increases in the late 1960's and early 1970's. These increases were the result of the expansionary economic policies of that era. If the structure of the simultaneous relationship between agriculture and the monetary sector is correct (as put forth by Schuh) then overly expansionary monetary policy might enhance the competitive position of all exports from the U.S.. According to Schuh, an expanded money supply above the growth rate of the economy leads to inflation. The reaction of foreign exchange markets to inflation in a particular country is a lowering of the value of that countries currency exchange rate, other things equal.

A wheat study by Johnson, Grennes and Thursby shed more light on the export question. They specified and measured the relationship between the devaluation of the U.S. dollar in 1971, the foreign trade policies of our major trading partners, and world wheat prices. Their conclusions pointed to the dollar devaluation as only one of several factors influencing domestic wheat prices. The other factors include the Soviet Unions wheat purchases, the wheat import tariff of the EEC, the Australian wheat export tax, Japanese trade policies, and shipping costs. In their conclusion they point out that devaluation is but one factor in a complex export market that has many other factors.

The treatment of foreign exchange rates in agricultural trade models was criticized by Chambers and Just (1979). They claimed that agricultural trade models had either excluded foreign exchange rates or simply used them to adjust export prices. According to the authors, a better approach would be to include a separate exchange rate variable in the export equation of the trade model because the percentage change in price due to a devaluation of an exporters currency may be less than the percentage change in the price of the currency. Another reason to include the exchange rate variable separately was given by Orcutt. He claimed that individuals react more rapidly to exchange rate movements than to price movements. Therefore many authors conclude that exchange rates should be differentiated from price changes to reduce the possibility of biased results.

Johnson (1977) also discusses the specification of exchange rates in trade models. He argues for a general model which would include multilateral variables such as trade restrictions, inflation rates and individual country by country exchange rate specifications. Utilizing a partial equilibrium framework, he compared a hypothesized free-trade world model to a world model with nominal price insulation policies and a world with real price insulation policies. This approach is generally superior to previous specifications because it considers the simultaneous nature of market operations. Although it does not consider cross-price effects it does consider production, consumption and prices for wheat in many countries.

The difficulty with partial equilibrium models such as those discussed above is their lack of information concerning relative prices of related commodities (i.e. cross-price affects). Chambers and Just (1981) attempted to overcome past limitations with a dynamic analysis of corn, wheat and soybeans. They used a simultaneous multimarket model to investigate exchange rate effects. The model was utilized to generate long-run multipliers needed to analyze exchange rate effects on U.S. agricultural export trade through a specified time period. The results of the analysis indicated different responces to devaluation among commodities. All commodities considered showed increased exports as a result of lower U.S. exchange rates, but revealed different timepaths of adjustment.

Barnett, Bessler, and Thompson (1981b) analyzed the connection between monetary instruments and agricultural trade. The connection between money supply, interest rates and exchange rates was studied but no specification made. Later, Hughes and Penson developed a theoretical model and applied it, finding support for the hypothesis that "tight" monetary policy adversely effects agricultural trade through stockholding and exchange rates.

Another approach to agricultural trade analysis is general equilibrium models. These models not only contain specifications for agricultural markets, they specify macroeconomic markets such as labor and capital. This approach offers promise for improved analysis of agricultural trade because the exchange rate, monetary variables, fiscal policy and international trade can be studied within a simultaneous framework. Some examples of the gereral equilibrium approach include research by Clements, Shei and Thompson (1979), Shei, Hughes, and Lamm. Of particular interest is the work of Shei and Thompson because they specify agriculture as a sector economy within their model[1].

Shei and Thompson separated the "real" sector from the monetary sector in their model. In the real sector products were broken down into crops, livestock, industry and services. This was done to distinguish differing market structures and adjustment patterns. The model was general equilibrium in the sense that the equilibrium prices and quantities in the four sectors of the economy were simultaneously determined. The general price level was a weighted average of the endogenously determined prices in the four sectors. Total national income was the sum of the

[1] Literature pertaining to simultaneous nature of agriculture and the general economy is sparce in part because general equilibrium models are difficult to formulate and estimate. To build a general equilibrium model, one must determine the structure of the general economy, then postulate the characteristics and interactions of agriculture within this framework.

price times output in the four sectors. Each sector had to satisfy the market clearing condition that production plus imports must equal domestic consumption plus exports.

The monetary sector of the Shei-Thompson model was based on Mundell (Chap. 8) and Prais. They assumed that full equilibrium in the monetary sector is not achieved within one period; only a fraction of the difference between actual and desired holdings of real monetary balances is eliminated within any given period. This is an important assumption because aggregate expenditures in the economy are not necessarily equal to national income within any given period. Total expenditures equal national income plus some fraction of the difference between the actual stock of money in the economy and the long-run desired stock that economic agents wish to hold. Since total national income and the price level are determined in the real sector, the function of the monetary sector is to explain the difference between real national income and real aggregate expenditures. One drawback of the Shei-Thompson approach is that the exchange rate was determined exogenously which limited the equilibrium results by making them conditional upon the predetermined exchange rate.

Recently many economists have postulated a commection between U.S. fiscal and monetary policy, with the recent decline in U.S. exports and a corresponding increase in imports. Generally the hypothesis states that large persistent federal deficits along with a low U.S. savings rate and tight money supply, have pushed up real interest rates. High real interest rates, according to the hypothesis, induce inflows of foreign currency, resulting in higher U.S. exchange rates. This effectively increases the foreign cost of U.S. exports and reduces the domestic cost of imports.

In a review article Belongia and Stone they investigated the linkages between federal deficits, real interest rates, real exchange rates, and U.S. agricultural exports. The authors reviewed the literature pertaining to the deficit-interest rate hypothesis and concluded, "changes in the deficit have no significant effect on movements in the real rate of interest". This is an interesting conclusion because according to their survey from the U.S. Congressional Budget Office (1984), qualified studies with data into the 1980's (when deficits increased with real interest rates) suggest that long-term interest rates are influenced by deficits.

The evidence for a positive relationship between real interest rates and the federal deficit is not conclusive. But, the evidence strong suggests long-term federal debt financing has increased real interest rates for those bonds. Studies by Carlson, DeLeeuw and Holloway, Dewald, Feldstein and Eckstein, Hoelscher (1983a), and Sinai and Rathjens all report a significant positive relationship. Of the 24 studies in the congressional Budget Office survey, 10 reported positive significant results, 10 reported positive insignificant results, 3 reported no effect, and 1 reported a negative relationship. The survey dealt with short and long-term interest rates. Long-term rates were influenced more than short-term rates according to the survey.

The literature pertaining to the real interest rate effect on real exchange rates is very limited. In the review by Belongia and Stone they refer to a forthcoming study by Batten and Belongia in which the authors estimated a very small interest rate differential-exchange rate effect. The effect is positive and significant but is limited by the estimation technic. Belongia and Stone state, "It appears that we know very little about the extent to which real interest rate differentials actually affect real exchange rates".

SUMMARY

This review is designed to examine research pertaining to U.S. agricultural trade and its relationship with macroeconomic conditions. It began with hypothesized relationships of agricultural trade early in the 1970's. The first models were simple in nature and did not account for the simultaneous nature of international markets nor cross-price effects of related commodities. A progression occurred with respect to these limitations until general equilibrium models were introduced. Fiscal policy of the U.S. government was also reviewed as an influencing factor in agricultural export trade. Much work is still needed to determine the analytical payoff from more complex specifications compared to simplier approaches.

CHAPTER III

THEORETICAL FRAMEWORK

The theoretical framework that will be used to test the hypotheses stated in Chapter I entails specification of a general equilibrium model. United States agriculture is modeled as a sector in the econometric model. Agriculture in the model is highly aggregated and is treated as though it is one of two sectors of the economy. All industries other than those of agriculture are aggregated into one industry called nonagriculture in the model. The structural equations of the agricultural sector and nonagriculture are added together and assumed to represent the real sector of the U.S. economy. The monetary sector is made up of domestic and international financial markets which are assumed to influence the real sector. This macroeconomic model, with agriculture as its primary sector of interest, is an attempt to define the "linkages" between U.S. agriculture and rest of domestic economy.

There are two schools of thought concerning modeling of agriculture in the U.S.. One of those schools is the Structuralist's which contend that supply and demand dictate prices and volumes. The other school, the Monetarist, contend that monetary factors play a significant role.

While it is true that supply and demand dictate prices in any particular market, an international U.S. agriculture must contend with currency valuations. Supply and demand in international markets also regulate prices, but the introduction of currency valuations and the factors which determine them require a synthesis of both schools of thought. The factors which determine the value of a country's currency are economic growth, money supply (supply of credit), and inflation.

An attractive and intuitive theory concerned with modeling the U.S. economy and its international linkages is the absorption approach to balance of payments by Alexander. Alexander's theory postulates that aggregate expenditures and national income are not equal. Aggregate expenditures are equal to national income minus current savings. They are always equal in a closed economy with a constant money supply. But in an open economy with differing rates of money supply growth and economic growth, they are not necessarily equal. When a country's expenditures are greater than its income the sources are savings, increased credit (money supply) by the central bank, and capital inflows. The Alexander model utilizes factors which affect the difference between national income and aggregate expenditures to construct the economic environment (linkages) in which individual markets and sectors operate.

Most modeling approaches utilize national income within their demand equations. In this approach, aggregate expenditures are substituted. The parameter of aggregate expenditure in a demand equation represents the marginal propensity to absorb. When an increase occurs in aggregate expenditures, the economy absorbs more products. Different sectors of the economy do not necessarily absorb at the same rate (Sayad).

Within the absorption approach, an equation representing aggregate expenditures and its determining factors is specified. Normal macroeconomic models utilize a national income equation but in the model aggregate expenditures is a function of national income. If the parameter is greater than one, the economy is purchasing at levels above its income and current savings. In this case one or all of the three sources of increased expenditures given above must be used.

If the central bank follows a "loose" monetary policy, it will accelerate public expenditures above current national income levels. Monetarists argue that loose monetary policy, other things equal, will increase inflation as proportionally more dollars attempt to purchase the same goods. Inflation, or the devaluation of dollars, reduces the value of the U.S. dollar relative to other currencies. Sectors engaging in export trade benefit because their effective price has been reduced in international markets.

The monetarist approach has been employed by Schuh (1974) and others to explain the rapid price increases in the 1970's. The same logic applies to the price declines of the 1980's. Support for their hypothesis was supplied by Chambers and Just (1979, 1981), and Soe Lin. The control of the money supply and its effects on the exchange rate are the main factors that the monetarist use to explain the price instability in the 1970's and 1980's.

Most structuralists fail to recognize the importance of the rate of growth in money supply because of the conventional assumption of the final neutrality of money. That is, increases in the money supply raise all prices by the same proportion, leaving relative prices unchanged. The increase in the general price level of the U.S. economy has slowed or actually decreased for particular products. In the 1980's agricultural prices (real) have declined relative to other prices in the economy. This presents a theoretical problem that structuralists are hard pressed to explain on structural grounds. Theoretical arguments have surfaced which cast doubt on the "final neutrality" assumption. The arguments state that monetary shocks have non-neutral effects on relative prices. On close inspection the conditions required for final neutrality to hold are very strict, at least in the short-run.

Within any given period of time, some prices in the economy are more flexible than others (Bordo). Different sectors of the economy reflect different competitive structures, the speed at which prices may change is dependent on that structure (Sayad). Bordo has defined a theory of implicit contracts of varying durations. He hypothesizes that the responce of relative prices to shifts in demand caused by changes in the money supply are associated with the length of the wage and price contracts.

