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by

Gordon C. Rausser

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Chapter 1

Introduction

Thus far in the 1980s, the course and path of the U. S. agricultural sector have been dramatically influenced by external events in the domestic and international economies. Many of these events can be traced to the change in U. S. Federal Reserve policy in October of 1979 and focus of the Reagan Administration on fiscal policy. In October of 1979, the Federal Reserve adopted a policy of attempting to control money supply directly, rejecting their previous policy of targeting interest rates. The Reagan Administration adopted a policy of reducing federal taxes and expenditures, with significantly more success achieved in reducing revenues. Huge federal government deficits have resulted which the Federal Reserve has, on the whole, consciously avoided monetizing.

The combination of U. S. fiscal and monetary policy has driven real interest rates to all-time highs. The management of money supply in the United States and the relatively high interest rates in this country have reversed the decline of the U. S. dollar that occurred throughout the 1970s. Interest rates have played a major role in enhancing the value of the U. S. dollar against other major currencies to a point that very recently exceeded the level of the dollar prior to the introduction of flexible exchange rates. Given the dominant role of the Federal Reserve and the rapid appreciation in the value of the dollar, other central banks also maintained a tight rein on their money supply. They also attempted to manage the value of their currency vis-à-vis the dollar by selling dollars and buying their currencies. As a result, they indirectly contracted their own respective money supplies.

These monetary phenomena, along with the following factors, combined to cause significant decreases in the real prices and, in fact, deflation in agricultural commodity markets over the period of the 1980s.

1. A steady increase in the value of the dollar which has increased import competition for a number of economic sectors including elements of U. S. agriculture and has had the additional effect of decreasing the inflation rate.
2. The reduction of some barriers to trade which enhanced supply response and increased the liquidity of international markets for a number of commodities.
3. A significant decline in the rate of export growth that faces the United States (from the less-developed, the industrialized, and the Communist countries), in part, due to the rapid increase in competitive supplies available from other agricultural exporting countries, for example, Brazil and Argentina.
4. The record crops that occurred in 1981 and 1982 which brought significant pressure on spot markets and led to market prices that enhanced the attractiveness of the farmer-owned reserve that was established by the Food and Agriculture Act of 1977 and continued under the Act of 1981.^{1/}

The deflation in agricultural commodity markets, along with the increasing attractiveness of financial assets, has resulted in some rather dramatic decreases in agricultural asset values, particularly land prices. Due to the role of land resources as collateral for agricultural loans and credit lines,

the apparent debt-absorption capacity of U. S. agriculture has fallen markedly. This is evidenced by the increased frequency of bankruptcies in the agricultural production sector and by what has come to be called the agricultural financial crisis of 1984.

In the decade of the 1970s, conditions in the U. S. general economy and the international economy are almost the exact opposite of the conditions that existed in much of the 1980s. In 1972-73, the magnitude of increases in farm product and food prices surprised even the most informed people within the public and private sectors. The move to flexible exchange rates, the rapid expansion of international markets, the emergence of a well-integrated international capital market, and the decreasing barriers between the agricultural economy and other domestic economic sectors all resulted in significant changes in the agricultural sector. During this period, the Federal Reserve expanded the U. S. money supply with the effective objective of holding the real price of energy at basically the same level; other countries attempted to "inflate their way out" of the energy price shocks by increasing their money supplies. They also attempted to manage their exchange rates with the U. S. dollar by selling their currencies and buying dollars and, thus, indirectly increasing their money supplies even more. These monetary phenomena, combined with the following factors, pointed in the same direction of rapidly increasing agricultural commodity prices.

1. The declining value of the U. S. dollar on international currency markets.

2. The barriers to trade which insulated many countries from the price-formation process on international markets and, thus, eliminated potential supply responses to the favorable prices and made international markets "thinner" than they otherwise would have been.
3. The "real" export demand growth in a number of less-developed countries (LDC) along with industrialized and Communist countries improving or upgrading the diet of their consuming population.
4. The elimination of the huge governmental stocks that had accumulated during the 1960s, resulting from the U. S. government holding price supports above market equilibrium prices and motivated by the huge U. S. Treasury exposure of carrying large public stocks.^{2/}

The increases in commodity prices, along with the rapid rate of inflation experienced in 1972-1974 and again in 1978-1980, resulted in a dramatic move in the valuation of the major resource input in agricultural production, namely, land. The price increases in land values indeed increased more than almost all other assets in the U. S. economy. Due to the distinction between tax rates on earned income and on capital gain income, U. S. agricultural land prices increased at a more rapid rate than the rate of inflation during much of the 1970s. Once again, due to the role of this resource input in agricultural credit markets, viz., its use as collateral for agricultural loans and credit lines, the total absorption capacity of U. S. agriculture for debt appeared to be augmented by leaps and bounds during the decade of the 1970s.

Hence, beginning in the early 1970s, the U. S. agricultural sector has been subjected to a vicious roller-coaster ride, the valleys and peaks of which have been defined in part by the external linkages to the U. S. macro-economy and the international economy. To be sure, the external linkages with the domestic economy and with the international economy have made it crystal clear that timing, in terms of entry and exit from U. S. agricultural production, is indeed critical. New entrants into agricultural production, prior to 1972, are doing quite nicely even in the face of the rapid declines that have occurred in asset values and in income levels during the 1980s. In fact, on the basis of asset values alone, such owners of agricultural land could be totally incompetent at farming and still have benefited substantially from their investment. Currently, anyone entering agricultural production during the period of 1978 through 1980 is either on the verge of bankruptcy or has an independent source of wealth and income, independently of how effective he or she might be as a farming entrepreneur or manager.

In addition to the external linkages with the domestic and international economies, government commodity policies continue to play a major role in determining the course and path of the U. S. agricultural sector. Numerous surveys and evaluations of U. S. agricultural policy have been conducted (Brandow; Gardner; Rausser and Farrell),^{3/} and many views exist on the formal justification for governmental intervention. As argued at some length in Just and Rausser,^{4/} only market failure justification for government intervention is excessive uncertainty or unanticipated instability.

Prior to 1972, the common explanations for this instability were the in-elastic nature of aggregate food demand; the low income elasticity of demand;

and, on the supply side, weather patterns, rapid technological change, atomistic behavior (and, in some treatments, naive price expectations), and asset fixity.^{5/} These characteristics were viewed as existing in a closed, insulated representation of the U. S. agricultural sector. Without governmental intervention, the inherent and unanticipated instability resulting from these characteristics was regarded by many to be unacceptable to all actors in the food and agricultural system: input suppliers, producers, assemblers, processors, distributors, and consumers.

Long ago, Keynes^{6/} argued that the inherent instability in storable commodity markets would lead to insufficient private stockholding. Risks associated with price volatility, coupled with uncertainty about the ultimate "normal price," and the length of time that stocks would have to be held were viewed as the three major contributing factors for this outcome. Keynes argued, as Houthakker^{7/} did some years later, that government intervention was needed because of divergence between social and private risks. Bosworth and Lawrence^{8/} consider this perspective along with a number of other justifications for government interventions to stabilize the prices of volatile commodities and come to the conclusion that the divergence between social and private benefits provides the best justification. In particular, private stockholders will not store for extreme contingencies because they do not expect to receive the true scarcity value of their stocks during such periods.

Since 1972, the conventional wisdom has placed increasingly less emphasis on the inherent instability in commodity markets and more emphasis on external linkages with other markets. During this period, the deregulation of the credit and banking system resulted in a greater exposure of agriculture to conditions in the domestic money markets. Also, because of the shift from

fixed exchange rates to flexible rates, commodity markets have become more exposed to international money markets and real trade among countries. Moreover, the emergence during this period of a well-integrated international capital market meant that agriculture, through domestic money and exchange rate markets, has become increasingly more dependent on capital flows among countries.^{9/}

Government behavior has also played an important role in commodity market instability. After the Soviet grain deal, the absence of government-held stocks contributed to the large price increases. With the Food and Agriculture Act of 1977, changes in the commodity programs were introduced which permitted a wider fluctuation in prices. The export embargo in 1980, variations on the rules of the Farm-Owned Reserve program since 1980, and the payment-in-kind (PIK) program of 1983, to name but a few major changes in government agricultural programs, make it clear that policy uncertainty can be a major contributor to private commodity market instability. In addition, the mere existence of governments is a major reason why private stockholders may not store for extreme contingencies and, thus, provide needed price stabilization. History reveals that it is difficult for governments to resist taking actions that interfere with the market system during periods of shortage.^{10/}

Since 1972, the greater dependence on trade has exposed U. S. agriculture to more shocks from foreign markets. Consistent with increased dependence on trade for the world economy as a whole, U. S. agriculture is heavily dependent on exports. In the late 1970s, U. S. agricultural exports accounted for almost 40 percent of total output. In addition, agricultural exports represent approximately 20 percent of the total U. S. exports. Net agricultural exports consistently make a positive contribution to the balance of payments, while

the nonagricultural sector is a net importer. To be sure, this increased dependence has made U. S. agriculture less stable due, in part, to the emergence of the Soviet Union, with its unstable agriculture, as a major importer and due to barriers to trade which cause changes in foreign markets to be borne by the United States and other exporting countries who practice relatively free trade.

The linkages of commodity markets with U. S. money markets is indeed pervasive. Since farming is extremely capital intensive^{11/} and debt-to-asset ratios have risen dramatically over the last 10 years, movements in real interest rates have significant effects on the cost structure facing agricultural production. Stock carrying in storable commodity systems is sensitive to changes in interest rates; and for nonstorable commodities (for example, live cattle and live hogs), breeding stocks are interest-rate sensitive. These effects, combined with the influence of interest rates on the value of the dollar, press grain products from both the demand side (for example, export demand, domestic livestock grain demand, and stockholding demand) and the cost side. The especially sensitive nature of agriculture to interest rates suggests that this sector is vulnerable to monetary and fiscal policy changes. It has been argued that, since 1972 but particularly since 1980, the instabilities in monetary and fiscal policies have contributed importantly to the instabilities of commodity markets.^{12/}

There is ample evidence that the U. S. agricultural sector has become more closely related, due to deregulation and the introduction of completely flexible exchange and interest rates, to the rest of the domestic and international economies. The instability in monetary and fiscal policies is thought

to have imposed sizable shocks on commodity markets. If agricultural commodity markets behave as "flex price" while other markets behave as "fixed price," "macro externalities" will be imposed upon the agricultural sector. Flex-price commodity markets and fixed-price nonagricultural output markets mean that overshooting in agricultural sector markets will occur even if expectations are formed nationally. Such overshooting results from the spillover effects of monetary and fiscal policy on commodity markets.^{13/}

Overshooting can introduce further instabilities into a sector that is already inherently unstable. These overshooting externalities can assume the form of implicit taxes or subsidies. For example, high and volatile interest and exchange rates, along with corresponding contractions in world income and agricultural export demand facing the United States all reinforce each other in calling for resources to move out of agricultural production. Only in this fashion will the agricultural sector reach an equilibrium with the balance of the U. S. economy. But agriculture's capital intensity and its major dependence on international trade have meant that farmers, without governmental intervention, are faced with a painful adjustment tax. Over the period 1980-1983, this tax took the form of higher interest payments and lower commodity prices for goods whose supply was not shrinking fast enough. An additional tax was imposed in the form of a significant drop in farmers' stock of wealth. Precisely the opposite situation occurred in 1973-1975. The externalities during this period assumed the form of subsidies. These subsidies led to the accumulation of wealth through the large increases in land values.