It has been shown that there are significant causal relationships between domestic money supply and nominal agricultural prices (Barnett, Bessler, and Thompson, 1981a). A significant difference was also found in relative price changes due to domestic money supply for the food and nonfood components of CPI (Barnett, Bessler, and Thompson, 1981b).

A widely held view with respect to linkages is that federal budget deficits impact net exports of agricultural commodities. The first three of the five hypotheses in Chapter I pertain to this question. Budget deficits are postulated to raise real interest rates. Given the low rate of savings in the U.S., large budget deficits increase credit demands and therefore real interest rates. Capital from foreign countries flows into the U.S. credit markets to take advantage of higher rates of return. Before foreign investors can do so they must first convert their currencies into U.S. dollars. When large amounts of foreign currency are converted to dollars in an environment of relatively tight U.S. money supply, the exchange rate of those U.S. dollars increases. The real exchange rate of dollars will continue to increase until real rates of return on investment, after conversion of currencies, are equilized. With a higher exchange rate net exports will decline. They do so because the higher exchange rate makes U.S. exports more expensive to foreign buyers relative to other sources. With a higher U.S. exchange rate, imports to the U.S. increase because they are less expensive to produce in foreign countries relative to U.S. products, other things equal. The result is lower net exports for the U.S. economy as a whole and agriculture in particular.

The fourth hypothesis investigates the impact of U.S. money supply on U.S. agriculture. Monetarists explain the situation by the relative change in the U.S. money supply aggregates. They argue that the excessively tight monetary policy of the U.S. has pushed real interest rates to historically high levels. Tight monetary policy was needed to correct a steady increase in inflation which was entrenched in expectations.

High real interest rates attracted world capital. In order to take advantage of the real interest rate, foreign investors must exchange their currency for U.S. dollars. Increases in the demand for dollars, given the slow rate of growth in money supply, resulted in an exchange rate move upward. Monetarists argue that the high levels of the exchange rate made exports of all kinds from the U.S. less price competitive. The slower rate of growth in U.S. money supply causes other countries to slow their money supply growth to stabilize the value their currencies. The result is lower growth rates and in some cases recession.

The fifth hypothesis pertains to the impact of world income on net exports of U.S. agricultural commodities. Rapid declines in agricultural prices and exports in the 1980's are explained by the structuralist school of thought in terms of supply and demand shifts. Large increases in production by the less developed countries (LDC's) boosted world supply of agricultural products when world income was declining, or at least constant. Given the cost structure of the LDC's and over-supply in world markets, real prices have fallen to historically low levels. Since U.S. agricultural prices are directly linked to the world market, domestic prices have dropped. Commodity programs have put a floor under prices that are below the cost of production for U.S. producers (Dunmore and Longmire). As world prices fall to these levels, the export market for U.S. producers decreases because other export suppliers are more price competitive.

General Equilibrium Model

The foundation of the general equilibrium model is a combination of two economic rationals that in the past have been opposing points of view. Structuralists and monetarists have explained the behavior of the economy with different models. The models represent the differences in how the economy reacts to changes in certain economic factors. In this work, a general equilibrium model is specified which draws from both schools of thought.

An open general equilibrium model for the U.S. economy was specified with consideration given to both structuralists and monetarists. The U.S. economy is modeled with a real and a monetary sector. The real sector is subdivided into agricultural and nonagricultural products. This division is based on the competitive nature of the sectors (Sayad). Agriculture is assumed to be perfectly competitive while nonagriculture is assumed to be oligopolistic. The competitive structure theory of Sayad implies that the oligopolistic sector utilizes "cost plus" pricing and is less price flexible. Agriculture, which has a much lower degree of concentration, is assumed to be more flexible with respect to price. Consequently, monetary shocks will cause uneven price changes in the respective sectors.

The monetary sector in the model is specified to account for the real interest rate, the real exchange rate of U.S. dollars, and capital flows. Real rates of return on investment and their effects on monetary behavior are assumed to be the critical elements of the monetary sector. Monetary shocks are assumed to have an effect on real interest rates in the U.S., they in turn affect capital flows and the U.S. exchange rate in foreign exchange markets, which in turn affects net exports of agricultural products. The federal deficit is the specific monetary shock to be analyzed with the following open general equilibrium model.

REAL SECTOR

The output of the real sector is divided into agricultural and nonagricultural aggregates on structuralist grounds. Agriculture is assumed to be perfectly competitive. It produces homogeneous goods whose prices are flexible up and down according to market forces. Nonagriculture is viewed as being oligopolistic, producing heterogeneous goods under increasing returns to scale. Financial barriers impede entry of new firms. Profit margins above variable costs of production are the basis by which prices are set. Nominal prices in the nonagricultural sector are cost-determined, and therefore are inflexible downwards.

The absorption approach to balance of payments was employed in the demand side of the real sector. The dependent variable in each of the "demand equations" is the real domestic absorption of the agricultural and nonagricultural output (Alexander). Absorption is defined as the sum of domestic consumption, investment and government purchases. Normally, microeconomic theory requires demand to be a function of price, real income, and the price of substitutes. The absorption approach replaces the real income indicator by real aggregate expenditures in each equation. In this approach, real aggregate expenditure is not necessarily equal to real national income. The national budget constraint requires the difference between national income and aggregate expenditure be exactly equal to the value of exports minus imports across the economy.

It is assumed that domestic credit creation directly increases expenditures in the model. The coefficient of the expenditures variable is interpreted as the marginal propensity to absorb the particular sector's output out of and increased aggregate expenditures. One of the key explanations as to why monetary shocks have differing effects on a particular sector's prices is represented by the difference in the respective sector's marginal propensity to absorb. This will be clarified in the monetary section.

Domestic agricultural absorption is defined as consumption of agricultural products in the U.S. economy. The variable is value aggregated in 1972 prices.

$$DDA = f(PAD, AED, DDAL) \qquad 3.1$$

DDA - domestic absorption of agricultural products in millions of 1972 dollars.

PAD - producer price index for all agricultural products (1977=100).

AED - aggregate expenditures in the U.S. economy in millions of 1972 dollars.

DDAL - lagged value of dependent variable.

Agricultural absorption was assumed to be functionally related to aggregated agricultural prices, domestic aggregate expenditures, and a lagged value of agricultural absorption. Domestic absorption and the index of agricultural prices are assumed to be endogenous. Aggregate expenditures were assumed to be endogenous and the lagged dependent variable was predetermined. Absorption of nonagricultural goods is specified as follows.

$$DDNA = f(PNAD, AED, POP, DDNAL) \qquad 3.2$$

DDNA - domestic absorption of all nonagricultural products in millions of 1972 dollars.

PNAD - producer price index for all nonagricultural products (1977=100).

POP - population of the U.S. (millions).

AED - aggregate expenditures in the U.S. economy in millions of 1972 dollars.

DDNAL - lagged dependent variable.

The variables DDNA and PNAD are endogenous. The exogenous variables are POP and AED, while DDNAL is predetermined. The parameter of AED indicates absorption of increased expenditures in that sector of the economy.

The domestic production of all agricultural products follows from the specification by Cromarty. Modeling production in a quarterly system with production at different times of the year presents a problem. A lagged dependent variable in this case would bias quarterly estimates by considering lagged production. Also an intercept would bias estimated because of the timing problem. Consequently, production in the equation is assumed to be a function only of agricultural prices and the prices paid for inputs. However, the reported t-values are biased downward because the intercept is forced through the origin (Chambers and Just, 1981).

$$DSA = f(PAD, PPF) \qquad 3.3$$

DSA - production of agricultural products in millions of 1972 dollars.

PAD - producer price index for all agricultural products (1977=100).

PPF - price index of prices paid by farmers (1910-14 =100).

Production DSA and price PAD in the equation are endogenous variables but prices paid by farmers is exogenous.

Nonagricultural production is assumed to be price dependent. The acceptance of the concept of different competitive natures and cost-plus pricing implies the structure of the production equation. The price of nonagricultural products is assumed to be a nonlinear function of wage costs and the price of imported competing products. It is nonlinear in variables because a change in nonagricultural production is the mechanism which producers use to control prices in an oligopolistic market. Although the equation is specified

PCPNA = f(PCW, PCPIDNA) 3.4

PCPNA = percentage change in the producer price index for all nonagricultural products.

PCW = percentage change in the index of private weekly wages adjusted for productivity.

PCPIDNA = percentage change in the import price index of all nonagricultural products.

as nonlinear in its variables, it is linear in all parameters. The variables PCPNA and PCW are endogenous while PCPIDNA is assumed to be exogenous.

The domestic demand for agricultural inventory or stocks is partly dependent on government farm programs. Because this model is aggregated across all agricultural commodities, the effect of government programs on inventory demand is assumed to be minimal. Therefore, the demand for stocks is assumed to be a function of the level of agricultural prices and previous levels of inventory.

DSKA = f(PAD, DSKAL) 3.5

DSKA - the level of inventories of agricultural products in millions of 1972 dollars.

PAD - producer price index for all agricultural products (1977=100).

DSKAL - lagged value of the dependent variable.

The price in this case is assumed to explain the difference between the current level of stocks and the previous periods inventory. All variables are endogenous except for the lagged dependent variable which is predetermined.

The last structural equation in the agricultural sector pertains to international trade. Imports represent an additional source of supply, and exports represent another component of the demand for agricultural products. From a sector point of view the difference between exports and imports represents a capital flow into or outside of U.S. agriculture. The economic environment in agriculture, given that imports displace domestic production, is assumed to be a function of the difference between the two. Generally U.S. agriculture has been a net exporter of agricultural products. Therefore, the difference between exports and imports is specified as the dependent variable in the international trade sector. Net exports are assumed to be a function of domestic agricultural prices, the exchange rate of the U.S. dollar, foreign income, and lagged net exports.

$$DXDA = f(PAD, ERA, YF, DXDAL) \qquad 3.6$$

DXDA - net exports of agricultural products in millions of 1972 dollars.

PAD - producer price index for all agricultural products (1977=100).

YF - foreign income indicator in million of 1975 dollars (US).

ERA - index of the real exchange rate of U.S. dollars adjusted for inflation by the implicit price deflator of GNP for the U.S. and trade weighted CPI for the G-10 currencies (G-10 classification).

DXDAL - lagged value of the dependent variable.

Net exports, real exchange rates, and agricultural prices are endogenous variables while foreign income is assumed exogenous to the model. Foreign income is total world net national income estimated by the United Nations. The lagged dependent variable is a predetermined variable.

The exchange rate used in the equation is the exchange value of dollars relative to a basket of the ten largest trading partners of the U.S. on a trade weighted basis (G-10 classification). The exchange rate used is also deflated by the implicit price deflator of GNP in the U.S. and the average rate of increase in CPI for the ten trading partners (trade weighted).

Nonagricultural international trade is specified as a net import variable. Over the years 1970 to 1984 (which is the time period of this study), the nonagricultural sector of the U.S. economy has imported more than it exported omitting returns on capital invested abroad. Net imports of nonagricultural products includes all products exported except for capital.

$$DIDNA = f(PNAD, ERA, YD, DIDNAL) \qquad 3.7$$

DIDNA - net imports of nonagricultural products in millions of 1972 dollars.

PNAD - producer price index for all nonagricultural products (1977=100).

ERA - index of the real exchange rate of U.S. dollars adjusted for inflation by the implicit price deflator of GNP for the U.S. and trade weighted CPI for the G-10 currencies (G-10 classification).