Given the above perspective, a number of basic questions arise. First, is the above story consistent with the empirical facts? Second, what are the major linkages between and among the macroeconomy, international economy, and

agricultural economy? Third, what is the order of magnitude of effects of policy changes originating in agriculture, the macroeconomy, and the international economy on the three sectors after consideration of the direct, indirect, and feedback effects? Fourth, given the importance of agriculture in the U. S. economy [food products contribute approximately 20 percent to the weight of the consumer price index (CPI)], what role have commodity markets had on the path (inflationary or deflationary) of general economy wages and prices? Fifth, what is the differential impact of macroeconomic policies (fiscal and monetary) versus agricultural sector policies on the performance of the U. S. agricultural sector? Sixth, should agricultural sector policies be conditional on shocks to macroeconomy and international economy emanating from U. S. fiscal and monetary policies?

The present study will only provide partial answers to the above list of questions. A principal constraint facing any empirical attempt to address these questions is the lack of sample data on flexible exchange rates and interest rates facing the U. S. agricultural sector. In the case of flexible exchange rates, approximately ten years of data are available; in the case of truly flexible interest rates facing agriculture, only four years of data are available. In any event, an attempt to answer these questions begins with a brief literature review in Chapter 2 followed by specification of the macroeconomy, the international economy, and the agricultural sector economy in Chapter 3. Appendix A provides a complete listing of all variables, endogenous and exogenous, appearing in the specification of each of the three components and selected estimated equations. Chapter 4 reports some simulation experiments, while Chapter 5 presents the major results and implications for agricultural policy choices in 1985 and beyond.

Chapter 2

Conceptual Frameworks and Empirical Evidence

The available theoretical and empirical evidence on the three major components under examination has been reviewed and evaluated in Rausser.^{1/} The review, from the perspective of U. S. agricultural policy, strongly suggests that what is missing is an integrative focus on the role of (1) the general price level (inflation or deflation); (2) exchange rates; (3) the effect of sector versus general economic policies; and (4) the major linkages between the domestic macroeconomy, the international economy, and the agricultural economy. Various separable elements of these concerns are available in existing conceptual frameworks. These elements will be discussed here briefly prior to moving on to the model structure specified in Chapter 3.

General Price Level and the Nonneutrality of Money

Among the first evaluations of food prices and inflation were those published by Hathaway.^{2/} He argued that food price inflation in the early 1970s was largely the result of increased demand and production shortfalls. D. Gale Johnson^{3/} argued, by contrast, that the large price increases in international markets occurred primarily because consumers and producers were prevented from reacting to price changes that resulted from governmental policies designed to stabilize domestic prices. In his view, all of the adjustment to the production shortfalls and demand increases was imposed upon a rather limited segment of the worldwide market for commodities. In support, he offered the classic example of sugar prices from early 1974 through early 1975.

An additional explanation by Bosworth and Lawrence^{4/} emphasized the role of speculators in this price explosion. Commodities were treated as assets as

well as inputs into consumption. They argue against the view that a rise in primary commodity prices represents solely a change in relative prices.

Some have argued that the rapid accumulation of international monetary reserves is a source of the disturbances. However, the transition mechanism between reserves and commodity prices has not been modeled adequately. Lawrence^{5/} has noted that the consequences of international monetary reserves on commodity market behavior can be appreciated fully only when these markets are embedded in a general equilibrium model of a dualistic economy which has both auction (flex) and customer (fixed) markets. A formal model of a dualistic economy is developed which includes three markets: a money market, a primary commodity market that clears in the short run by price adjustments, and a manufactured goods market that clears in the short run by quantity adjustments. Because expectations are presumed to be rational, in the long run nominal changes are neutral; but, in the short run, unanticipated monetary disturbances affect relative commodity prices. Commodity booms may stem from monetary factors in addition to changes in the conventional determinants of supply and demand. Monetary changes are allowed to operate through channels other than those of interest rates and the level of aggregate demand. For such a dualistic economy representation, macroeconomic externalities associated with commodity price fluctuations provide a rationale for direct governmental intervention.

In a frictionless classical framework with complete price flexibility, one-shot monetary disturbances will be neutral. Such frameworks have been referred to as monetarist-new classical models.^{6/} Other frameworks, however, imply different adjustment speeds in nominal variables and departures from money neutrality. In fact, investigations of the money neutrality

proposition have empirically addressed the "stickiness" of prices in various markets. If prices are sticky, quite obviously the strict monetarist proposition that money supply growth in excess of the growth in money demand instantly translates into rapid inflation does not hold.

The underlying forces that make some prices sticky do not, of course, hold to the same extent in all markets. Okun^{7/} has emphasized the distinction between manufactured goods and services, which he has referred to as customer markets, and basic commodity markets which he has referred to as auction markets. In this descriptive analysis, customer markets are characterized by imperfect competition, noninstantaneous arbitrage, and differentiated products which make the adjustments of prices to economic demand and supply forces sluggish. On the other hand, homogeneity and the ease of arbitrage make prices in auction markets instantaneously adjust to demand and supply forces. Perhaps more importantly, it has been demonstrated by Dornbusch^{8/} that, in an economy with both sticky prices and flexible prices, a monetary shock that leaves sticky prices unchanged in the short run causes the flexible price markets to overshoot their long-run equilibrium until all prices reach an equilibrium reflecting the initial monetary shock. As Frankel and Hardouvelis^{9/} point out, "This overshooting phenomenon can be thought of as a macroeconomic example of the Le Chatelier principle. Because one variable in the system (manufactured good prices) is not free to adjust, the other variables in the system (commodity prices) must jump correspondingly further in order to compensate" (page 4).

Conceptual and empirical validation of the fixed/flex price distinction, along with the overshooting phenomenon, has been addressed by a number of authors. Generally, the question that is investigated is not whether commodity prices respond instantaneously while manufactured prices do not but,

rather, whether commodity prices adjust at a faster rate than do manufactured or noncommodity prices. As early as 1975, Gordon^{10/} investigated the effect of aggregate excess demand on price movements and concluded that, while non-food prices are responsive to changes in the ratio of actual to potential income (defined as the inflationary gap), food prices were not found to be so affected. The conclusion drawn by Gordon^{11/} was that food prices adjust quickly to excess demand, while nonfood prices adjust very slowly.

In a subsequent investigation, Gordon^{12/} empirically investigated the Sargent-Wallace-Lucas (SWL) policy effectiveness argument. Here, Gordon^{13/} attempts to isolate those forces that dictate price stickiness. In particular, he focuses on adjustment costs, long-term contracts, and the decentralization of decision making. In the empirical analysis presented in this paper, price changes are related to changes in the inflationary gap, lag prices, and various forces representing supply shocks. Gordon^{14/} concludes that the empirical results obtained unambiguously reject the SWL proposition in favor of the notion of fixed-price markets. In particular, prices are found to respond slowly to changes in the ratio of current to natural output and respond only partially to expected money growth.

Bordo^{15/} has also investigated the differential rates of adjustments of sectoral prices to monetary changes. In essence, Bordo explains the pattern of industry and sectoral price response to monetary changes by implicit contract lengths. His framework implies that the degree of price flexibility across sectors can be represented by price variability in that sector. On the basis of this proposition, commodities respond more rapidly than manufactured goods to monetary changes. His empirical results validate the distinction between the behavior of auction markets that are characterized by price

flexibility and customer markets characterized by the use of long-term contracts and price inflexibility.

On the conceptual front, Mussa^{16/} has recognized the internal inconsistencies that arise when imposing rational expectations on models with sticky prices. To achieve consistency, Mussa has developed a price adjustment rule that ". . . circumvents these theoretical difficulties and analyzes the essential characteristics of this rule" (page 1021). The rule is derived from a microeconomic model in which there is an implicit cost in continuously changing prices; thus, it is optimal to adjust individual prices only at discrete intervals and by finite amounts. In essence, the rule provides for price changes at such frequencies so as to equate the marginal gains of reducing the losses from disequilibrium to the marginal costs of continuous price changes.

Along similar but more formal lines, Rotemberg^{17/} has developed a formal theoretical model from which fixed-price markets naturally emerge. Specifically, he constructs a dynamic model in which perceived costs of adjustments by firms play a dominant role. Empirical representations are derived that correspond to the fixed-price hypothesis. Empirical estimation of the theoretically derived price paths satisfy all the relevant theoretical constraints and appear to be robust. In other words, the empirical results support the fixed-price hypothesis. Moreover, a nested hypothesis of a "Walrasian adjustment" (instantaneous price adjustment to contemporaneous changes of money balances) is rejected by the data. The principal reasons for these results appear to be the small response of aggregate demand to changes in money balances and the high cost of changing prices. Among the more important results obtained by Rotemberg is the significance that is obtained when food

prices and fuel prices are removed from the price indices (gross domestic product price deflator). This result further supports the fixed-price/flex-price separation and differential responses to monetary growth.

In theoretical models which incorporate price stickiness, overshooting of flex-price markets is an obvious result. Very few direct tests of overshooting have, however, been conducted. To be sure, overshooting can only be tested in conjunction with a particular model specification. Thus, the results obtained depend, in part, upon the assumptions therein imposed. Several models of exchange rate determination have been advanced which lend indirect support for the price stickiness hypothesis as well as exchange rate overshooting. A direct test of whether overshooting can be validated for exchange rates has been conducted by Meese.^{20/} His results show that domestic and foreign prices for the United States, Germany, Japan, and the United Kingdom are predetermined with respect to the exchange rate. These results are also consistent with exchange rate overshooting.

Another model of the fixed-price/flex-price variety of the inflation process has been presented by Van Duyne^{21/}. In the long run, output in this model is supply determined; and the inflation rate depends solely on the rate of growth of the nominal money stock. In the short run, however, shocks to food prices can induce substantial and persistent bursts of inflation even if the rate of growth of the money supply is fixed. This framework is used to test the hypothesis that consumers' expectations are biased in the sense of their placing too much weight on the recent behavior of food prices. An acceptance of this hypothesis suggests that shocks to food prices may have magnified effects on subsequent rates of inflation. The empirical results obtained do not support this hypothesis; thus, Van Duyne argues that sectoral

anti-inflation policies, such as agricultural export controls and meat price ceilings, are less effective and, hence, less justifiable than is generally presumed.

Still other studies have emphasized the effect of inflation on the performance of the agricultural sector. Tweeten and Griffin^{22/} have investigated prices paid to, and received by, farmers relative to the general price level. This and other related studies incur possible specification errors by omitting other real factors determining prices received and paid. Several studies have investigated the effects of inflation on agricultural finance^{22/} and on farm assets and values.^{23/} In general, these studies support the view that inflation has real effects on the structure and performance of the agricultural production component and on income distribution.

Gardner^{24/} presents some ad hoc relationships for agriculture during recessions and inflations over the period 1976-1978. Not surprisingly, with only five years of data under a less-regulated agricultural sector, the major variables that possessed explanatory power are recessions and the exchange rate. More recently, Lombra and Mehra^{25/} investigated the dynamic relationship between an index of food prices and proxies representing monetary and fiscal policies. They found that money stock has a statistically significant cumulative effect on food prices, and this effect increases quantitatively as we move from the farm to the retail level.

Focus on Exchange Rates

The theory of exchange-rate determination has evolved from the traditional Keynesian^{26/} model to the modern asset-market portfolio balance approach--a

framework better suited to the analysis of inflation, expectations, and portfolio substitution. The role of the current account in influencing exchange rates has been integrated in the portfolio balance models of Branson; Kouri and Porter; and Rodriguez^{27/} and empirically tested by Hooper and Morton.^{28/}

The shift to flexible exchange rates adds a new dimension to the interdependence between the agricultural and nonagricultural sectors. In a regime of floating exchange rates, the equilibrium rate of exchange is not a price that equilibrates one particular market, such as the market for foreign exchange, or a price that assures flow equilibrium (balance of payments), or the price of relative monies determined in the asset markets (stock equilibrium). Rather, as Fair^{29/} notes:

The exchange rate is not in any rigorous sense determined either in a stock market or in the flow market. The exchange rate has an effect on many of the decisions of the economic agents in the model, decisions regarding both the stock and flow variables, and these decisions in turn affect a number of different markets.

The effects of exchange rates on U. S. agriculture were highlighted by Schuh.^{30/} He argued that the exchange rate was overvalued during the 1960s. This exacerbated the adjustment problems facing U. S. agriculture, and the devaluations and movement to flexible exchange rates during the 1970s led to significant structural changes. The movement away from the fixed exchange rate scheme made U. S. agriculture more vulnerable to international economic events and policies while, at the same time, freeing U. S. agriculture from the implicit export tax burden of the overvalued dollar in the latter days of the Bretton Woods Agreement.

Empirical analyses on the effects of exchange rates on agriculture include works by Chambers and Just.^{31/} The 1981 study constructed a dynamic, quarterly model to analyze the time path of effects of the exchange rate on prices received; quantities produced, consumption, exports, and inventory stocks for wheat, corn, and soybeans. Johnson, Grennes, and Thursby^{32/} have reported a similar analysis for the wheat commodity system. These empirical studies suggest that the exchange rate elasticity of price is greater than unity, that there is a complex time pattern of adjustment, and that the pattern differs across commodities. However, these empirical investigations are very partial in their perspective, ignoring any effects of exchange rate changes on domestic price inflation and incomes that, in turn, affect agricultural input costs and output demand. Shei^{33/} analyzes the effects of the devaluation on the general economy and supports the view that the partial equilibrium approach overestimates the domestic price effect of a devaluation on agricultural prices by a substantial margin.

Chambers and Just^{34/} continued their effort to examine the effects of exchange rates on U. S. agriculture by investigating the effects of monetary policy through its influence on the exchange rate. They augmented their model with an endogenous determination of exchange rates. This empirical framework allows the monetary effects to work their way exclusively through the exchange rate. However, the effects of changes in the monetary stock on interest rates, inventories, production costs, etc., are ignored.

Considerable controversy has arisen on whether exchange rates have real as well as nominal effects. In large part, the resolution of this controversy depends on rigidities in the economy, expectation formations on prices and further exchange rate changes, and whether the initial state is one of

equilibrium or disequilibrium. In any event, the principal factors and causal mechanisms determining exchange rates now that market forces (rather than governmental decree) play a dominant role have been subject to considerable debate. Focusing on the capital component of the balance of payments, there is a growing body of theory and empirical studies supporting the view that monetary and fiscal policies affect capital flows. This component, in turn, is an important causal force explaining short-term movements of exchange rates. Both Frankel and Driskill^{35/} provide supporting empirical studies for the monetary approach. These efforts, along with other studies on the traded goods and services component, suggest that the exchange rate and agriculture must be imbedded in the model which recognizes economywide behavior along with monetary, fiscal, and official foreign reserves policies.

The specification of exchange rate determination is intimately tied to the export demand relationships facing U. S. agricultural commodities. In most empirical studies to date, the exchange rate is treated as exogenous. Most operate with net export demand functions along the lines of Houthakker and Magee^{36/} and, thus, omit potential causal factors that are likely to bias estimates of export price elasticities downward. Bredahl, Meyers, and Collins^{38/} have specified a framework that allows for partial responses of domestic to world prices resulting from policy intrusions, transport cost, and product heterogeneity. (Work along similar lines in an empirical setting may be found in Abbott as well as P. R. Johnson.)^{38/} This work is motivated by the controversy surrounding the price transmission elasticity for different countries due to national agriculture and trade policies including the sensitivity of these policies to market conditions. For these reasons, empirical estimates of the export demand elasticities for particular commodities vary

widely. For aggregate net export demand in the United States, these estimates range from less than unity up to approximately ten. Operationally, it is indeed likely that the time path of adjustment will depend upon short-run inventories, lagged supply responses, and eventual policy reactions to market prices. Zwart and Mielke^{39/} have investigated these issues for wheat and argue, based on their results, that foreign policies have exaggerated the instability of world excess demand for U. S. agricultural commodities. This empirical work supports the views of D. Gale Johnson.^{40/}

Focus on General Economic Versus Sector Policies

Unfortunately, there has been little quantitative analysis on the effectiveness of general economic policies versus sector policies on the performance of the U. S. agricultural sector. In general, there remains a dearth of analysis on the indirect and feedback effects resulting from these two general types of policy interventions. The first empirical investigation points in the direction of the price and quantity interlinks among commodity policies, general inflation indices, the exchange rate, and aggregate economic activity; aggregate economic activity is based on the Wharton macro and agricultural sector econometric models.^{41/} In this study, the "parity price" values for nineteen commodities were introduced into the Wharton agricultural model using inputs from the Wharton macroeconomic model. The resulting simulations of the Wharton agricultural model were fed into the Wharton macro- econometric model to generate revised general inflation levels, national income levels, world trade, and related magnitudes. These revised values were, in turn, fed into the agricultural models, and the effects were evaluated. The simulation indicated large increases in farm income, the CPI, and U. S. Treasury costs with significant reductions in domestic and export demand.

A short-run theoretical model of the interaction between the financial and agricultural sectors has been developed by Chambers^{42/}. The model is used to examine the effects of monetary policy on the agricultural sector. The short-run effects are not neutral since agricultural prices are more flexible than nonagricultural prices. The theoretical results are explained by the effect of a restrictive monetary policy on commodity stockholding behavior and the decreased competitiveness of agriculture in world markets due to an increase in the exchange rate.

McCalla^{43/} has described the relationship between commodity markets and international liquidity, exchange rates, and money interventions using McKinnon's^{44/} basic results on currency substitution. Commodity price declines, according to McKinnon, were caused by a combination of tight monetary policy causing dollar revaluation and export demand reduction and also international portfolio substitutions away from commodities. Apart from the questions concerning currency substitutions, per se, several hypotheses advanced in the paper have to be tested before such explanations are given to commodity price variations.

Shei and Thomson,^{45/} following the earlier work of Shei,^{46/} advanced a model centered on the analysis of the relationship between inflation and agriculture by combining both structuralist and monetarist characteristics in the model. They consider as structural characteristics the differential path of adjustment among sectors--agriculture being the flex-price part and manufacturing and services being the fixed-price part. As monetarist characteristics, they consider the "autonomous" increases in prices caused by monetary increases. While this model has a number of the intersectoral linkages included, it omits the effects of interest rates on private and public grain

storage, most forms of agricultural policy instruments, and the dynamics of adjustment in the livestock component. Moreover, their model and simulations treat the exchange rate as fixed.

Major Linkages

The differential effects of macro versus agricultural policies cannot be determined without first capturing a number of major linkages, some representing causal influences from the macroeconomic sector to the agricultural sector and some running from the international component to the agricultural sector. Both types of causal influences are defined as forward linkages. The opposite effects, that is, those that run from the agricultural component to the macroeconomic or the international economic components, are defined as backward linkages. In addition to forward and backward linkages, there are potentially important linkages between U. S. monetary policy and foreign monetary policies. Each of these linkages is examined in this subsection.

Forward Linkages. Macroeconomic variables should be integrated into the agricultural sector wherever they are theoretically relevant. The most important linkages are observed in acreage, yield, demand, and inventory behavior. The macroeconomic variables included in these linkages are interest rates, personal income, nonfood and general inflation rates, and energy costs.

An increase in interest rates will have several direct effects on the agricultural sector. The most immediate impact will be on inventory behavior. Within the grain sector, rising interest rates will result in the movement of grain from private positions into government positions including the farmer-owned reserve and the Commodity Credit Corporation (CCC) inventories or the selling of grain on spot markets. Moving grain into government

positions allows farmers to gain the benefit of subsidized interest rates offered by the CCC, while selling grain reduces interest costs to zero. Since some farmers may not be eligible for the benefits of the farmer-owned reserve or CCC nonrecourse loans, their only alternative may be to sell grain on the spot market.

Within the livestock sector, rising interest rates make it more costly for livestock producers to hold breeding animals. Therefore, in the short term, higher interest rates will lead to slaughter of breeding inventories. Other short-term effects include (1) reduced feed demand since it becomes more costly to hold livestock to heavier weights; (2) reduced acreage since, all else constant, an increase in interest rates both increases production costs and increases the implicit interest subsidy offered by the CCC and, therefore, increases the incentive to participate in any acreage reduction programs that may be offered; and (3) increased yield per planted acre since increased participation in acreage reduction programs allows farmers to take their least productive land out of production.

The short-term impacts of these changes include (1) movement of grain into the farmer-owned reserve which "insulates" that grain from the market so that it has a less depressing effect on price, (2) pressure for lower grain prices because higher interest rates may lead to more grain being sold by farmers who are not eligible for the government storage programs, and (3) pressure for lower meat prices because increased slaughter of breeding animals will lead to higher meat supply and a lower price. Which of these effects dominates depends on the current levels of all the variables and on the magnitude of the change in the interest rate. However, the crop production effect will probably be small; and, in most cases, the pressures for lower prices will outweigh

the pressures for higher prices. All else constant, a sudden rise in interest rates will result in a fall in meat prices.

The longer term impacts of these changes will lead to pressure for higher grain prices. This will occur in the intermediate run because there will be less grain stored in private inventory positions than in the case with lower interest rates, and less grain will be in total inventories because larger quantities will have been consumed after the rise in interest rates. Later, pressure will be felt for lower grain prices because grain must be removed from the farmer-owned reserve if the market price reaches the call level (at least historically), or the government must take possession of the farmer-owned reserve grain at the end of three years. In either case, the effect is to depress prices. Pressure for higher meat prices will be felt in the longer run because there will be fewer breeding animals and, therefore, fewer placements of animals on feed and a smaller meat supply.