YD - national income of the U.S. economy in millions of 1972 dollars.

DIDNAL - lagged dependent variable.

The variables DIDNA, PNAD, ERA, and YD are endogenous. The lagged dependent variable is predetermined.

To account for changes in wages, a labor market was specified. The labor market in this model takes on the form of a Philip's Curve. A nonlinear relationship was assumed between wages and the rate of unemployment.

$$PCW = f(U, PCHPMS) \qquad 3.8$$

PCW - percentage change in index of wages in manufacturing (1977=100).

U - percentage rate of unemployment.

PCHPMS - percentage change in the supply of money.

Again the variables are nonlinear but the parameters are linear.In this specification PCW is endogenous and the independent variables are both exogenous. The labor market is an important link in the chain of monetary effects on nonagricultural prices. In the model, shocks to the money supply are transmitted through the labor market into the production equation for nonagricultural goods.

The absorption approach to balance of payments defines the difference between imports and exports (net capital flow) as being "exactly equal to the difference between aggregate expenditures and national income when the growth in money supply is equal to the growth in the economy" (Alexander). Real aggregate expenditures are assumed to be a function of

$$AED = f(YD, RPR, U, AEDL) \qquad 3.9$$

AED - aggregate expenditures in the U.S. economy in millions of 1972 dollars.

YD - national income of the U.S. economy in millions of 1972 dollars.

RPR - real prime rate of interest on short-term loans.

U - percentage rate of unemployment.

AEDL - lagged dependent variable.

The parameter of national income is expected to be greater than one if the domestic economy is a net exporter (net capital inflow) of products or if the growth in the money supply is greater than that of the economy. A reduction in the total level of savings, spent in the economy would also result in a parameter of greater than one. If it is a net importer, a coefficient of less than one is expected. It is assumed that AED, YD, and RPR are endogenous. The unemployment rate is exogenous and the lagged dependent variable is predetermined.

The real sector is interconnected by three identities which define the equilibrium conditions for agriculture, nonagriculture, and national income. The first condition requires production to be exactly equal to the sum of domestic absorption, net exports, and current stock levels, minus lagged stock levels. Nonagriculture is restricted by the market clearing identity so that domestic absorption is equal to production plus net imports (imports minus exports). The national income identity states that national income must equal the sum of agricultural absorption, nonagricultural absorption, and net exports, minus net imports.

Agriculture: DSA = DDA + DXDA + DSKA - DSKAL 3.10

Nonagriculture: DSNA = DDNA - DIDNA 3.11

National Income: YD = DDNA + DDA + DXDA - DIDNA 3.12

Monetary Sector

The monetary sector in this model will be specified in the simplist manner possible. The monetary model should capture the essence of the adjustment process between the supply and demand for real money balances without overtaxing parameter requirements. As refered to in the proceeding discussion, aggregate expenditures are not necessarily equal to national income within one period. Total expenditures will equal national income plus some fraction of the difference between the actual stock of money in the economy and the long-run desired stock that persons wish to hold. This framework is based on Mundell, Prais, and Alexander. Full equilibrium is not attained in one period. Only a fraction of the difference between actual and desired holdings of real balances is eliminated within any given period. The function of the monetary sector in the model is to explain the difference between national income and aggregate expenditures through changes in the demand for real balances.

The condition for equilibrium in the monetary sector includes both the foreign and domestic components of money supply plus the balance of payments position of the U.S. economy. The condition is:

$$HPMS = FRDL + NDAD + BOPD \qquad 3.13$$

where HPMS is the supply of high powered money (M1), FRDL is lagged foreign reserves including the U.S. position in the

IMF, NDAD is net domestic money asset, and BOPD is the balance of payments position of the U.S..

To more fully explain the monetary sector of this model it would be helpful to review the theoretical workings of the sector. The monetary base times the money multiplier is equal to the supply of money. The monetary base is comprised of the domestic component and international reserves. The domestic component is made up of net liabilities of the central bank, vault cash by non-member banks, and currency held by the public. The international reserves component is comprised of official holdings of gold, foreign exchange, and the net U.S. position in the International Monetary Fund. Therefore, a change in the monetary base through either the domestic or international component will result in a change in the money supply via the money multiplier. The Federal Reserve Board controls the domestic component of the monetary base, which is assumed to be exogenous to the model. An increase in aggregate expenditures can result from the bond market operations of the Board. If the Board increases the money supply by credit creation, then aggregate expenditures will also increase, according to the model.

The other component of the monetary base, international reserves, is changed in any particular period by the balance of payments position of the U.S.. Balance of payments in this model refers to the balance of trade plus net capital flows:

BOPD = DXDA − DIDNA + DKD 3.14

The balance of payments condition (BOPD) reveals that net agricultural exports (DXDA) minus net nonagricultural imports (DIDNA) plus capital flows (DKD) determine the change in international reserves for the U.S.. If there are net capital inflows or an excess of export revenue over import expenditures, the official settlement of balance of payments will increase. This will increase the money supply through the monetary base unless the Fed engages in market operations to regulate the actual increase in the money supply. This type of operation is known as sterilization, whereby the effect of a capital inflow is neutralized and thus has no effect.

The flow of capital between countries is determined by the real rates of return to that capital. The net capital flow equation for the domestic economy is given below.

DKD = f(ERA, RPR, PRDD, DPRF, DKDL) 3.15

DKD − net capital outflow of capital for the U.S. economy in millions of 1972 dollars.

ERA − index of the real exchange rate of U.S. dollars adjusted for inflation by the implicit price deflator of GNP for the U.S. and trade weighted CPI for the G-10 currencies (G-10 classification).

RPR − real prime rate of interest on short-term loans.

PRDD - change in the prime rate of interest on short-term loans.

DPRF - difference between foreign and domestic interest rates.

DKDL - lagged dependent variable.

The first three variables are assumed to be endogenous. PRDD and DPRF are specified as exogenous while DKDL is predetermined.

The real interest rate specification will not include all financial market components.

RPR = f(ERA, DKD, GPDID, FGSDD, HPMS) 3.16

RPR - real prime rate of interest on short-term loans.

ERA - index of the real exchange rate of U.S. dollars adjusted for inflation by the implicit price deflator of GNP for the U.S. and trade weighted CPI for the G-10 currencies (G-10 classification).

DKD - net capital outflow of capital for the U.S. economy in millions of 1972 dollars.

GPDID - gross private domestic investment in millions of 1972 dollars.

FGSDD - federal government budget (surplus) in millions of 1972 dollars.

HPMS - supply of high powered money (M1-B) in millions of 1972 dollars.

Real interest rates are simply specified as a function of variables which determine the excess supply and demand for real balances.Modeling of the interest rate would normally include a lagged dependent variable. Because of the short-run stochastic nature of real rates of interest it was omitted in this model. The first three variables, RPR, ERA, and DKD are assumed to be endogenous. The last three variables are all exogenous in the model.

According to the absorption approach, balance of payments in the long-run must equal zero. In the long-run the exchange rate will adjust according to the relative demand for U.S. dollars in international currency markets. Foreign importers of U.S. products must exchange their currency for dollars which increases the demand for dollars. If a surplus of exports over imports occurs, the exchange rate increases to make exports less competitive and imports cheaper. The exchange rate increases because a net export position with respect to balance of payments increases the demand for dollars in international currency markets. The exchange rate is an indicator of the relative supply of and demand for U.S. dollars. Since the FED controls the supply of money, the exchange rate generally indicates the demand for dollars in international capital markets. The real prime rate of interest was an indicator of domestic demand for real balances or money. In both cases the FED's control is assumed exogenous because the monetary behavior of the board does not necessarily correspond with economic conditions.

$$ERA = f(RPR, PRDD, DPRF, BOPD, ERAL) \quad 3.17$$

ERA - index of the real exchange rate of U.S. dollars adjusted for inflation by the implicit price deflator of GNP for the U.S. and trade weighted CPI for the G-10 currencies (G-10 classification).

RPR - real prime rate of interest on short-term loans.

PRDD - change in the prime rate of interest on short-term loans.

DPRF - difference between foreign and domestic interest rates.

BOPD - balance of payments for the U.S. economy in millions of 1972 dollars.

ERAL - lagged dependent variable.

The variables, ERA, BOPD, and RPR are endogenous. The rest are exogenous except for ERAL which is predetermined. The specification attempts to capture the effects of domestic real rates of return, changes in the nominal rate of return, the difference between U.S. and foreign real rates of return and balance of payments pressure. The "pressure" of balance of payments stems from the assumption of flexibility. When complete flexibility is assumed, long-run balance of payments must equal zero. Therefore if a country runs a trade deficit for a prolonged period of time, its exchange rate must fall to correct the difference between exports, imports, and capital flows. In the short-run the country may have to import capital to keep it's exchange rate stable.

SUMMARY

The general equilibrium model developed has 17-equations. Twelve of those are behavioral and 5 are identities or equilibrium conditions. The model accounts for product markets in the aggregate and monetary behavior with respect to real rates of return on capital, real exchange rates, and capital flows. The framwork for the method of analysis can easily be placed into a general form. The general equilibrium model is represented within the general form below. The model is a set of linear difference equations, including structural equations and identities.

$$Ay_t + By_{t-1} + Cx_t = e_t \qquad 3.18$$

where:

A - coefficient matrix of the current endogenous variables.

B - coefficient matrix of the lagged endogenous variables.

C - coefficient matrix of the current exogenous variables.

y_t - a vector of current endogenous variables.

y_{t-1} - a vector of lagged endogenous variables.

x_t - a matrix of current exogenous variables.

The general form can accommodate many different approaches and could include any number of products of markets with supply and demand equations for each. Identities for market clearing conditions, definitional equations, and so forth can also be included. The model structure implies a dynamic and simultaneous relationship between endogenous variables. The general form is restricted to a one period lag in any particular equation.

CHAPTER IV

ESTIMATED PARAMETERS AND RESULTS

This chapter contains estimated parameters of the general equilibrium model. A partial equilibrium model of U.S. agriculture was also estimated for comparison with the the general model. It was specified utilizing the agricultural equations of the general model without the absorption aspects and interdependent linkages. The estimated structural and reduced form equations of the agricultural model are reported in Appendix I.

The estimated parameters of the open general equilibrium model described in Chapter III will now be reported and discussed. As indicated earlier, the model contains 17 equations -- 12 behavioral equations and 5 identities. The parameters of the simultaneous equation model were estimated by two-stage least squares using quarterly data from the beginning of 1970 to the end of 1984. Because the model is nonlinear in particular variables, a system method such as three-stage least squares was not applicable. Otherwise, all behavioral equations are linear in their parameters. Table V contains the structural estimates with t-values in parentheses and short-run elasticities in brackets. The reduced form multipliers are reported in Appendix II.

The structural equations in Table V represent an open general equilibrium model of the U.S. economy with international linkages. Based on preliminary analysis, several variables suggested by economic theory were deleted from certain equations based on the coefficient sign and level of significants. Stability analysis was performed to validate the dynamic properties of the estimated model. One stability indicator is the lagged dependent variable in each equation. If any parameter is greater than unity the model is not stable (Kmenta p. 592). The econometric model did not have an element greater the one.

Another test for stability entails calculating the charteristic vector and finding its roots (See Appendix III). The eigenvector, and eigenvalues for the vector, were calculated for the model. The largest eigenvalue of the system was .9504 with .8770 and .4003 as the next largest values. A system is stable according to Luenberger if the largest root (or modulus) is less than unity. Using the quadratic formula, the largest root of .9504 is .9384. Since the modulus was less than unity the econometric model is stable and convergent over time.

The tests above confirm that the model is stable. It means that if the exogenous variables do not change over time, the endogeneous variables will converge on their equilibrium values. The timepath of the convergence, which is determined by the eigenvalues, contributes the dynamic aspects of the econometric model.

TABLE V

MACROECONOMIC MODEL

Structural Equations of the Real Sector

Disappearance Equations

$$DDNA = 125038.60 - 189880.00PNAD + 0.60AED + 726.29POP + 0.02DDNAL$$

	Constant	PNAD	AED	POP	DDNAL
DDNA =	125038.60	− 189880.00PNAD	+ 0.60AED	+ 726.29POP	+ 0.02DDNAL
	(6.58)	(−26.02)	(12.26)	(5.26)	(0.45)
		[−1.12]	[0.86]		

$R^2 = .99$ $F = 1903.30$

$$DDA = 4852.35 - 800.89PAD + 0.02AED + 0.25DDAL$$

	Constant	PAD	AED	DDAL
DDA =	4852.35	− 800.89PAD	+ 0.02AED	+ 0.25DDAL
	(4.84)	(−2.21)	(5.18)	(1.84)
		[−0.10]	[0.47]	

$R^2 = .82$ $F = 65.77$

Export-Import Equation

$$DXDA = 960.35 - 1204.69PAD - 2258.97ERA + 0.0031YF + 0.40DXDAL$$

	Constant	PAD	ERA	YF	DXDAL
DXDA =	960.35	− 1204.69PAD	− 2258.97ERA	+0.0031YF	+ 0.40DXDAL
	(0.44)	(−2.94)	(−3.11)	(2.28)	(3.01)
		[−1.18]	[−1.48]	[2.61]	

$R^2 = .79$ $F = 65.77$

$$DIDNA = 5806.57 - 14429.40PNAD + 1009.31ERA + 0.04YD + 0.32DIDNAL$$

	Constant	PNAD	ERA	YD	DIDNAL
DIDNA =	5806.57	− 14429.40PNAD	+ 1009.31ERA	+ 0.04YD	+ 0.32DIDNAL
	(0.88)	(−3.12)	(0.43)	(3.16)	(2.23)
		[−1.31]	[0.06]	[0.87]	

$R^2 = .64$ $F = 18.47$

Stock Equation

$$DSKA = 51090.61 - 16142.70PAD + 0.04DSKAL$$

	Constant	PAD	DSKAL
DSKA =	51090.61	− 16142.70PAD	+ 0.04DSKAL
	(9.35)	(−9.11)	(0.35)
		[−0.76]	

$R^2 = .88$ $F = 18.47$

V (Continued)

<u>Production Equation</u>

$$DSA = 47266.02PAD - 4085.31PPF$$
(14.03) (-5.90)
[0.71]

$F = 2031.58$

$$PCPNA = 0.83PCW + 58.22PCPIDNA$$
(3.18) (3.67)

$F = 12.13$

<u>Philips Curve</u>

$$PCW = 1.71 - 0.05U + 91.79PCHPMS$$
(1.09) (-0.19) (4.71)

$R^2 = .34$ $F = 11.13$

<u>Aggregate Expenditures</u>

$$AED = -13097.90 + 1.005YD - 147.51RPR - 420.19U + 0.05AEDL$$
(-4.60) (15.61) (-1.20) (-1.84) (0.83)

$R^2 = .99$ $F = 4941.73$

Structural Equations of the Monetary Sector

<u>Real Interest Rate</u>

$$RPR = -25.35 + 13.90ERA + 0.00006DKD + 0.00025GPDID$$
(-3.35) (4.20) (1.29) (2.24)

$$-0.000027FGSDD - 0.0000007HPMS$$
(-0.81) (-0.29)

$R^2 = .29$ $F = 3.28$

<u>Exchange Rate</u>

$$ERA = -0.006 + 0.0038RPR + 0.0076PRDD + 0.011DPRF$$
(-0.15) (1.81) (2.28) (2.24)

$$+ 0.0000009BOPD + 0.99ERAL$$
(1.97) (25.52)

$R^2 = .97$ $F = 268.73$

V (Continued)

Net Capital Outflow

$$DKD = \underset{(1.65)}{9667.26} - \underset{(-1.59)}{9457.41ERA} - \underset{(-0.49)}{170.14RPR} - \underset{(-2.72)}{1300.07PRDD}$$

$$+ \underset{(-1.43)}{1038.63DPRF} + \underset{(9.64)}{0.82DKDL}$$

$R^2 = .69$ $F = 18.45$

Numbers in parentheses are t-values.
Numbers in brackets are elasticities.
All value variables are deflated (1972=100) and in millions of U.S. dollars.

TABLE VI

Structural Identities

Agricultural Market Clearing Condition

DSA = DDA + DXDA + DSKA − DSKAL

Nonagricultural Market Clearing Condition

DSNA = DDNA − DIDNA

National Income Condition

YD = DDNA + DDA + DXDA − DIDNA

Balance of Payments Condition

BOPD = DXDA − DIDNA + DKD

Money Supply Condition

HPMS = FRDL + NDAD + BOPD

Real Sector

The domestic disappearance equations for agriculture and nonagricultural fit well, with most explanatory variables significant at the 95 percent level. Price elasticities for nonagriculture and agriculture are -1.12 and -.10, respectively. These estimates lend credibility to the division of the economy based on market structure. Although the price elasticity of agricultural demand seems somewhat low, one must consider the aggregate nature of the equation. Aggregate expenditure parameters in these equations represent the marginal propensity to absorb products from increased expenditures. The parameters reveal that a one dollar increase in aggregate expenditures yields 60 cents to nonagricultural disappearance and only 2 cents to agricultural disappearance. The elasticities of aggregate expenditure in the two equations show a somewhat different picture. Nonagricultural disappearance increases by .86 percent for a 1 percent increase in aggregate expenditures. Agricultural disappearance will increase .47 percent for a 1 percent increase in aggregate expenditures as compared to .52 percent for a rise of 1 percent in national income in the agricultural model in Appendix I. The difference in adjustment is explained by the relative proportions spent in the sector.

Net export-import specifications are exports minus imports for agriculture and the opposite for nonagriculture. The fit is reasonable and all signs meet a priori expectations. The assumption made in Chapter III concerning the behavioral relationship between import and domestic prices of nonagricultural products seems to be reasonable according to the estimated model. The parameter of that particular variable has the correct sign and is significant. Recall that import demand is a function of import prices and import prices are assumed to be a linear function of domestic prices. Export and domestic prices also utilize this assumption. Net import demand of nonagricultural products is inelastic with respect to domestic income and exchange rates. In the case of exchange rates, the import impact appears to be rather small. This is especially true in relation to the relatively large price elasticity. Net exports of agricultural goods on the other hand show an elastic response to price and the exchange rate. The relative size of the elasticities suggests that international trade of nonagricultural goods is more stable than trade in agricultural products in response to changing prices and exchange rates.

Inventory or stock demand of agricultural commodities is a function of prices received by farmers and inventory lagged. Normally the cost of holding stocks would be included as an explanatory variable. This variable is usually represented by the interest rate but it consistently exhibited a positive sign and was deleted. The elasticity with respect to price was -.76 in the short-run and -.80 in the long-run.

Production equations for agricultural and nonagricultural products were specified without intercepts. The nonagricultural specification is based on a price dependent "cost-plus" concept. Therefore the percentage change in the price of nonagricultural products is a function of the percentage change in the price of imports. The t-values are significant at the 5 percent level. The percentage change variables are nonlinear but the parameters of the equation are linear. A 1 percent increase in wages increases prices by .83 percent. According to the cost-plus concept, this parameter should be close to one. The coefficient was found not to be significantly different than one at the 5 percent confidence level .

The percentage change in wages is a function of the change in the unemployment rate and the percentage change in money supply. The coefficient of the unemployment variable was not significant at the 5 percent level but the percentage change in the supply of high powered money was significant. The signs meet a priori expectations, with increased unemployment retarding wage growth and increased high powered money pushing wages up. The fit of the equation and the low t-value of the unemployment variable limit inferences from the equation. However, a survey of other studies (Shei and Thompson, Rausser, and Hughes and Penson) found almost identical results.

The specification outlined in Chapter III places emphasis on the relationship between aggregate expenditures and national income. According to the specification, if the actual stock of money exceeds demand, aggregate expenditures will exceed national income as people "dishoard" (Mundell, Chap. 8). Full adjustment is not achieved in one period. Only a fraction of the difference between actual and desired holdings of real balances is eliminated within any given period. The structural equation of aggregate expenditures reveals a dishoarding situation within the time period of the data. National income has a parameter of 1.005 which means that individuals were dishoarding real balances on the average over the period of analysis. This is translated as "loose" monetary policy by the Federal Reserve Board. It was assumed in Chapter III that domestic credit creation directly increases expenditures. According to Shei and Thompson, "The increase in money supply may be viewed as paying for government expenditures that Congress is unwilling to increase taxes to pay for directly." The model indicates that this type of operation increases wages and therefore prices. Increased tax revenues result from the progressive tax structure.

Increases in the unemployment rate and the real rate of interest retard growth in aggregate expenditures according to the parameter signs. Of these two explanatory variables, only the enemployment rate is significant at the 5 percent level. The fit of the equation is good with an R^2 of .99 and the adjustment process is rather quick according to the parameter of the lagged dependent variable.

Monetary Sector

As discussed in Chapter III, the function of the monetary sector in this model is to explain the difference between national income and aggregate expenditures. The difference represents "hoarding" and "dishoarding" of real balances by individuals. That is, the model attempts to capture the essence of the adjustment between the supply and demand for real money balances.

To capture the determining factors which affect individual preferences with regard to real balances, three equations are specified. The first is an equation representing the determinants of the real rate of interest on short-term loans. This variable is defined as the nominal prime rate minus the change in the implicit price deflator of gross national product. The equation is given in Table II with t-values in parentheses. Generally the fit of the equation is acceptable with the F-ratio significant at the 5 percent level. Parameter signs meet a priori expectations with the exchange rate, net capital outflow, and gross private domestic investment having a positive affect on the real interest rate. Federal government surplus and the supply of high powered money have a negative effect.

The last four variables in the real rate equation represent the supply of and demand for money in the economy. Effects from federal government spending above tax collections are calculated using the parameter estimate of

FGSDD, which is -.000027. Since the variable is in millions of U.S. dollars, the affect of a $100 billion increase in deficit spending is a 2.7 percentage point increase in the real prime rate. Accordingly, if Congress reduces deficit spending by $50 billion in 1986, the real prime rate will be reduced 1.35 percentage points relative to what it would have been without the reduction in spending.

Exchange rates are the next topic of consideration. The equation in Table V fits well with an R^2 of .97 and a significant F-ratio. Signs of the parameters meet a priori expectations but the slow speed of adjustment as indicated by the parameter of the lagged exchange rate is questionable. Considering the nature of the market for foreign currency, one would expect almost instantaneous adjustment.

Increases in domestic interest rates, both real and nominal, push exchange rates higher. Also, an increase in the difference between domestic and foreign interest rates increases the exchange rate. This conclusion is consistent with the model specification because the variables represent rates of return on investment which determine demand for U.S. dollars. An increase in the balance of payments position of the U.S. economy will also increase the exchange rate. This variable represents the economic health of the foreign trade sector of the economy. If the U.S. increases its exports relative to imports, then the demand for U.S. dollars is increased because foreign importers must exchange their currency for dollars in order to purchase these imports. If the balance of payments position of the U.S. increases $100 billion, then one would expect the exchange rate index (mean=.951) to increase by .09 or approximatily 10 percent.