An increase in the CPI will primarily affect the consumer market for agricultural commodities. In the short term, an increase in the CPI can have two possible effects, depending on the behavior of wages. If wages increase at the same rate as the general price level and no monetary illusion exists, then an increase in the CPI will have no impact on the demand for agricultural commodities. If wages increase at a slower rate than the CPI, then the demand for agricultural commodities, in particular beef, will fall. In general, only changes in relative prices will affect demand for agricultural commodities over both the short and long runs.

If demand for beef does fall as a result of a decrease in real wages, this will result in a decline in beef prices and a possible decline in pork and broiler prices because these are substitutable commodities. However, previous

studies suggest that, for pork and broilers, a decrease in real income may cause a greater expansion in demand for these goods than the increase in demand caused by the substitution effect away from beef. Therefore, the price of pork and broilers may fall or rise from an increase in prices where wages do not keep up. These ambiguous results hold for both the short and long terms.

An increase in the nonfood CPI results in increased costs of producing crops and changes in relative prices associated with meat demands and food demand for wheat. Increased production costs will result in reduced crop production and, perhaps, some substitution among competing crop enterprises. In general, increases in the nonfood CPI will result in only small changes in food consumption. In the short run, increases in the nonfood CPI will have little impact on prices. However, in the longer run, higher crop prices should result.

Crop production requires both direct energy inputs (for example, fuel for tractors) and indirect energy inputs (for example, fertilizer). Thus, higher energy costs are associated with increased crop production costs. As with increases in the nonfood CPI, increases in energy costs will result in reduced crop production and higher long-term crop prices.

Backward Linkages. There are three main influences in the macroeconomy which reflect backward linkages from the agricultural sector. The three linkages are reflected in the CPI, endogenous deficits, and the effects on the balance of trade.

Food prices, represented by grain and livestock prices, are determined endogenously within the agricultural sector. Grain prices are determined at

the farm level, and these influence the production of livestock and, hence, retail livestock prices. The set of prices then is converted into an index of food prices--one component of the overall CPI. The food CPI linkage is important everywhere that the CPI enters the macroeconomic model. These linkages occur in any equation for which variables, such as income, are deflated by the CPI as well as equations with the CPI entering as a separate explanatory variable.

A second linkage from the agricultural sector to the macroeconomy is through agricultural program expenditures. Operation of government storage programs and deficiency payments are examples of legislated expenditures which are fixed in contrast to much of the nonfarm components of the budget and which are likely to be fixed in dollar terms. The outcome for prices, production, private storage, and other variables endogenous to the agricultural sector thus determines the level of government spending on agriculture and its contribution to deficits. As government expenditures rise, the gross national product (GNP) increases; and this enters into consumption, investment, etc. There are multiplier effects leading to further increases in the GNP and in taxes.

Finally, the level of agricultural exports is a third linkage. *Ceteris paribus*, an increase in agricultural exports would be expected to increase the value of the dollar. Since the increase in exports leads to an increase in GNP, this is captured by the inclusion of GNP of the United States in the exchange rate equation.

International Monetary Linkages. In addition to the above linkages between the agricultural and domestic macroeconomic sectors, there are possibly important linkages between U. S. monetary policy and foreign banks' policies.

To the extent that such interdependence exists, it represents another linkage between the domestic macroeconomic sector and agriculture. As U. S. monetary policy changes, if there are responses in the rest of the world which affect foreign GNP, exchange rates, or prices, this will translate into shifts in the export demand curve faced by U. S. agricultural producers. Monetary interdependence is generally recognized to exist in fixed exchange rate regimes, while one of the arguments advanced by proponents of flexible exchange rates includes "monetary independence." The presence of currency substitution, however, suggests that this basis for flexible exchange rates is invalid.

Under fixed-rate regimes, such as the monetary system set up by the Bretton Woods Agreement, central banks are compelled to engage in interventions in currency markets to maintain a fixed exchange value of their domestic currency vis-à-vis foreign currencies. This is in contrast to the case of flexible rates where no such intervention is necessary; while monetary authorities may still engage in intervention to affect the foreign exchange value of domestic money, such actions become discretionary. The monetary independence result follows from the observation that, under fixed-rate regimes when one country follows a particular monetary policy, say, an expansionary one, if that policy creates pressure on the rate of exchange with another currency, a response is called for by central banks abroad. For the present example, foreign monetary authorities are compelled to engage in a similar expansionary monetary policy when they observe a tendency for their currency to appreciate. Thus, the country beginning the process is said to have "exported" its inflation. When exchange rates are flexible, no such obligation exists on the part of central banks; only if they act to maintain exchange rates within a certain band (for example, by following the U. S. lead and inflating their currency)--in a "managed float"--can inflation be exported by other countries.

McKinnon^{47/} and others have argued in recent years that the monetary independence argument for flexible exchange rates involves an untested assumption about the portfolios of moneyholders. In order for monetary independence to hold, it must be assumed that the country in question is an "insular" economy, at least as far as money demand is concerned. Moneyholders must substitute foreign currency holdings when the domestic currency becomes less desirable and vice versa. If this does not hold, currency substitution implies that the effects of domestic monetary policy are exported even under perfectly flexible rates.

This exporting of monetary policy and resulting loss of independence can occur in two ways. Each scenario follows an essentially monetarist treatment of the effects of monetary policy, with short-run effects on real variables such as income. First, suppose that foreign monetary authorities target a growth rate for foreign currency consistent with objectives for unemployment, interest rates, or some other variable or mix of variables, based on their expectations of the demand for that currency. In the case of substitution between currencies, such a targeted growth rate is also conditional on expected money growth abroad. If the United States engages in some unanticipated monetary policy, say, expansion, there will be an increase in the demand for the foreign currency if expansionary policies in the United States are expected to depreciate the value of the dollar. The upshot is that the foreign monetary authorities will have underanticipated money demand, and their monetary policy will then be more restrictive than was desired. Independence from U. S. policies of the operation of foreign monetary policy is lost.

A second possibility is that the foreign authorities are able to recognize the unanticipated shift in U. S. monetary policy quickly. In that case, they

may act so as to maintain the value of their currency rather than to allow it to appreciate. They accommodate the U. S. money growth by responding with the same policy. Money is no longer as tight in the foreign country, but the result is an even greater increase in the world money supply. This is exactly the phenomenon McKinnon^{48/} has claimed is responsible for the rapid worldwide inflation of the 1970s.

Currency substitution has interesting implications for the agricultural, domestic macroeconomic, and international sectors. In particular, a new linkage of agricultural and nonagricultural variables is introduced. The direct effect of monetary policy on agriculture through exchange rates and interest rates is straightforward. However, domestic monetary policy also affects money growth abroad, under currency substitution, and real variables such as income. These feedback effects from U. S. money supply to foreign currencies work in addition to direct effects through financial markets--the changes in the growth rates of foreign currency will affect foreign income. Foreign income, in turn, is an important variable in the demand for U. S. agricultural exports as increased income abroad will lead to greater consumption through an income effect. Either of the currency substitution scenarios described above can cause this income effect.

It is interesting to note that, depending on whether the result is for foreign monetary policy to be more or less restrictive than originally intended, U. S. agricultural exports can either fail or rise relative to the monetary independence outcome. The magnitude of foreign income effects and the resulting change in export demand will depend on the extent to which economic agents abroad failed to anticipate the change in monetary policy following the U. S. policy change. As long as any part of the change in money growth is unanticipated, real effects on income and other variables result.

The offsetting changes in money growth rates required in the presence of currency substitution and monetary interdependence can be thought of as sterilization of the effects of the unanticipated money shocks from abroad. It is important to distinguish our use of the word from the conventional sterilization of reserve flows. The usual interpretation involves the central bank intervening in the currency market, say, to prevent its currency from depreciation. Since this involves buying its currency for either bonds or foreign exchange, there is a reduction in the money stock. Sterilization would involve an offsetting expansion of domestic money so as to maintain previous growth targets. However, there is no clear reason for such an operation; as long as capital is mobile, the sterilization operation will restore the currency to a situation of excess supply. The so-called sterilization of the effects of intervention in exchange markets does, indeed, leave the total money stock unchanged; but the situation of excess currency supply is also unchanged.

Our use of sterilization involves a different concept. We assume that the central bank targets the growth rate of some monetary aggregate, based on desired levels of unemployment, interest rates, etc. This will involve some forecast of money demand, both by domestic resident and foreign holders of the currency. The foreign demand, in the presence of currency substitution, will be a function of foreign banks' policies, requiring that these also be forecast. When there is some unanticipated shift in monetary policy abroad, then there will be a shift in money demand which leaves the original target either too restrictive or too easy in comparison with the levels of money growth consistent with original goals.

It will, therefore, be necessary to adjust monetary growth to accommodate or sterilize the unanticipated change in money demand. To the extent that monetary authorities are able to make this adjustment and to the extent that moneyholders do not perceive this as a shift in policy but merely a response to other central banks' policies, there will be no real effects. More likely, there will be shocks in real variables, such as income and the real rate of interest, as the unanticipated money growth is discovered by moneyholders. To incorporate this effect in the most general way, a set of reaction functions measuring monetary interdependence could be added to the model. This would complete the linkage between U. S. monetary policy and domestic agriculture operating through effects on foreign income. As interdependence becomes important, foreign GNP and other variables become endogenous to the model.

While theoretically satisfying, the empirical significance of currency substitution has yet to be either demonstrated or rejected conclusively. McKinnon^{49/} has presented some evidence in support, while a recent study by Batten and Hafer^{50/} finds that changes in the rate of return to holding foreign currencies seem to have little effect on the demand for domestic money. Related empirical work by Grilli and Yang^{51/} illustrates the role of increases in worldwide liquidity in explaining the inflation of primary commodity prices. Currency substitution exacerbates this growth in liquidity and, therefore, in commodity prices. While empirical determination of the real effects of currency substitution remains an open question, its presence introduces another linkage between monetary policies and agricultural markets.

The most recent major effort at conceptualizing and empiricizing most of the major linkages described above is in the work of Freebairn et al.^{52/} that reports a detailed agricultural sector (crops, livestock, dairy, and

poultry) and a small demand-side macro model. Their improvements over previous studies include endogenizing the international sector (exchange rates) and direct links from the macroeconomy to agriculture (for example, interest rates on inventories and price/wage inflation on agricultural supply through variable costs) and the influence of certain key agricultural policies.

The agricultural sector representation, advanced in the present study, is a condensed and improved version of the agricultural component appearing in the Freebairn et al. work. The international and macroeconomic components of Freebairn et al. have been altered substantially. A behavioral determination of exchange rates has been introduced, and a more detailed monetary sector subcomponent has been constructed. These revisions are based, in part, upon the work of Stamoulis,^{53/} especially his treatment of the origins of monetary control in both domestic and international money markets.