Net capital outflow from the U.S. economy is specified and estimated in the last equation of Table V. It is a function of the rate of return on investment and of other variables. All variables have signs that meet a priori expectations and the fit is reasonable. If the rate of return on domestic investment increases, then the net outflow of capital will decrease. This is also true for relative rates of return between the U.S. and foreign countries. For example, if the difference between domestic and foreign interest rates increases by 1 percentage point, the net capital outflow is reduced by about $1.04 billion.

Together the three equations of the monetary sector help to explain the demand for real balances of U.S. dollars. The specification of the monetary sector deviates from most in that real interest rates are utilized in place of nominal rates. This is an important difference because the demand for real balances is not a function of nominal rates because they do not reflect a real rate of return on balances held. If it were, then rational individuals would be suffering "money illusion" which is not rational in the long-run.

Reduced form estimates of the general equilibrium model will be reported and discussed in Appendix II where they can be compared to the partial equilibrium structural and reduced form estimates more easily.

Hypothesized Linkages

The reduced form and total multipliers of the general equilibrium econometric model reveal the impacts of the exogeneous variables on the current endogenous variables. Reduced form multipliers are estimates of the initial impact, while total multipliers are estimates of the long-run impacts of a sustained change in an exogeneous variable. The difference between the two multipliers is a gauge of how the dynamic processes of the model adjust over time to an exogeneous variable change. When the two multipliers are almost equal, the impact of the particular exogeneous variable is immediate and sustained.

Federal budget deficits impact the U.S. economy in a systematic manner. The reduced form estimates for the federal deficit are multipliers representing the impact of a one-time shock. The total multipliers are estimates representing the effect of a sustained change in the federal deficit. An increase of 1 percent in the deficit will result in a 3.5 percent increase in real interest rates in the short-run for a one-time shock. Expectations play a role because after a 1 percent increase in the deficit is eliminated, real interest rates should drop to previous levels. Economic agents hold real rates up after the deficit is eliminated because of expectations of future deficits. As time passes with no deficits real rates return to previous levels.

Like the U.S. economy, the econometric model adjusts to sustained increases in the federal deficit. A sustained increase in the federal deficit of 1 percent increases real interest rates by 1.1 percent according to the total multiplier. When the deficit is increased and sustained the real interest rate initially rises, but capital flows into the U.S. to take advantage of higher real rates of return and rates fall. The long-term impact is a 1.1 percent increase in real interest rates when the economy again attains equilibrium.

The effect of increased real interest rates, resulting from increased deficits, is rising capital inflows. A one dollar increase in the federal deficit results in a 0.006 dollar increase in capital inflows in the short-run. A sustained increase of one dollar in federal deficits yields a 0.185 dollar increase in capital inflows in the long-run. The rapid increase in capital inflow is the result of two factors. One is the capital needed to supply the deficit and the other is the attraction of higher real interest rates which attract capital as long as real rates of return are high in the U.S. relative to other countries.

Increased capital inflow puts pressure on currency exchange markets to increase the value of U.S. dollars. According to the reduced form estimates a one dollar increase in the federal deficit raises the real exchange rate index by 0.00000109 percentage points initially. For a $100 billion deficit, the index increases 0.109 percentage point, which is approximately 10 percent. The sustained effect of a $100 billion deficit is 0.346 percentage point increase. This represents an approximate 32 percent increase in the real exchange rate.

Net agricultural exports are affected by the linkages above. When federal deficits increase real interest rates, capital inflows, and the exchange rate, they also affect net agricultural exports. Reduced form estimates show that for a $100 billion deficit, net agricultural exports decrease by $2.1 billion initially. The same deficit sustained over time results in a 10.6 billion dollar increase. The parameters which these estimates are based on are calculated at the margin and considering the lagged endogeneous matrix the sustained effect is very long-term for net agricultural exports.

It would seem clear that federal deficits have a pronounced effect on the international competitiveness of the U.S. and particularly U.S. agriculture. The estimates above are calculated from reduced form and total multipliers. The reduced form multipliers gauge the impact of a deficit shock and total multipliers measure a sustained effect but the timepath of adjustment is not considered. For example if a total multiplier is much larger than the reduced form estimate, the effect may be very large but is very long-term in nature. Therefore simulation analysis is conducted in the next chapter to gauge the impact over a three year period.

CHAPTER V

MODEL SIMULATION

The estimated general equilibrium model is now utilized to examine the consequences of specific economic policies. Policies impact different sectors of the economy unevenly, sometimes even in opposite directions. The results are discussed from an agricultural perspective in most cases.

Estimated parameters and the economic structure from the general equilibrium model are the basis of the simulation experiments. The structural form of the model is represented by a set of linear structural difference equations. Forecasts are calculated from these equations based on changes in the exogenous variables only. Simulation predictions are for the years 1985, 1986, and 1987.

To gauge the impact of governmental policy actions "Simulation Predictions" and "Base Predictions" are contrasted in Tables VII-XVI. The "Base Predictions" for the years 1985, 1986, and 1987 are made from predetermined variables which are assumed to be linear extentions of past values based on their trends from 1981 to 1984. Two notable exceptions to this method of forecasting are the federal deficit and the unemployment rate. These predetermined variables are assumed to be averages (1981-1984) because their trends seem beyond what society would be willing to accept. The "Simulation Predictions" use the same predetermined variable values as in the Base Prediction except for the specific policy action variables altered for the experiment.

Federal Deficit Simulation

Simulation of reduced government borrowing from the private sector is the first experiment. In this experiment the deficit is reduced to zero in the years 1985, 1986, and 1987. The effects of such an action are cumulative and slightly larger in the longer run. This characteristic stems from the dynamic nature of the model. Not all results will be discussed in this section because the focus of this work is the economic behavior of U.S. agriculture.

When government borrowing is reduced through decreased spending, more currency is available for the private sector. Capital markets will adjust to this situation by reducing the market price, which in this case is the real rate of interest. The effect of this policy action on the real prime rate of interest is given in Table VII.

The deficit for the base simulation is the average yearly federal deficit from 1981 through 1984. The average deficit was calculated to be \$32 billion per quarter or \$128 billion annually. Deficits for fiscal year 1985 were well above that (about \$200 billion) and the impact would be

TABLE VII

FEDERAL DEFICIT SIMULATION

REAL PRIME RATE OF INTEREST

YEAR/QUARTER	BASE PREDICTION	SIMULATION PREDICTION	% DIFFERENCE
	Percent		
85/1	4.97	4.19	-15.62
85/2	5.08	4.28	-15.60
85/3	5.16	4.35	-15.58
85/4	5.22	4.40	-15.58
86/1	5.26	4.44	-15.59
86/2	5.28	4.45	-15.59
86/3	5.29	4.46	-15.61
86/4	5.28	4.46	-15.62
87/1	5.27	4.44	-15.64
87/2	5.24	4.42	-15.66
87/3	5.21	4.40	-15.69
87/4	5.18	4.36	-15.71

correspondingly larger. The base simulation of the real interest rate shows the model prediction without the change in government borrowing ($128 billion deficit). The column labeled "Simulation Prediction" is the model prediction based on an exogenous elimination of government borrowing for the years indicated. Deficit reduction causes a stable and sustained reduction in the real prime rate of approximately 15 percent throughout the simulation period. The effect of government deficit reduction alone is approximately a 1 percentage point lowering of the real interest rate. The reduction would have been nearly two percentage points if the 1985 federal deficit were utilized.

Deficit reduction translates into lower exchange rates for U.S. dollars (Table VIII). The simulation exercise assumes that the supply of money is held constant in real terms. Therefore changes in the real rate of return on capital influence financial markets through changes in the demand for particular currencies. The time path of adjustment reveals that at least one year of reduced deficit spending is needed to achieve a 3 percent decrease in the exchange rate. This result stems from the dynamic nature of the system modeled.

Agriculture in the U.S. is highly dependent upon exports as a source of income. Domestic consumption of farm products has consistently been shown to be very price and income inelastic. This fact reinforces the dependence of agriculture on an export market which has more macroeconomic

TABLE VIII

FEDERAL DEFICIT SIMULATION

EXCHANGE RATE OF U.S. DOLLARS INFLATION ADJUSTED

YEAR/QUARTER	BASE PREDICTION	SIMULATION PREDICTION	% DIFFERENCE
	Index 1973=1.00		
85/1	1.155	1.141	-1.21
85/2	1.174	1.141	-2.43
85/3	1.181	1.163	-1.52
85/4	1.193	1.168	-2.09
86/1	1.206	1.169	-3.06
86/2	1.213	1.174	-3.21
86/3	1.218	1.182	-2.95
86/4	1.224	1.187	-3.02
87/1	1.226	1.181	-3.67
87/2	1.225	1.180	-3.66
87/3	1.226	1.180	-3.73
87/4	1.226	1.179	-3.75

variability than does the domestic market. Macroeconomic factors affect the export market primarily through the exchange rate. In the case of reduced federal deficits, the reduction causes real rates of interest to fall, which translates into a lower exchange rate, which lowers the foreign cost of exports. The simulation results in Tables VIII and IX support this line of thought.

Generally the effect of deficit reduction on real rates of interest is less than 1 percentage point in the beginning of 1985. But as the exchange rate falls (by 4 percent in later years), net exports climb over 6 percent above the level predicted without deficit reduction. An interesting aspect of the base simulation is that exports decline in the near future based on conditions which existed from 1981 to 1984. A reduction in the federal deficit slows the decline in exports shown in Table IX, but it does not reverse the trend.

Prices of agricultural products are represented by the index of all prices recieved in the sector. Competition in international markets is quick to react to rising agricultural export prices. Prices are hypothesized to move toward some long-run equilibrium. The simulation experiment resulted in a small increase in agriclutural price: less than 2 percent in later years. The increase is restrained by the high level of world stocks which exist at the present time.

TABLE IX

FEDERAL DEFICIT SIMULATION

NET EXPORTS OF AGRICULTURAL PRODUCTS

YEAR/QUARTER	BASE PREDICTION	SIMULATION PREDICTION	% DIFFEREENCE
	Millions of 1977 U.S. Dollars Quarterly		
85/1	1587	1594	0.44
85/2	1493	1510	1.11
85/3	1415	1440	1.85
85/4	1349	1384	2.58
86/1	1296	1338	3.25
86/2	1253	1302	3.85
86/3	1219	1233	4.36
86/4	1193	1250	4.77
87/1	1174	1234	5.10
87/2	1161	1223	5.34
87/3	1153	1216	5.50
87/4	1149	1213	5.58

Overall the deficit reduction experiment revealed the expected changes suggested by macroeconomic theory. Deficit reduction does play a role in the marketability of U.S. agricultural products abroad.

MONEY SUPPLY SIMULATION

The base simulation model used in this experiment assumes a constant real rate of growth in money supply of 4 percent per year. The experiment increases this rate to 8 percent for comparison in the years 1985, 1986, and 1987. Operationally, the increase in the dependent variable for money supply was achieved by inflating net domestic money asset. This exogenous variable is linked to the money supply by the identity: money supply = net domestic money asset + foreign reserves. Results of the experiment with respect to the real prime rate are reported in Table X.

The behavior of the modeled credit market is consistent with market forces. When the supply of money increases to an 8 percent rate in 1985, the first reaction of the credit market is to offer lower rates of interest. When market participants decide that the rate of increase is not a short-term policy, they hedge their capital by requiring higher interest rates.

The model does not contain an equation specifically measuring changes in the general price level. But an indicator for the price level is the Philip's curve equation. In this model the real rate of wage increases, adjusted for productivity and inflation, is a function of

TABLE X

MONEY SUPPLY SIMULATION

REAL PRIME RATE OF INTEREST

YEAR/QUARTER	BASE PREDICTION	SIMULATION PREDICTION	% DIFFERENCE
		Percent	
85/1	4.97	4.66	-6.20
85/2	5.08	4.88	-3.90
85/3	5.16	5.04	-2.31
85/4	5.22	5.15	-1.33
86/1	5.26	5.23	-0.61
86/2	5.28	5.29	0.20
86/3	5.29	5.31	0.44
86/4	5.28	5.33	0.94
87/1	5.27	5.32	0.90
87/2	5.24	5.30	1.14
87/3	5.21	5.28	1.34
87/4	5.18	5.26	1.54

unemployment rate and the supply of money. As the supply of money increases, so does the rate of wage inflation. Table XI compares an 8 percent annual increase to the assumed 4 percent annual increase in the supply of money.

The increases in wages are changes in the index of private sector weekly wages with a base of 1977=100. According to the exogenous data for the simulation years, the rate of increase in wages (reported values are on a yearly basis) ranges from 4 to 6 percent. By doubling the rate of money supply growth to 8 percent, the change in wages rises to an annual range of 12 to 15 percent. The index of prices for all nonagricultural goods absorbs increased wage costs according to the model. Percentage changes in nonagricultural prices, on a yearly basis, range from 6 to 8 percent. Resulting price level increases account for the credit market's behavior with respect to real rates of interest.

Exchange rates in the model are deflated for price level increases, and are expected to decrease. But according to the specification, exchange rates are also a function of the real prime rate. A combination of these effects determine the actual change. Exchange rates react much like the real prime rate. The combination of effects result in an insignificant change in the exchange rate (Table XII).

Agricultural exports do not change significantly enough to list them here. It appears that money supply growth at the 8 percent level, which is twice the base rate, does not

TABLE XI

MONEY SUPPLY SIMULATION

WAGE INCREASES ADJUSTED FOR PRODUCTIVITY

YEAR/QUARTER	BASE PREDICTION	SIMULATION PREDICTION	% DIFFERENCE
	Increase in the Index of Real Wages		
85/1	5.1	12.9	153
85/2	4.6	12.5	169
85/3	5.1	13.1	155
85/4	4.7	12.7	166
86/1	5.4	13.4	147
86/2	5.2	13.2	154
86/3	5.9	14.1	136
86/4	5.8	13.9	140
87/1	6.1	14.7	124
87/2	6.3	14.8	126
87/3	6.9	15.0	117
87/4	6.8	15.3	125

TABLE XII

MONEY SUPPLY SIMULATION

EXCHANGE RATE OF U.S. DOLLARS INFLATION ADJUSTED

YEAR/QUARTER	BASE PREDICTION	SIMULATION PREDICTION	% DIFFERENCE
	Index 1973=1.00		
85/1	1.155	1.136	-1.64
85/2	1.174	1.163	-0.94
85/3	1.181	1.174	-0.59
85/4	1.193	1.191	-0.17
86/1	1.206	1.212	0.50
86/2	1.213	1.220	0.57
86/3	1.218	1.225	0.58
86/4	1.224	1.230	0.49
87/1	1.226	1.232	0.48
87/2	1.225	1.228	0.34
87/3	1.226	1.228	0.16
87/4	1.226	1.227	0.18

impact real exchange rates and therefore exports significantly. Money supply growth in the 20 to 30 percent range would surely have an effect, but historically it would be outside the domain of the estimated model and therefore was not attempted. Real agricultural prices did increase in the range of 1 to 2 percent consistently throughout the simulation period which indicates that money supply growth impacts agricultural prices although it did not significantly impact export volume.

EXCHANGE RATE SIMULATION

A simulation experiment was undertaken to estimate the impact of more optimal federal economic policies and their effect on the exchange rate. The term " optimal" is a subjective term which can mean different things to different people. Here we arbitrarily assume that more optimal macroeconomic policies are a zero difference between foreign and domestic interest rates, a real rate of interest of 4 percent, a zero balance of payment position, and a balanced federal budget.

Table XIII contains values of the exchange rate which is the index of ten currencies relative to the dollar with a 1973 base. Furthermore, the values have been deflated for price level increases in the U.S. and for the ten currencies (G-10 classificaion of the ten largest U.S. trading partners). The dynamics of the model reveal only a small initial decrease. But as the hypothesized economic

TABLE XIII

EXCHANGE RATE SIMULATION

EXCHANGE RATE OF U.S. DOLLARS INFLATION ADJUSTED

YEAR/QUARTER	BASE PREDICTION	SIMULATION PREDICTION	% DIFFERENCE
	Index 1973=1.00		
85/1	1.155	1.119	-3.07
85/2	1.174	1.107	-5.72
85/3	1.181	1.086	-8.05
85/4	1.193	1.072	-10.11
86/1	1.206	1.062	-11.95
86/2	1.213	1.048	-13.61
86/3	1.218	1.034	-15.12
86/4	1.224	1.022	-16.50
87/1	1.226	1.020	-16.80
87/2	1.225	1.016	-17.06
87/3	1.226	1.017	-17.04
87/4	1.226	1.017	-17.04

conditions become entrenched, the simulation predictions level off at approximately 1.02. This is about a 17 percent decrease from what would have resulted if the current situation were continued. If the "current" situation would have contained a deficit as large as that in 1985, the real exchange rate would have fallen considerably more in the experiment.

A comparison of this experiment with the one pertaining to federal deficit reduction reveals a much lower exchange rate than can be attributed to the deficit alone. Those other factors reflect a monetary-fiscal policy which reduces the demand for dollars in exchange markets. Other such policies could result in the desired changes, but most would require a slowdown in economic growth and import consumption.

Agriculture in the U.S. would benefit from a lower exchange value of the dollar. It would become more competitive in world markets and there would be less incentive to import agricultural products. Net exports of agricultural products reported in Table XIV increase dramatically in the simulation experiment. This is especially true when one compares the rate of increase on simulation prediction to the basic model prediction. In one case, exports increase in the period and in the other they decrease.

From an economy-wide perspective, the results of this simulation are quite different than for agriculture.

TABLE XIV

EXCHANGE RATE SIMULATION

NET EXPORTS OF AGRICULTURAL PRODUCTS

YEAR/QUARTER	BASE PREDICTION	SIMULATION PREDICTION	% DIFFERENCE
	Millions of 1977 U.S. Dollars Quarterly		
85/1	1587	1594	0.44
85/2	1493	1623	8.71
85/3	1415	1647	16.39
85/4	1349	1751	29.70
86/1	1296	1832	41.35
86/2	1253	1871	49.32
86/3	1219	1898	55.70
86/4	1193	1943	62.86
87/1	1174	1989	65.55
87/2	1161	2021	74.07
87/3	1153	2033	76.32
87/4	1149	2062	79.46

Aggregate expenditures in the economy drop by approximatly 3 percent while national income falls by about half that amount. Prices of nonagricultural goods fall by 4 percent in the fourth quarter of 1987. The flow of capital into the country is reduced by 24 percent initially and by 62 percent at the end of the simulation period. The slowdown in capital inflow is the direct result of simulated changes in the real rate of return on capital. Other decreases come about indirectly. The implications of increasing exports and decreasing imports at any cost are clear. To do so would likely entail a recession. Any remedy that avoids the large social costs of recession would take time to make the adjustment and a degree of fine-tuning of macroeconomic policy probably beyond current capabilities.

FOREIGN INCOME SIMULATION

World income since 1981 has declined relative to U.S. income. Since exports are a direct function of income, U.S. export decline is not surprising. The next simulation experiment examines the consequences of an exogenous increase of 15 percent in world income.

Results in Table XV indicate that exports rise if current macroeconomic factors are continued but with increased foreign income. Although export volume is above the level they would be without increased foreign income, the volume declines after the relatively large initial gains. The relative volume decreases because of pressure on

TABLE XV

FOREIGN INCOME SIMULATION

NET EXPORTS OF AGRICULTURAL PRODUCTS

YEAR/QUARTER	BASE PREDICTION	SIMULATION PREDICTION	% DIFFERENCE
Million of 1977 U.S. Dollars Quarterly			
85/1	1587	2023	27.58
85/2	1493	1938	29.86
85/3	1415	1846	30.49
85/4	1349	1774	31.54
86/1	1296	1724	33.02
86/2	1253	1669	33.26
86/3	1219	1631	33.73
86/4	1193	1593	33.56
87/1	1174	1551	32.14
87/2	1161	1523	30.88
87/3	1153	1441	24.93
87/4	1149	1382	20.31

capital markets. Increased foreign income and economic growth puts upward pressure on interest rates. Given that, exchange rates also increase but not dramatically in Table XVI.

The real prime rate of interest is higher by about .5 percentage points in the end of the simulation period. The decline in exports is noticeable and is the indirect result of increased demand for funds overseas. Another notable aspect of this experiment is that the flow of funds into the U.S. declined by about 22 percent in 1987 because real interest rates increased less in the U.S. than abroad where funds are needed to finance economic activity.

One conclusion from this simulation is that an increase in foreign income has complex and sometimes opposing impacts on U.S. exports. The income effect on exports is the largest but is partially offset by the interest rate effect.

TABLE XVI

FOREIGN INCOME SIMULATION

REAL PRIME RATE OF INTEREST

YEAR/QUARTER	BASE PREDICTION	SIMULATION PREDICTION	% DIFFERENCE
	Percent		
85/1	4.97	5.07	2.13
85/2	5.08	5.21	2.62
85/3	5.16	5.32	3.15
85/4	5.22	5.42	3.84
86/1	5.26	5.48	4.38
86/2	5.28	5.54	5.13
86/3	5.29	5.58	5.54
86/4	5.28	5.60	6.03
87/1	5.27	5.62	6.75
87/2	5.24	5.61	7.34
87/3	5.21	5.62	7.93
87/4	5.18	5.64	8.52

CHAPTER VI

SUMMARY AND CONCLUSIONS

A general equilibrium econometric model was estimated with agriculture as one of its two "real sectors" components. The econometric model was utilized to address the objectives, form the basis of the simulation experiments, and test the hypotheses. The simulations were used to gauge the impact of macroeconomic policies on the U.S. farm sector. One of the simulation experiments gauged the impact of federal fiscal policy on real interest rates, real exchange rates and net agricultural exports. Another simulation experiment forecasted the impact of a more liberal U.S. monetary policy on the real interest rate, real exchange rate and net agricultural exports. An increase in foreign income was simulated in an experiment to determine its impact on net agricultural exports. The final objective was satisified by a simulation experiment that incorporated a "preferred" combination of U.S. monetary and fiscal policy.

The first hypothesis of this study proposed that an increase in the federal deficit increases the real interest rate. According to the structural equations and the simulation results there exists a positive relationship between the deficit and the real interest rate. Although the structural coefficient is not statistically significant, a number of studies substantiate a positive significant relationship (See Tweeten, Feldstein and Eckstein, and Carlson). Given the evidence of this study and others, I am unable to reject the hypothesis that higher federal deficits increase real rates of interest.