Chapter 3

Model Structure

The questions posed at the end of Chapter 1 dictate a model structure which concentrates upon the effects of macroeconomic and agricultural sector policies. For this reason, the model structure advanced here is guided by the principal purpose of policy analysis. The version of the specified model is not intended to serve as a forecasting tool. At this juncture, the model is only a preliminary attempt to assess the effects of policy changes and of other exogenous shocks in one sector on each of the three components. In particular, the model structure must be able to assess the effect of (1) sectoral policies on agriculture, (2) the resulting endogenous variables in the agricultural sector on the general economy, (3) fiscal and monetary policies on the general economy, and (4) the resulting general economy endogenous variables on the agricultural sector. This is accomplished by treating endogenously the links among U. S. agriculture, the U. S. general economy, and the international economy.

Previously developed conceptual frameworks and empirical analysis provide the building blocks of an integrative framework which attempts to capture the interrelationships among agriculture, the domestic economy, and the international economy. These interrelationships establish a dynamic pattern of feedback effects among prices, outputs, and incomes among the different sectors. Only a general equilibrium representation of these interrelationships allows analysis of the full effects of the agricultural sector, general economy, and trade policies. In what follows, the specified structure of each component (macroeconomy, international, and agriculture) is briefly developed.

Structure of the Macroeconomy

There are at least three major specifications that could be advanced for the macroeconomy component: (1) new classical and monetarist, (2) Keynesian, and (3) neo-Keynesian. In (1), price determination occurs in flex-price of auction markets with relative prices set by a neoclassical general equilibrium market; and the general price level closely follows the rate of monetary expansion. Expectations are rational, the Phillips curve is vertical, and a monetary exchange rate approach is taken to explain the balance of payments. The Keynesian framework, (2), is well known and need not be repeated here. The third framework, (3), follows the fixed-flex price determination advanced by Hicks^{1/} and elaborated on by Okun.^{2/} The macroeconomic representation of (3) contains a number of customer markets. In these markets, prices are sticky due to contracts which set prices (based upon economic forces in some previous period) and, thus, disequilibrium output adjustments are required.

Macro externalities or overshooting can be imposed upon the agricultural sector under (2) and (3), but no externalities are admitted by (1). The model advanced in the present study for the macroeconomy component can be described as a demand-side neo-Keynesian sticky-price framework. Its fixed-price character comes from the specification that prices adjust slowly to changes in excess demand through an expectations-augmented Phillips curve. The major subcomponents of the specified structure are aggregate consumption, aggregate domestic investment, domestic monetary sector, Phillips curve relationship, domestic income sector, and government finance sector. A complete listing of the endogenous variables for each of these subcomponents is provided in Appendix A. Aggregate domestic demand is composed of equations for private

consumption expenditure, private fixed-capital investment, change in inventories, and government expenditure. Interest rates influence private expenditures. Aggregate supply is represented by price and wage equations. Nonagricultural prices are determined as a markup over wages (adjusted for productivity) and material costs. A price expectation formation process, based upon expected money growth, is used to construct an expectations-augmented Phillips curve to explain nonfarm price-wage relationships. These equations provide the key relationships determining prices, wages, and real income. The general price level, which also enters the wage equation, is a weighted average of nonfarm prices and food prices. A conventional money demand equation and changes in reserve movements are used to determine short-term and long-run interest rates.

In specifying the macroeconomy component, particular attention was paid to a framework that easily handles fiscal and monetary policies as well as agricultural policies. As a result, the framework incorporates a series of links with the agricultural sector and a series of important policy instruments--both monetary and fiscal. As revealed in Figure 1, a high degree of interaction exists between the subcomponents of the macro model. For linkages within the income-determining subcomponent, aggregate income and its elements (consumption and investment) are linked such that changes in any of the elements bring about changes in income through the GNP identity and through multiplier effects appearing in the individual equations of consumption and investment. An increase in aggregate income flows into the monetary sector through an increase in aggregate demand. It leads to an increase in the total demand for money and an increase in the yield on bonds as demand for credit increases for new investment. As the gap between current and potential income

closes, employment tends to rise as do wages and prices. Linkages with the international economy component, revealed in Figure 1, lead to an increase in imports and appreciation in the exchange rate as the domestic demand for money rises, provided that domestic money supply remains fixed. For the financial sector of the model, an increase in nonborrowed reserves tends to reduce short-term interest rates and, consequently, long-term interest rates.

The government finance sector includes an equation determining total tax collections by the federal government which is affected by changes in nominal GNP. Increases in tax collections help finance the deficit and, also, reduce disposable income which is endogenously determined by income and taxes. As implied in Appendix A, two different formulations on nonborrowed revenues and changes in government debt outstanding allow two scenarios for financing government deficits.

Because of the importance of monetary policy, the change in policy regimes from controlling interest rates to controlling the money stock is reflected in the specification of the monetary-financial sector. A monetary policy shock has a number of effects. For example, if the shock assumes the form of an increase in money growth rates, short-run interest rates will decrease because of increases in nonborrowed reserves of commercial banks and relative credit availability. The decrease has spillover effects on the long-term instruments and tends to drive the long-term bond rate down. This tends to increase investment, GNP, etc. As argued in the section on "Structure of the International Economy," it also affects the exchange rate directly and indirectly (through changes in short-run interest rates). It creates inflationary expectations to the extent that part of the shock (increase in this case) is considered to be permanent. Those expectations feed directly into the price level through the expectations-augmented Phillips curve.

The monetary sector of the macroeconomy component and the associated actions of the Federal Reserve Bank's accommodation-nonaccommodation of the government deficit/surplus (or sterilization-nonsterilization of foreign reserves) may be represented in many different forms. In the specification advanced here, three identities will form the basis for the role of the Federal Reserve and the interaction among money creation, deficit spending, and government debt holding. These identities are:

$$G - T = \Delta B_d + \Delta B_{cb} + \Delta B_f \quad (\text{government deficits})$$

$$CA + KA + ORT = 0 \quad (\text{current account})$$

$$\Delta B_{cb} - ORT = \Delta MB \quad (\text{monetary base})$$

where

G = government expenditures

T = taxes (net transfers to public sector)

ΔB_d = net change in domestic holdings of government bonds

ΔB_{cb} = net change in the Federal Reserve Banks' holdings of government bonds

ΔB_f = net change in foreign holdings of government bonds

CA = current account

KA = capital account

ORT = official foreign reserve transactions

and

ΔMB = change in the monetary base (high-powered money).

Note that G and T are part of the demand model of the macroeconomy model; and CA , KA , and ORT are as defined in the balance-of-payments equations appearing

in the international economy component. The government deficit equation is defined to be the government budget constraint, and the budget surplus/deficit is financed through bond purchases/sales by the U. S. Treasury.

Two extreme cases illustrate the workings of the government deficit identity. If the entire deficit is publicly financed, then the change in Federal Reserve bond holdings is zero; investors finance the deficit by accepting additional government securities. On the other hand, complete monetization of the deficit occurs if the Federal Reserve engages in open-market operations creating money by buying bonds. This increases the stock of high-powered money and Federal Reserve holdings of government securities. Thus, the money supply, rather than the supply of bonds held by the public, is increased; and the deficit is financed by money supply creation.

At the same time, there is also a constraint on the operations of the central bank which holds under fixed or flexible exchange rates. This is a condition on the international transactions of the United States reflected by the current account identity. Under fixed exchange rates, official reserve transactions are dictated by the other two balances and are necessary to offset excess demand or supply for dollars without exchange rate movements. Under floating rates, the exchange rate adjusts in a manner consistent with this identity, and there is no need for official reserve transactions.

The final identity relates to the creation of high-powered money or monetary base. The difference between the change in bond holdings by the Federal Reserve and the official reserve transactions is the change in high-powered money. In the more general case, the first term, representing the monetization of the debt, creates money since the Federal Reserve's open-market operations involve the purchase of bonds which are paid for by increasing its

liabilities to the banking sector. However, to the extent that bonds are acquired through official reserve transactions and then sold to the general public through the opposite open-market operation, the change in monetary base is offset.

Our money supply process reflects the latest Federal Reserve Banks' operating procedures of controlling the monetary aggregates through control of the banks' nonborrowed reserves. Conceptually, a change in nonborrowed reserves because of open-market operations by the Federal Reserve will tend to change the federal funds rate since banks will have to secure the necessary reserves to cover reserve requirements. This change in the federal funds rate will subsequently spread through the system and change the rates across the whole maturity spectrum.

Thus, the model specification basically considers the Federal Reserve as conducting monetary policy in a discretionary fashion. However, note that, as shall be demonstrated later, other possible frameworks can be advanced. Discretion of the Federal Reserve is exercised in terms of whether or not and to what extent they conduct open-market operations.

The model of the monetary process does not treat bank behavior explicitly. Instead, it moves directly from the federal government finance sector to the interest rates. Modeling the market for reserves is a tedious process and not necessary for our purposes. In any event, the monetary equilibrium can be summarized by two equations:

$$G - T - ORT = \Delta B_d + \Delta B_f + \Delta MB$$

and the equilibrium condition in the money market. The interest rate is determined by the money market equilibrium condition. Changes in the interest

rate directly affect private expenditure decisions in the rest of the domestic economy and a number of relationships in the international and agricultural economy components.

Note that the government deficit equation can be decomposed to permit the endogenous variables of the agricultural sector to be jointly determined with the government finance sector. When particular conditions in agricultural markets make necessary some expenditures, as part of agricultural policies, that portion of government spending is no longer exogenous. Thus, agricultural markets have a feedback directly into the domestic macroeconomy--one which does not exist with either exogenous government spending or with the typical "satellite" model approach to the agricultural sector.

Structure of the International Economy

For reasons of simplicity and variable parsimony, the structure of the international economy was specified to involve six endogenous variables and a large number of exogenous variables (see section 2 of Appendix A). The specification revolves around the balance-of-payments equation. Exports and imports are disaggregated into agricultural and nonagricultural components. The exchange rate is determined by an asset market equilibrium framework. The detailed specification of the identity for U. S. transactions with the rest of the world in terms of U. S. dollars is given by

$$CX*PC + OX*\frac{PW}{E} - LM*PPL - OM*PW*E + KA + ORT = 0$$

where

CX = real quantity of crop exports

PC = index of crop prices in U. S. dollars

OX = real quantity of other exports

PW = index of world prices (using the same weights as for exchange rate)

E = index of exchange rate (defined as number of U. S. dollars required to purchase a unit of foreign currency) given by the Federal Reserve Board's bilateral 10-country weighted index

LM = real quantity of livestock imports

PPL = index of livestock import prices in U. S. dollars

OM = quantity of other imports

and KA and ORT are as defined in the section on "Structure of the Macroeconomy." Note that, given the model specification, the current balance, CA, is determined by

$$CA = CX*PC + OX*\frac{PW}{E} - LM*PPL - OM*PW*E.$$

Crop exports, CX, and crop price, PC, are aggregates of the export quantities and prices of wheat and feed grains. Similarly, livestock imports and prices, LM and PPL, refer to aggregates for beef. Livestock imports are treated exogenously, but wheat and feed grain exports are determined endogenously. The demand portion of this endogenous determination is specified as a net rest-of-world excess demand function. The key price variable is the relative U. S. farm price adjusted for any export subsidy divided by the world price. The exchange rate measured in dollars (U. S.) per unit of foreign currency enters the specifications as a separate explanatory variable. Because there are substitution possibilities in both the production and the consumption of those grains in other countries, the export demand will have cross-price as well as own-price arguments. The effects of shifts in foreign

income, of production shifts in other countries, and of seasonal conditions are incorporated in the specification.