The second hypothesis stated that an increase in the real interest rate increases the real value of the U.S. dollar in foreign exchange markets. The structural equations indicate that the real interest rate has a significant positive relationship with the real exchange rate. The simulation experiments indicated that a decrease in the real interest rate reduces the real exchange rate. The results provide support for the converse of the hypothesis which is equally valid for our hypothesis. Therefore I am unable to reject the hypothesis that an increase in the real interest rate increases the real exchange rate of the U.S. dollar. Moreover, the evidence indicates that I can reject the hypothesis that there is not a positive relationship between real interest rates and real exchange rates.

The third hypothesis proposed that a rise in the real value of the dollar reduces net exports of U.S. farm products. The real exchange rate variable in the export-import (net export) equation has a significant negative relationship. This indicates that net exports fall when the exchange value of the dollar rises. The simulation experiments consistently revealed a decrease in net agricultural exports resulting from increased real exchange rates. I am unable to reject the hypothesis that an increase in the value of the dollar reduces net exports of U.S. farm products. Given the consistent results of the simulation experiments and other studies, I can safely reject the hypothesis of no significant negative relationship between net agricultural exports and real exchange rates.

The fourth hypothesis states that an increase in the U.S. money supply does not influence real interest or exchange rates except in the short-run. The structural equation for the real interest rate reveals a negative and insignificant relationship between the level of money supply and the real interest rate. Simulation of the relationship assumed that the money supply was expanded at an 8 percent annual rate as compared to the 4 percent annual rate used in previously simulations. The results indicate only small decreases in the real interest rate and small increases in net exports. The reduced form and impact multipliers suggest that the shock effect of an increase in the money supply does have an impact, but it seems to be very short-run in nature. It seems that large unsustained changes in the money supply do not have a significantly lasting impact on the model. I am unable to reject the hypothesis that an increase in the money supply does not influence real interest or exchange rates except in the short-run.

Foreign income had a significant impact on net agricultural exports. Conventional economic thought states that foreign income will be one of the most important shifters of export demand. When foreign income was increased in the simulation, agricultural exports moved higher, increasing net exports. Given the simulations and parameters of the model, I cannot reject the hypothesis that increases in foreign income increase net agricultural exports. The evidence indicates the I can reject a no positive relationship hypothesis.

Macroeconomic factors affect the international competitiveness of U.S. agriculture. Most of these factors are directly controled by the federal government. The most important factor according to this study is the federal deficit and its effect on the real exchange rate through real interest rates. Money supply, which is controlled by the Federal Reserve Board, seems to have an impact but it is small relative to the fiscal policy of the federal government. A factor outside the direct control of the government, foreign income, has a significant effect on net exports of agricultural products. But, it is indirectly affected by the governmental policies which determine the health of the U.S. economy and its demand for foreign imports.

Limitations

The simulation experiments are based on hypothesized exogenous variables. They were estimated according to their trends from 1980 to 1984. Therefore, forecasts for 1985, 1986, and 1987 are contingent on the accuracy of estimates made for the exogenous variables in that time period.

This study utilized data from 1970 to 1984. The statistical significance of the relationship between federal deficits and real interest rates would most likely increase if more data were available in the period when federal deficits increased above historical norms. Researchers in the early 1970's faced the same problem when exchange rates were first floated. It took a considerable period of time to find statistical relationships between the exchange rate and agricultural exports because of little variation in the exchange rate. The same can be said about the federal deficit and its impact on real interest rates. As time and larger variations occur in the federal deficit the theoretical interconnections with the real interest rate should became statistically more evident.

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APPENDIXES

APPENDIX I

AGRICULTURAL PARTIAL EQUILIBRIUM MODEL

The market for agricultural goods is represented by a five equation dynamic trade model. It has four behavioral equations and one identity. The model was estimated with two-stage least squares. Data for the analysis is quarterly from the beginning of 1970 to the end of 1984. Structural estimates of the equations are given in this appendix. The structural equations have t-values in parentheses and elasticities in brackets.

AGRICULTURAL SECTOR

Structural Equations

Disappearance Equation

$$DDA = \underset{(4.72)}{4650.91} - \underset{\substack{(-2.22)\\ [-0.10]}}{854.57PAD} + \underset{\substack{(5.23)\\ [0.52]}}{0.02YD} + \underset{(1.83)}{0.26DDAL}$$

$R^2 = .82 \qquad F = 66.85$

Production Equation

$$DSA = \underset{\substack{(14.16)\\ [0.72]}}{48162.15PAD} - \underset{(-5.60)}{3909.82PPF}$$

$F = 2027.26$

Export-Import Equation

DXDA =502.79 - 1067.40PAD - 2069.90ERA + 0.003YF + 0.42DXDAL
(0.23) (-2.37) (-2.84) (2.33) (3.18)
[-1.02] [-1.35] [2.62]

R^2 = .80 F = 40.79

Stock Equation

DSKA = 51154.99 - 16164.50PAD + 0.04DSKAL
(6.72) (-6.41) (0.25)
[-0.76]

R^2 = .86 F = 143.74

Market Clearing Condition

DSA = DDA + DXDA + DSKA - DSKAL

Numbers in parentheses are t-values.
Numbers in brackets are elasticities.
All value variables are in millions of 1972 dollars.

The first equation to be discussed is domestic disappearance of agricultural products. All signs meet a priori expectations and the equation fits reasonably well with an R^2 of .82. Price elasticity of disappearance shows a very inelastic response. The short-run elasticity of -.10 is consistent with the aggregate nature of the specification. Domestic disappearance is also inelastic with respect to income. The income elasticity is .52. The parameter of the lagged dependent variable indicates that domestic markets adjust so that the domestic price and income elasticities are -.14 and .70, in the long-run.

Agricultural production in this model is specified without an intercept following a similar specification by

Chambers and Just (1981). In this specification, the R^2 is not applicable but the F-ratio reveals significant explanatory power. The price elasticity of production is .72 which is within the range of the short elasticities commonly cited in other supply studies (Tweeten and Rastegari, 1985). An inverse relationship between output and prices paid by farmers exists according to the parameter of that variable. The cost of production affects the aggregate output by restricting the use of output-enhancing inputs such as agrichemicals and fertilizers. In most situations land is not taken out of production but only made less productive.

A net export specification was estimated to account for trade with other countries. Exports minus imports of agricultural products is the dependent variable. The elasticities resulting from this specification are expected to be larger than those from exports alone. The logic stems from the fact that net flows of trade account for two flows in opposite directions. For example, when a price increase in the domestic market raises import demand it also reduces export demand. Therefore the change in the dependent variable for a given price change is larger than if exports were modeled alone. The same logic applies to the exchange rate and foreign income. The short-run elasticities of price, exchange rates, and foreign income are -1.02, -1.35, and 2.62, respectively. Long-run elasticities are -1.76, -2.33, and 4.52, respectively. The estimates are somewhat higher than one might expect from an aggregated study without the "net" export variable. Overall the equation fits well with an R^2 of .80 and F-ratio of 40.79.

Inventory or stock demand is the final behavioral equation in the model. It is a function of price and lagged inventory only. Other variables suggested by theory were delated because of a high degree of intercorrelation and inconsistent signs. The price elasticity of inventory demand was estimated to be -.76 in the short-run and -.80 in the long-run. The fit of the equation is adequate with an R^2 of .86 and F-ratio of 143.74.

Reduced form estimates along with impact multipliers and total multipliers were estimated. The impact and total multipliers utilize the reduced form equations along with the lag structure to trace the speed of adjustment and final equilibrium of the model. These estimates are based upon an exogenous change in the predetermined variables.

AGRICULTURAL SECTOR

Reduced Form Equations

Disappearance Equation

DDA =3924.56 + 0.25DDAL + 0.018YD − 50.43PPF + 26.70ERA −
[0.46] [−0.03] [0.002]

0.0000YF
[−0.004]

Production Equation

DSA =40935.90 + 0.013YD − 1067.42PPF − 1504.58ERA + 0.0023YF
[0.05] [−0.07] [−0.02] [0.03]

Export-Import Equation

DXDA =−404.45 + 0.42DXDAL − 0.0003YD − 62.99PPF − 2036.25ERA
[−0.07] [−0.28] [−1.33]

+ 0.003YF
[2.58]

STOCK EQUATION

DSKA =37415.80 + 0.27DSKAL − 0.004YD − 953.99PPF + 504.98ERA
[−0.04] [−0.21] [0.02]

− 0.0008YF
[−1.31]

Price Equation

PAD = 0.85 + 0.0000003YD + 0.059PPF − 0.031ERA + 0.0000005YF
[0.07] [0.27] [−0.02] [0.04]

AGRICULTURAL SECTOR

Total Multipliers

Disappearance Equation

$$DDA = 6087.70 + 0.024YD - 87.66PPF + 80.30ERA - 0.00012YF$$
[0.61] [-0.05] [0.006] [-0.012]

Production Equation

$$DSA = 6695.96 + 0.023YD - 228.83PPF - 3371.75ERA + 0.005YF$$
[0.09] [-0.02] [-0.05] [0.07]

Export-Import Equation

$$DXDA = 613.26 - 0.0009YD - 141.17PPF - 3452.04ERA + 0.0053YF$$
[-0.21] [-0.62] [-2.25] [4.56]

Stock Equation

$$DSKA = 50769.60 - 0.008YD - 1282.48PPF + 1174.74ERA - 0.0018YF$$
[-0.09] [-0.28] [0.05] [-2.95]

Price Equation

$$PAD = 0.13 + 0.000005YD + 0.076PPF - 0.07ERA + 0.00000011YF$$
[0.12] [0.35] [-0.05] [0.09]

APPENDIX II

MACROECONOMIC MODEL

Reduced Form Equations of the Real Sector

<u>Disappearance Equations</u>

$$DDNA = 266059 + 0.03DDNAL + \underset{[0.75]}{793.93POP} + \underset{[0.20]}{0.04YF} \underset{[-0.008]}{-275.59}$$

$$- \underset{[-0.03]}{1086.92PPF} - \underset{[-0.02]}{20013.90PRDD} - \underset{[-0.17]}{0.84GPDID} - \underset{[-0.31]}{14.50HPMS}$$

$$+\underset{[0.05]}{0.09FGSDD} - \underset{[0.03]}{17100.20DRPF}$$

$$DDA = 8428.48 + 0.26DDAL + \underset{[0.23]}{13.80POP} + \underset{[0.07]}{0.00073YF} - \underset{[-0.006]}{12.06U}$$

$$- \underset{[-0.04]}{69.79PPF} - \underset{[-0.005]}{323.89PRDD} - \underset{[-0.05]}{0.014GPDID} - \underset{[-0.88]}{0.23HPMS}$$

$$+ \underset{[-0.0018]}{0.002FGSDD} - \underset{[-0.008]}{277.05DRPF}$$

<u>Export-Import Equation</u>

$$DXDA = 63.85 + 0.39DXDAL - \underset{[-0.03]}{0.26POP} + \underset{[2.46]}{0.003YF} + \underset{[0.001]}{0.23U}$$

$$- \underset{[-0.33]}{74.87PPF} - \underset{[-0.0015]}{10.95PRDD} - \underset{[-0.07]}{0.002GPDID} + \underset{[0.66]}{0.002HPMS}$$

$$+ \underset{[0.0018]}{0.00002FGSDD} - \underset{[-0.005]}{19.87DRPF}$$

$$DIDNA = 15109.60 + 0.0015DIDNAL - \underset{[-0.004]}{0.20POP} + \underset{[0.24]}{0.007YF} + \underset{[0.00009]}{0.22U}$$

$$- 0.83PPF - 1386.34PRDD - 0.06GPDID - 1.01HPMS$$
$$[-0.03] \quad [-0.02] \quad [-0.02] \quad [-3.24]$$

$$+ 0.006FGSDD - 1179.16DRPF$$
$$[0.0018] \quad [-0.03]$$

Stock Equation

$$DSKA = 35921.90 + 0.27DSKAL - 3.45POP - 0.0009YF + 3.02U$$
$$[-0.03] \quad [-0.04] \quad [0.00007]$$

$$- 1003.22PPF + 85.24PRDD + 0.004GPDID + 0.06HPMS$$
$$[-0.22] \quad [0.0005] \quad [0.006] \quad [0.97]$$

$$- 0.0004FGSDD + 75.59DRPF$$
$$[-0.006] \quad [0.0009]$$

Production Equations

$$DSA = 44414.20 + 10.10POP + 0.003YF - 8.83U - 1147.87PPF$$
$$[0.02] \quad [0.04] \quad [-0.006] \quad [-0.08]$$

$$- 249.60PRDD + 0.012GPDID - 0.17HPMS + 0.09FGSDD$$
$$[-0.0005] \quad [0.006] \quad [-0.87] \quad [0.011]$$

$$- 221.33DPRF$$
$$[-0.0008]$$

$$DSNA = 250949.00 + 794.19POP + 0.04YF - 275.81U - 1012.05PPF$$
$$[0.75] \quad [0.20] \quad [-0.007] \quad [-0.03]$$

$$- 18627.50PRDD + 0.78GPDID - 13.49HPMS + 0.09FGSDD$$
$$[-0.02] \quad [0.17] \quad [-2.84] \quad [0.004]$$

$$- 15291.10DPRF$$
$$[-0.02]$$

$$PCPNA = 1.45 - 0.03U + 58.22PCPIDNA + 76.58PCHPMS$$
$$[-0.06] \quad [0.18] \quad [0.02]$$

Philips Curve

$$PCW = 1.71 - 0.04U + 91.79PCHPMS$$
$$[-0.22] \quad [0.07]$$

<u>Aggregate Expenditures</u>

$$AED = 251270.00 + 0.09AEDL + \underset{[0.54]}{811.21POP} + \underset{[0.16]}{0.045YF} - \underset{[-0.14]}{709.09U}$$

$$- \underset{[-0.023]}{1161.69PPF} - \underset{[-0.011]}{19046.60PRDD} + \underset{[0.12]}{0.84GPDID} - \underset{[-2.03]}{13.79HPMS}$$

$$+ \underset{[-0.003]}{0.09FGSDD} - \underset{[-0.02]}{16299.90DPRF}$$

<u>National Income Equation</u>

$$YD = 259442.00 + \underset{[0.53]}{807.73POP} + \underset{[0.17]}{0.045YF} - \underset{[-0.006]}{287.65U} - \underset{[-0.02]}{1156.70PPF}$$

$$- \underset{[-0.011]}{18962PRDD} + \underset{[0.12]}{0.80GPDID} - \underset{[-2.03]}{13.72HPMS} + \underset{[-0.003]}{0.08FGSDD}$$

$$- \underset{[-0.02]}{16218.06DPRF}$$

<u>Price Equations</u>

$$PNAD = 0.06 + \underset{[0.32]}{0.002POP} - \underset{[-0.079]}{9.02 \times 10^{-8}\ YF} - \underset{[-0.004]}{0.008U}$$

$$+ \underset{[0.01]}{0.002PPF} + \underset{[0.007]}{0.05PRDD} + \underset{[0.06]}{1.75 \times 10^{-6}\ GPDID}$$

$$+ \underset{[1.18]}{0.00003HPMS} - \underset{[0.002]}{2.0 \times 10^{-7}\ FGSDD} + \underset{[0.01]}{0.03DPRF}$$

$$PAD = 0.94 + \underset{[0.03]}{0.0002POP} + \underset{[0.05]}{3.7 \times 10^{-8}YF} - \underset{[-0.0009]}{0.0002U} + \underset{[0.28]}{0.06PPF}$$

$$- \underset{[-0.0007]}{0.005PRDD} - \underset{[-0.01]}{2.6 \times 10^{-7}\ GPDID} + \underset{[0.14]}{0.00003HPMS}$$

$$+ \underset{[0.0003]}{3.0 \times 10^{-8}FGSDD} - \underset{[-0.001]}{0.005DPRF}$$

Structural Equations of the Monetary Sector

<u>Real Interest Rate</u>

$$RPR = -25.82 + 1.63 \times 10^{-15}POP - 1.30 \times 10^{-20}\ YF$$

$$- 3.99 \times 10^{-16}U - 1.30 \times 10^{-15} PPF + 0.017PRDD$$
[0.03]

$$+ 0.00026GPDID + 0.000012HPMS - 0.000028FGSDD$$
[13.46] [6.16] [3.51]

$$+ 0.081DPRF$$
[0.29]

Exchange Rate

$$ERA = -0.10 + 0.99ERAL + 1.24 \times 10^{-16} POP$$

$$- 9.93 \times 10^{-22}YF - 3.03 \times 10^{-17}U$$

$$- 9.91 \times 10^{-17}PPF + 0.0076PRDD + 9.95 \times 10^{-7}GPDID$$
[0.002] [0.05]

$$+ 9.87 \times 10^{-7}HPMS - 1.09 \times 10^{-6}FGSDD + 0.011DPRF$$
[0.50] [0.0014] [0.004]

Net Capital Outflow

$$DKD = 15045.70 + 0.80DKDL - 1.45 \times 10^{-12}POP$$

$$+ 1.16 \times 10^{-17}YF + 3.54 \times 10^{-13}U$$

$$+ 1.16 \times 10^{-12}PPF - 1375.39PRDD - 0.054GPDID$$
[-0.27] [-2.80]

$$- 0.011HPMS + 0.0059FGSDD - 1159.29DPRF$$
[-0.57] [0.08] [-0.43]

Numbers in brackets are elasticities.
All value variables are deflated (1972=100) and in millions of U.S. dollars.

APPENDIX III

Dynamic Stability

In the setting of dynamic econometric models, stability is defined with respect to a given equilibrium point. A vector x is an equilibrium point of a dynamic system if it has the property that once the system state vector is equal to x it remains equal to x (Luenberger). An equilibrium point is stable if when the state vector is moved slightly away from that point, it tends to return to it, or at least does not keep moving further away. Now consider stability of equilibrium points corresponding to linear time-variant systems of the form

$$x(k+1) = Ax(k) + b \qquad 1.$$

It is important to observe that stability issues for the equation above are tied directly to the corresponding homogeneous equation. Suppose, for example, that $\bar{x}$ is an equilibrium point of the equation above. Then we have

$$x(k+1) - \bar{x} = Ax(k) - A\bar{x} + b - b \qquad 2.$$

and thus

$$x(k+1) - \bar{x} = A(x(k)-\bar{x})$$

It is clear that the condition for $x(k)$ to tend to $\bar{x}$ is identical to that for $z(k)$ to tend to 0 in the homogenous system

$$z(k+1) = Az(k) \qquad 3.$$

Therefore, in the case of a linear system, asymptotic stability or instability does not depend explicitly on the equilibrium point, but instead is determined by the properties of the homogeneous equation.

Another way to deduce the above conclusion follows. The complete solution to Equation 1. consists of a constant $\bar{x}$ (a particular solution) and a solution to the homogeneous equation. Asymptotic stability holds if every homogeneous solution tends to zero. The character of the solutions to the homogeneous equation is determined by the eigenvalues of the matrix A.

Discrete-Time Systems

The generalized system description above applies to both discrete and continuous time cases. The model in this work is a discrete-time model, therefore only the discrete-time system stability charteristics are discussed. Consider the discrete-time system

$$x(k+1) = Ax(k) \qquad 4.$$

To obtain conditions for asymptotic stability assume initially that A can be diagonalized. Then there is a matrix M such that

$$A = MDM_{-1} \qquad 5.$$

where D is a diagonal matrix with elements d_i being eigenvalues of D. Furthermore,

$$A_k = MD_kM_{-1} \qquad 6.$$

The requirements of asymptotic stability is equivalent to the requirement that the matrix A^k tend toward the zero matrix as k increases, since otherwise some initial condition could be found that had a corresponding solution not tending toward zero. This requirement, in turn, is equivalent to requiring that all the terms d_i tend toward zero as k increases.

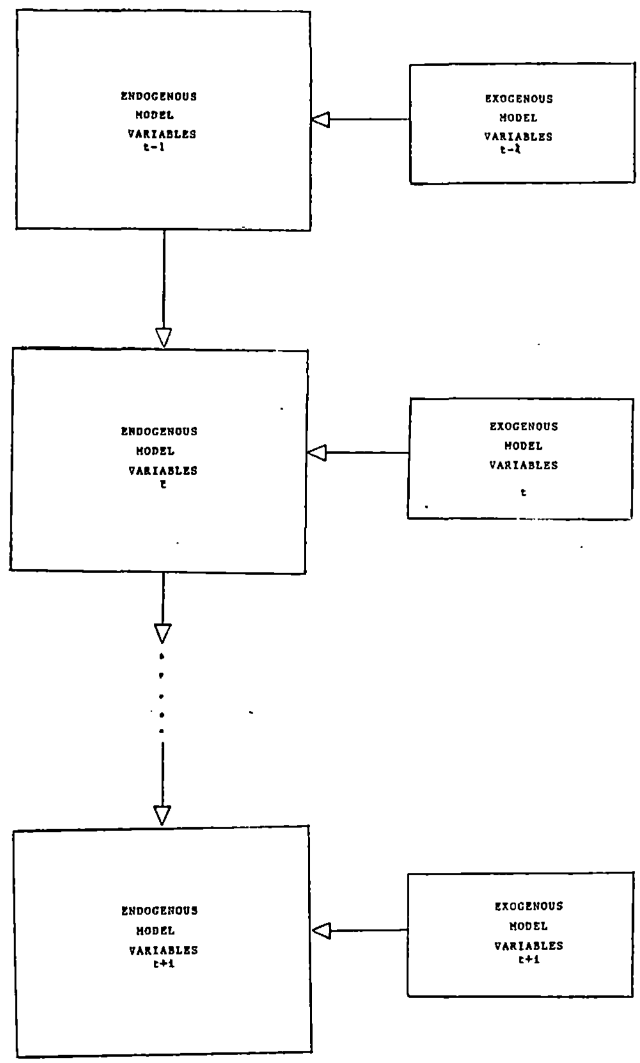
All terms will tend toward zero if and only if $|D_i|<1$ for every i. Thus, a necessary and sufficient condition for asymptotic stability is tha all eigenvalues of A lie inside the unit circle of the complex plane.

If the matrix A has multiple eigenvalues, the conclusion is unchanged. A multiple eigenvalue d introduces terms of the form d_k, kd_{k-1}, k_2d_{k-2} , and so forth into the responce. The highest-order term of this form possible for an nth-order system is $k_{n-1}d_{k-n+1}$. As long as d has magnitude less than one, however, the decreasing geometric term outweighs the increase in k_i for any i, and the overall term tends toward zero for large k. Therefore, the existence of multiple roots does not change the qualitative behavior for large k.

It is easy to deduce a partial converse result concerning instability. If the magnitude of any eigenvalue is greater than onem then there will be a vector x(0), the corresponding eignevector, which leads to a solution that increases geometrically toward infinity. Thus, the existence of an eigenvalue with a magnitude greater then on is sufficient to indicate instability.

APPENDIX IV

FLOW CHART



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