The import demand of nonagricultural products implicitly assumes that the supply of imports to the United States is nearly infinitely elastic. The export equation is regarded as a reduced-form equation of a supply of and demand for U. S. exports described in Goldstein and Khan.^{3/} While the response to income changes is considered to be fairly immediate, the specification allows for delayed adjustments in the case of price changes.

In the exchange rate asset market determination, increased money stock exerts upward pressure on the exchange rate through the log differential between the U. S. money stock and the world money stock indices. Interest rate increases work in the same fashion in the exchange rate determination equation since they are presumed to approximate expectations about future inflation rates. As the causal flows revealed in Figure 1 show, the international sector's real part (imports and exports) feed directly into the income determination sector (with opposite signs). The exchange rate affects both import and exports and, thus, these effects spread throughout the model through aggregate demand changes. Note, also, that changes in the wage-price combinations affect the international sector via the changes in the U. S. wholesale price index that enter both export demand and import demand equations.

Structure of the Agricultural Economy

The agricultural sector is specified as a series of supply and demand equations with price playing the key equilibrating role; hence, this sector is specified as a series of flex-price markets. Agricultural crop production is disaggregated into wheat and coarse grains (soybeans, cotton, tobacco, fruits,

vegetables, and other crops are not included in this condensed version of the agricultural sector model).⁴ Demand equations are specified for domestic food demand, private storage demand, government storage demand, and government export disposal. Planted acreage equations representing planned supply are expressed as functions of expected market prices, government policies regarding target and loan rates and diversion payments, and input costs. The input costs are related to general economy movements in wages, interest rates, and material costs. Yields are explained by seasonal conditions, technology, current output prices, and current input costs.

Livestock products are disaggregated into beef, pork, and poultry (eggs, fluid milk, and manufactured milk products are not included in this condensed version of the model). Domestic supply is influenced by expected and past output prices, by feed costs, and by costs of nonfarm purchased inputs. Allowance is made for cyclical response behavior, particularly in the cattle and hog subsectors. Domestic supply plus government-determined import volumes are equated with domestic demand to determine prices.

The structure of the agricultural sector represented here is decomposed into two major blocks of grain equations and three blocks of livestock equations. As shown in Figure 2, these blocks are related to the international and macroeconomy sectors through forward and backward linkages. Each grain block (see Appendix A, section 3) includes behavioral equations for acreage planted, yield per planted acre, domestic utilization, and inventories. Production is computed as the product of acreage and yield. Domestic utilization is divided into two components: (1) livestock and residual demand and (2) industry or food demand.

Inventories are either publicly controlled (government-owned stocks, inventories tied to outstanding CCC loans, and stocks in the farmer-owned

reserve) or privately owned. The government-owned and CCC inventories are aggregated into a single inventory position, while farmer-owned reserve and privately owned stocks are each modeled separately. This allows the different characteristics and rules governing control of the different types of stocks to be incorporated.

Since the planting decision is inextricably tied to the choice of participation in farm programs, an appropriate specification must incorporate the trade-off between compliance or noncompliance with government programs that depend on acreage reductions as well as the trade-off between expected returns of all potential crop choices. Traditional acreage equations included in past models do not fully incorporate these trade-offs. Acreage planted of each crop is presumed to depend on (1) the difference between expected returns from noncompliance and compliance with acreage programs for the crop under consideration, (2) acreage that can be planted under full program compliance, and (3) lagged acreage.

Since both yields and acreage crop allocation emanated from a common decision model, each yield equation is specified to be a function of the same expected profit variables as the acreage equations, the diversion requirement, a time trend to measure technical progress, and a number of indicator variables representing incidents of bad weather. The comparative static characteristics of the acreage and yield equations indicate, inter alia, that an increase in their own target price will result in a reduction in acreage planted and that an increase in the diversion requirement can result in an increase or decrease in acreage planted.⁵

As noted above, domestic feed grain consumption is divided into feed and other uses. Both are determined endogenously. Domestic wheat consumption is

divided into food consumption and other uses, but only food consumption is determined endogenously. Domestic feed demand for feed grains is specified to be a function of the inventories of cattle on feed, pigs on feed, and broilers on feed. Cattle on feed is specified as a function of lagged placements of cattle on feed, pigs on feed is equal to the pig crop for the preceding two quarters, and broilers on feed is determined by the hatch of broiler chicks in the preceding period. Feed grain consumption increases with the number of animals on feed. Per capita demand for feed grains in other uses is specified as a function of real per capita income, the real price of corn, and a time trend. Domestic per capita food demand for wheat is a function of the real price of wheat, an index of real food prices, and real per capita income.

Inventory equations are used to complete the grain blocks and determine the price of each crop. Inventories are separated into three components: stocks controlled by the government (CCC inventories plus government-owned stocks), the farmer-owned reserve, and other privately held stocks. In general, it is expected that a measure of the expected profitability of holding stocks will be the main determinant of stockholding. The different specifications for the various inventory positions reflect the various constraints imposed on release and entry in the publicly controlled stocks.

Quantity demanded by the private sector for stocks by both the producers and the users is motivated by transactions and precautionary motives (a large part of this is due to the seasonability of production) and, also, to some extent, by a speculative motive. All motives are conditioned by the cost of holding stocks. Expected commercial sales for domestic food and feed and for export are important determinants of transactions and precautionary needs. Speculative demand is influenced by the farm price relative to

expected farm price. It is also presumed that the farm price relative to loan price and quantity demanded by the government sector for stocks has an influence.

Interest rates represent a major component of the cost of inventory holding. The interest rate plays an important role in the inventory equations but one that differs from equation to equation. For instance, while it is expected to enter in the private stock equations with a negative coefficient, interest should have a positive coefficient in the equations for the farmer-owned reserve. This is because, while private stockholders must forego the interest on their asset, in some years participants in the farmer-owned reserve received an interest subsidy in the form of interest-free loans. Thus, higher interest rates correspond to increased subsidization from participation in the farmer-owned reserve and, therefore, to increased net entries into the farmer-owned reserve.

Quantities demanded by the government sector include government-owned stocks and those placed in either the CCC nonrecourse loan scheme or the farmer-owned reserve scheme. To a large extent, government stocks are a residual with the government playing a passive role. Farmers place stocks with the government when the farm price is close to the loan price, and they redeem loans only as the farm price moves above the loan price. Again, the government is loath to release its own supplies until prices rise above the loan price; and, in the case of the farmer-owned reserve, such prices are prespecified and are well above the loan price.

The livestock sector includes blocks of equations for beef, pork, and broilers. The qualitative structure of each block in the meat sector is the same. The meats are disaggregated to reflect different consumption patterns

over time; different income elasticities; and different production processes, for example, length of time on feed. Per capita meat demand is modeled in price-dependent form as a function of own-quantity, the price of substitute meats, and income. Prices and income are measured in constant dollars, and income is per capita. A nonagricultural price index representing the price of substitute nonfood items is also included in the meat demand equations.

Supply behavior in the cattle sector is disaggregated into equations explaining the closing inventory of beef cows, the gross number of placements of cattle on feed, and the production of beef. Disaggregation of the cattle sector facilitates the capture of some of the dynamics associated with biological production lags and interactions between cattle and feed prices. Our model follows that described by Jarvis; Freebairn and Rausser; and Arzac and Wilkinson^{6/} except that, for simplicity, we have only one cattle price. The cattle-breeder and fed-cattle activities are treated as distinct operations with different decision-makers.

Decisions to hold cows and heifers reflect a balancing of the expected returns of retaining them for breeding and selling feeder calves some seven to nine quarters ahead (nine-month gestation and twelve-to-eighteen-month yearlings) or selling the animals for current-period slaughter. The closing inventory of beef cows is expressed as a function of expected farm price of beef reflecting the breeding option, current farm price of beef reflecting the slaughter option, and the cost of nonfeed purchased inputs for beef cows when running a breeder cow operation.

The gross number of placements of cattle on feed is expressed as a function of the number of feeder calves and the expected profitability of cattle feeding. Profitability is influenced by the expected farm price of beef and

the costs of the feeder calves as measured by the current farm price of beef; the feed cost for beef cows which, in turn, depends on the cost of feed grains as measured by the farm price of corn and the farm price of soybean meal; the cost of nonfeed purchased inputs for cattle on feed which are functions of the wage rates, market interest rate, and general economy material and services prices. Production of beef comes from gross number of placements of cattle on feed in previous periods, cull beef and dairy cows, and other nonfed cattle slaughter. The previous period's closing inventory of beef cows and the previous period's closing inventory of dairy cows act as proxies for the potential supply of cull beef and dairy cows. The farm price of beef and the feed cost for beef may have two effects; on the one hand, they encourage feeding of animals to heavier weights and, on the other, they encourage withholding of breeding stock. The latter effect stems directly from the dynamics of beef cow inventory.

As with the cattle sector, the representation of the hog sector is highly aggregated. It is specified to allow for cyclical responses of pork production to changes in the final product price and costs. Equations are given for the closing inventory of breeding sows, market hogs, and production of pork.

The decision to retain breeding sows or send them for slaughter is based on a comparison of their current sale value and the expected returns from the sale of hogs in the future. Algebraically, the closing inventory of breeding sows is positively related to the farm price of hogs; to the expected feed cost for hogs which, in turn, depends on feed grain and soybean prices; to the cost of nonfeed purchased inputs for hogs; and, negatively, to the expected farm price of hogs. The number of market hogs is a mirror image of the sow equation with the addition of the previous period's sow inventory. Production

of pork depends on the beginning inventory of market hogs with adjustments for hog and feed costs as they affect the final market weight. Similarly to the beef and pork subcomponents, equations presuming the same type of causal influences are specified for poultry production, broiler chicks hatched, and broiler hatchery supply flocks.

The supply equations for both grains and meats contain a cost of nonfeed purchased inputs to reflect costs of input, most of which are purchased from the nonfarm sector. Specifically, for each activity, the nonfeed purchased input price variable is a weighted average of wage rate paid for hired labor; market interest rate paid for financing working capital, machinery, and buildings; index of raw material prices paid for energy and fertilizer; and index of nonfood prices paid for services and materials not included above and equipment. This cost measure provides a direct link with performance of the general economy.

Chapter 4

Model Validation and Simulation Experiments

The estimated model appearing in Appendix A has been interpreted and evaluated in a more detailed study prepared by Russer^{1/} for the American Enterprise Institute. Since the models representing each of the three components (macro, international, and agriculture) have been constructed over the last few months, very few validation exercises and simulation experiments have been conducted. The validation exercises have focused on the ex post forecasting properties of the model. The flex/fixed price specification or, equivalently, the differential response of markets to changes in money supply has also been investigated. This investigation results in a determination of the degree of money nonneutrality in the short run. To assess the verifiability of the model, we have also investigated some of its stability properties. The stability characteristics of the model have been examined for the estimated parameters based on the entire sample. Moreover, we have also investigated the stability of the parameters over some major, distinguishable regimes that define the nature and structure of linkages between the agricultural sector and the macro and international economies.

The simulation experiments, only some of which are reported here, are pairwise comparisons. In all of these comparisons, the macromodel is combined with the international model as one submodel and the agricultural sector representation is treated as one submodel. First, the within-sample simulations are performed for each of the two submodels as separate structures. These are then compared with the joint simulation of the two submodels running

in tandem. Each of these simulations was performed to check that the model tracks the data well and that no apparent specification errors exist.

Some simulation experiments focus on evaluating the effects of two alternative scenarios, one corresponding to a "tax period" and another to a "subsidy period." First, a situation such as the 1981-1983 period is re-created with a strong dollar, expansionary fiscal policy, falling energy prices, and tight money. This is compared with the 1973-1975 regimes of a weak dollar accompanied by easy money and rising energy prices. Each will be analyzed to determine the extent to which the macroeconomic and international environments affect agricultural markets.

There are two versions of the model that are used for the above simulations. First, only the "forward" linkages are included. This set of simulations will be analogous to most econometric models with an agricultural sector; agriculture appears only as a "satellite." Second, the backward linkages from the agricultural sector to the rest of the economy will be incorporated. This set of simulations will allow us to evaluate the extent to which ignoring backward linkages, *ceteris paribus*, has affected previous models and the results derived therefrom.

Finally, simulation experiments will be undertaken with different agricultural policies. The above simulations are conducted with all of the agricultural policy instruments set at present levels. Possible alternatives which might come out of the 1985 farm bill, such as reduced price supports, will be examined. The goal here will be to compare the effects of alternative policies. This work is currently ongoing.

Validation Exercises

The macro/international submodel performs reasonably well based on the within-sample simulations. For these experiments, the agricultural submodel and the estimated linkage equations are excluded. Overall, prediction errors are well within acceptable bounds. The in-sample tracking properties of the model were assessed using a Gauss-Newton simulation provided by the Time Series Processor (TSP Version 4.0). The algorithm is sufficiently flexible to handle nonlinear simulations and uses the sum of squared derivations for each equation as its criterion function. The sample period chosen was the 1979 to 1983 period. As Rausser^{2/} reported, it is apparent that the model tracks observed data well, even for variables which are difficult to predict such as the money supply or the exchange rate. Similar assessments are reported in Rausser for the agricultural sector representation reported in Appendix A.

The dynamic stability properties of the complete model have been investigated from a number of different perspectives. First, we have investigated the local, component stability of each of the two submodels: macro/international and agricultural. For each submodel, the analytical stability properties of the linearized versions have been derived. In each instance, all of the relevant characteristic roots satisfied the conditions for stability. We have also investigated the dynamic properties of the linearized version of the complete model which incorporates the linkages between the macro/international and the agricultural sector submodels. Here again, the analytically derived characteristic roots satisfy the conditions for stability. As yet, however, we have not investigated the global stability properties of the model--that is to say, the model in its original nonlinear form. We have investigated the dynamic paths of the two nonlinear submodels

separately as well as the complete nonlinear model over three-year horizons. The model has been shocked with wide ranges of exogenous variables, as well as initial conditions, and it has generated dynamic paths composed of internally consistent values. Based on these results, we have drawn the conclusion that the nonlinear version of the model is sufficiently stable, at least for the three-year horizons needed for the simulation experiments.

A major issue of validation relates to the fixed/flex price specification of the model advanced in this study. Without the fixed-price sector, money is nonneutral in the short as well as the long run. Moreover, no overshooting results and, thus, there is no need to account for macroeconomic linkages in the design of any agricultural policies. This suggests that it is indeed imperative to determine whether or not the fixed/flex price specification is appropriate.

As noted in Rausser,^{3/} an eclectic approach may be used to distinguish between the fixed- and flex-price assumptions for a specified model. This involves estimation of both a fixed/flex model and flex/flex model and making several comparisons. Ad hoc comparisons are necessary because the nonnested hypothesis testing procedures are only asymptotically valid, and their behavior is quite uncertain for complex models of the type considered here. The plausibility of the two sets of parameter estimates, their relative success in simulation, their ability to predict outside of the sample, etc. must be evaluated. These comparisons could be conducted to supplement any formal statistical testing. A very important comparison would involve the predictive performance of the two competing models, especially for the flex-price markets.

A simpler approach can be pursued to discriminate between the fixed/flex versus the flex/flex specification. This approach has been used by Stamoulis, Chalfant, and Rausser^{4/} to test for the importance of overshooting. As is well known, no overshooting occurs with the purely flexible price model; it takes some price inflexibility to generate overshooting. Thus, Stamoulis, Chalfant, and Rausser focus on the sensitivity of food and nonfood prices to anticipated money growth as defined by Barro.^{5/} In this analysis, the rate of change of the nonfood consumer price index is taken as the growth rate of prices that are potentially generated in fixed-price markets while the growth rate of the U. S. Department of Agriculture index of prices received by farmers was used to measure growth in the potentially flex-price markets.

To explain variation in these two rates of change, Stamoulis, Chalfant, and Rausser^{6/} used as explanatory variables the anticipated money growth variable, distributed lags of the gap between potential and actual income, oil price inflation, the differential of wage and productivity growth rates, and a lagged dependent variable. In comparing the coefficients across the two equations, it was found that the lagged dependent variable had a large significant coefficient in the nonfood price inflation equation and an inconsequential coefficient in the food equation. Moreover, anticipated money growth caused a much greater response in food inflation than for nonagricultural goods. In fact, the estimated coefficient exceeded one, corresponding to overshooting of food prices following money growth. By contrast, the coefficient in the other equation was significantly less than one, implying sluggish response to anticipated money growth. These results strongly support the specification that prices in the nonfood sectors adjust more sluggishly to changes in money growth than do food prices.

In conjunction with the money demand equation that appears in Appendix A, the above results lead to the conclusion that overshooting of food prices results from the nonneutrality of money in the short run. Note also that, with the growth in money, individual willingness to hold real balances is augmented. Specifically, since the demand for money is negatively sloped, individuals are willing to hold more real balances if the interest rate falls because it is the opportunity costs of storing wealth in the form of real balances. With a fall in interest rates, it would be possible for less of the excess money balances to be spent on food, more money balances would be held, and the resulting price increase in the food market would be reduced.

This reasoning illustrates the importance of interest rates in the overshooting scenario. While money demand is found to be interest elastic, it does not always follow that interest rates can adjust to make individuals willing to hold an increase in real balances. For example, interest rates may not be flexible. Such was the case prior to October, 1979, as the Federal Reserve operated monetary policy so as to "peg" or "target" interest rates maintaining market interest rates within a specified range. As a result, money supply was allowed to vary widely. With the switch to targeting of reserves in managing money growth, interest rates became a flexible price.

When interest rates are fixed and the real balances are initially at their long-run equilibrium level, money growth results in large food-price increases. Of course, if interest rates can vary, the overshooting is spread into two markets--interest rates will fall somewhat while food prices rise less. Then, as nonfood prices gradually adjust to a new equilibrium level, there is again a reduction in food prices, accompanied now by a rising interest rate. Again, subject to the assumption that the structure of the

markets is unchanged by any developments during the adjustment phase to money growth, the long-run equilibrium occurs with the price level twice its original level and all quantities and interest rates back to their original levels.

The extent to which the overshooting result causes real price changes in flex-price markets depends on both the interest elasticity of the money demand and the degree of flexibility of interest rates. Overshooting is inversely related to both the demand elasticity and the ease of adjustment of interest rates. This means that, prior to October, 1979, when interest rates were pegged, overshooting was more severe in food markets. After that time, interest rates became flexible and, *ceteris parabis*, the effect of overshooting on food prices was lessened. This phenonemon has been examined by Stamoulis, Chalfant, and Rausser^{7/} who proved the general proposition that the degree of overshooting in a particular flex-price market is decreasing in the number of additional flex-price markets in the system.

The above reasoning does not imply that the degree of instability in food prices will necessarily fall with the introduction of flexible interest rates. Instead, it simply means that the linkage between interest rate or financial markets and food commodity markets will be smaller as a result of flexible interest rates. If interest rates are shocked significantly, however, the interaction of the linkage parameters with the large variability in interest rates could, in fact, imply more instability in food prices after the introduction of flexible interest rates.

Empirical implications of the above proposition have been examined in the context of the model presented in Appendix A by evaluating the parameter and linkage stabilities over the major regimes of macroeconomic environments facing agriculture. In a context of the number of flexible price markets in

the macro/international economy, three major regimes can be distinguished for the sample period employed to estimate the equations of Appendix A. The period 1965-1972 was a period of fixed exchange rates and pegged interest rates. The period 1973-1979 corresponds to partially flexible exchange rates and target interest rates. During that period, exchange rates are viewed as partially flexible because the U. S. government pursued a "dirty float" policy of exchange rate manipulation. The third and last regime corresponds to 1980-1983, during which time exchange rates as well as interest rates were flexible.

For each of these regimes, the equations in the model that involve interest rates or the exchange rate were reestimated. The results obtained in the form of significant shifts in the parameter estimates support the hypothesis of reduced overshooting in food markets. Because the results are too detailed to present here, only a few of the regime estimated equations will be highlighted.

One of the more interesting sets of parameter shifts occurred for the money demand equation. Prior to 1979 and for the sample as a whole, the lagged dependent variable in the money demand equation had a rather large coefficient reflecting slow adjustment in money balances over time. For the flexible interest rate period, that coefficient is much smaller and corresponds to more rapid adjustment of money balances. The response to increased opportunity costs of holding money was more rapid adjustment to interest rate changes. The increase in the interest rate elasticity of money demand for the post-1979 period is also consistent with this result.

Another set of interesting results for parameter and linkage stability occurred for the breeding stock equations of the livestock sector. For both

cattle and hog inventories, the equations for the entire sample during 1965-1973 show the inventory-reducing effects of increasing interest rates and feed costs. Distributed lags on both variables feature negative coefficients in both equations. However, when these linkage equations are estimated using only observation prior to 1979, the effects of interest rates (nominal) become insignificant and positive, reflecting the fact that at that time nominal interest rates were not a major determinant of inventory decisions. This is due in part to the lack of variation in nominal interest rates during the period 1965-1979. By contrast, for the last sample regime (1980-1983) there is significant evidence that food markets responded to the change in flexible interest rates. In particular, for cattle inventories, while the first several distributed lagged coefficients are positive, the last few are larger in magnitude, negative, and statistically significant. Similar results were obtained for the hog inventory equations. The results for these equations, however, were complicated by the technological changes that occurred for hog production over the sample period under investigation.

"Tax" and "Subsidy" Simulation Experiments

To provide some flavor for the preliminary simulation results of the model, consider the scenario that corresponds to the economic environment in 1981-1983. For this scenario, the model describes the likely path of general prices, wages, income, agricultural prices, and inventories; it also describes income over a three-year period under bountiful harvests, tight monetary policy with no changes in fiscal policy, and a flexible exchange rate policy with no changes in agricultural sector programs.

The initial price-depressing effect of the bountiful harvest will be exaggerated by secondary effects. The tight monetary policy causes a rise in real interest rates. These, in turn, depress nonfarm inventory investment and fixed investment. After a period of steady adjustment, there are reductions in real income, employment, and consumption expenditure including that on food--more so for income-elastic beef. At the same time, the high interest rates encourage greater capital inflow which, together with the fall in imports caused by the slowdown of real income growth, causes appreciation of the exchange rate. In addition, the higher interest rates induce the private sector to hold less grain inventories. After extended lags, the forces of lower rates of price increases reduce the rate of decline in real money balances and modify pressures on nominal interest rates.

Effects on the livestock sector are more complex. The fall in crop prices, by reducing animal feed costs, raises expectations about the future profitability of animal production. While this means greater supplies of poultry, eggs, and dairy products in the next quarter, the initial effect for beef and pork is the reverse since animals are retained for breeding rather than sent for slaughter. Those animals intended for slaughter will be fed to attain heavier weights. However, the fall in income associated with the tight monetary policy causes, in due course, a shift to the left of the food demand curves. After some quarters, the meat price decline may exceed the effect of the feed cost decline on expected livestock profitability. The longer run and, perhaps, the intermediate run effects will be for livestock prices to fall.

Developments stemming from the tight monetary policy and the fall of agricultural commodity prices are deflationary. Low commodity prices work

through to lower food prices with the full effect taking up to two quarters reducing, in turn, expected prices used in the wage-bargaining process. Slower real income growth also exerts a downward force on the growth of nonfarm prices. The reduced rates of wages and nonfarm prices offer some relief to nonfarm costs but, of course, the high interest rate costs are still incurred.

After some quarters, a set of countervailing forces emerge to affect the agricultural sector. First, as wage and nonfarm prices fall in the general economy, the costs of agricultural production tend to fall. Second, particularly for the more income-elastic livestock products, the revival of real income stimulates demand. Third, where the initial response was to reduce production, the forces of supply and demand raise prices to more attractive levels. In the case of the cattle and hog industries, there is a process of dampened cyclical adjustment because of the short-term perverse response of supply to increased profitability as inventories of breeding animals are accumulated.

For the scenario corresponding to 1973-1975, dynamic paths at the other end of the spectrum were generated. Farm incomes were observed to be substantially above present levels, and inventories were significantly lower. Repeating the macroeconomic experience of those years leads to rapid growth in U. S. and worldwide money supply, lower real rates of interest, and exchange values significantly below present levels. These phenomena lead to increasing export sales and reduced inventories. These developments are, of course, tempered by supply response. This is especially the case for wheat where excess supply capacity is an important constraining influence on price increases.

For one of these simulation experiments, we allowed exports to rise at the same growth rate that they did during the early 1970s. For this rate of growth in exports, along with the 1973-1975 fiscal and monetary policies, the cropland base would have to rise significantly. For example, acreage in the neighborhood of 100 million acres for corn and grain sorghum would be necessary. Obviously, given rises in both prices and output, farm incomes would improve quite dramatically. Initially, there would be some liquidation in livestock breeding herds, especially cattle, which would help to moderate meat-price increases at the wholesale and retail levels. Later, within the three-year simulation horizon, breeding inventories begin to rebuild and meat prices jump substantially.

In the simulation experiments that have been conducted thus far, the large-scale model presented in Appendix A provides an internally consistent set of results. In all instances, increases in the real rate of interest and the exchange value of the dollar have distinct negative effects on commodity prices and the expected money growth rate has a positive effect on these prices. The latter variable causes the long-run equilibrium commodity price path to move in a corresponding direction. Hence, if a very restrictive monetary policy is put in place, the long-run equilibrium commodity price falls but with a corresponding rise in the real rate of interest and the exchange value of the dollar. Because of slower adjustments in other markets of the macroeconomy, short-run commodity prices overshoot the new long-run equilibrium commodity price. With a very expansionary monetary policy, all three of these effects run in the opposite direction.

The comparative dynamic simulation experiments conducted with the model representation of Appendix A show that, for the current 1981 Food and

Agriculture Act, macroeconomic policies can easily dominate the short-run effects of agricultural policies on the price and income paths for U. S. agriculture. In the long run, of course, money is neutral, and agricultural sector policies can have a more significant influence on resource allocation to the U. S. agricultural sector. Agricultural sector policies which provide incentives for overallocation of resources to agricultural production simply make the sector especially vulnerable to macropolicies that impose implicit taxes by lowering the long-run equilibrium of commodity prices and also overshoot in a downward direction these equilibrium prices in the short run. This is, in fact, the causal basis for the current financial crisis in U. S. agriculture. Agricultural policies can be set at extreme levels for the model representation presented in Appendix A which would counteract extreme taxations as well as excessive implicit subsidizations.

Chapter 5

Concluding Remarks

To the extent that money is nonneutral in the short run, analysis of agricultural market dynamics must take into account not only real demand and supply forces and the effects of sectoral governmental intervention but also the macroeconomic policies of the federal government. The fixed/flex price dichotomy of the U. S. economy implies that money is in fact nonneutral. Because some goods and services do not respond to changes in demand in the short run, namely, the "customer" goods defined by Okun^{1/} or the fixed-price goods defined by Hicks,^{2/} analysis of commodity markets requires an explicit treatment of monetary factors and the linkages with the macroeconomy. The prices of most other goods are sticky while the prices of agricultural commodities, in the absence of governmental intervention, are free to respond to fluctuations in demand and supply.

Since the general price level is not free to respond fully in the short run, changes in nominal money supply are also changes in the real money supply and, therefore, induce changes in the real interest rate which in turn induce changes in relative prices. As a result, changes in the money supply will lead to overshooting in flex-price markets. Through much of the 1970s and 1980s, exchange rates have been flexible; hence, changes in the money supply will lead to changes in the value of the dollar that are more than proportionate to the change in money supply. Only when the dollar is "overvalued" ("undervalued") will investors rationally expect a future rate of depreciation (appreciation) that is sufficient to offset the interest rate differential so that the interest rate parity condition holds and investors are willing to

hold foreign currency. In the short run, the exchange rate overshoots its long-run equilibrium. This quite obviously happened from 1980 to 1982 when the Federal Reserve adopted a stringent monetary policy. Unlike the 1970s, the resulting higher nominal interest rates did not reflect higher expected inflation but, rather, represented higher real interest rates. As a consequence, the dollar appreciated sharply.

In the "tax" and "subsidy" simulation experiments conducted in the analysis presented here, overshooting was found to occur in U. S. feed grain and food grain markets. This overshooting is a direct implication of the fixed/flex price framework. This framework was formally tested, and the empirical results corroborate the differential response of nonfood market prices and food market prices to changes in anticipated money growth. Factors affecting commodity price overshooting were shown to be the number of fixed-price markets, the speed of adjustment of those prices, and the interest rate elasticity of money demand.

Nonmonetization of large federal government deficits can be interpreted as a restrictive monetary policy. Such a restrictive monetary policy leads to increases in the real rate of interest and the exchange value of the dollar and to decreases in the long-run equilibrium feed grain and wheat commodity price path. Because of slower adjustment in other segments of the macroeconomy, commodity prices in the short run add insult to injury by overshooting the new long-run equilibrium commodity price. With a very expansionary monetary policy, all of these factors run in the opposite direction.

The simulation results reported in this paper demonstrate that macroeconomic policies can easily dominate the short-run effects of agricultural

policies on the price and income paths for U. S. agriculture. The implicit taxes resulting from overshooting that are imposed on U. S. agriculture are modified by the current form and shape of U. S. agricultural policy. In particular, price supports imply downward inflexibility of some commodity prices which, in turn, cause the incidence of the macroeconomic policy tax on agriculture to show up as an unexpected increase in the cost of maintaining price supports and the various forms of government stockholding. Overshooting agricultural commodity markets in the downward direction places some of the implicit tax on the private sector and some on the public sector. Due to the form and shape of current U. S. agricultural policies, the overshooting effects of expansionary monetary policies are asymmetric. Much, if not all, of the subsidy accrues to the private sector.

In the long run, because money is neutral, agricultural sector policies have a more significant influence on resource allocation to the U. S. agricultural sector than do macroeconomic policies. The sector policies that provide incentives for overallocation of resources to agricultural production quite obviously make the sector especially vulnerable to macroeconomic policies that impose implicit taxes via overshooting. Such sector policies, when combined with macroeconomic policies that "subsidize" U. S. agriculture, must by definition lead to a financial crisis for both private and public sectors if and when macroeconomic policies begin to impose "taxes" via overshooting on agriculture. The dynamic path composed of a subsidy period followed by a tax period during which sector policies provide incentives for overallocation of resources to agricultural production can be expected to create crises.

The implications of this study for the 1985 Food and Agriculture Act must, of course, focus on the overshooting phenomenon. If macroeconomic policies

were appropriately designed, there would be no need for the sector-specific policies to address the implications of overshooting for the U. S. food and agriculture system. Presuming that no significant changes will take place in the design and implementation of fiscal and monetary policies, the normative justification for governmental intervention in food and agriculture continues to be excessive instability and the nonexistence of a complete set of markets for risk transfer. As noted in the introductory comments, this market failure provides an efficiency justification for governmental intervention to reduce the degree of inherent instability in agricultural markets.^{3/}

For the objective of risk reduction or, equivalently, the management of instability in food and agriculture markets, flexible storage and conditional target price policies introduced by Just and Rausser^{4/} are appropriate. These conditional policies are designed to reduce risk, meet minimal food security goals, achieve an adaptable farm sector, minimize treasury cost, and minimize the probability of political failure. The implications of overshooting for instability in agricultural commodity markets resulting from macroeconomic policies is not addressed in the design of the conditional policies advanced by Just and Rausser. The augmentation to the degree of instability by the phenomenon of overshooting can and should be recognized and taken into account in setting the flexible storage and target price policies. Failure to condition agricultural programs on monetary and fiscal policies will result in crises of the type generated by the Payment-In-Kind Program and the unexpected imposition of huge treasury costs. In essence, the flexible storage and target price policies are concerned with the distribution of tax and subsidies across the private and public sectors. Aside from the need to manage inherent instability during periods of "subsidy overshooting," the

flexible storage and target price policies would impose a self-regulating tax on agriculture. For periods of "tax overshooting," the conditional policies would involve a self-regulating subsidy to agriculture.

In the actual implementation of agricultural policies, there are goals or objectives in addition to those listed above. As noted in Rausser and Foster,^{5/} these additional goals might include income distribution, reasonable food prices, preservation of the family farm, and conservation of resources. The flexible storage-price and target-price policies outlined above do not address these specific objectives. As argued by numerous analysts, the conservation of resources objective can be handled through land-retirement programs while the preservation of family farms and the redistribution of income are most effectively dealt with through direct subsidies to the "family farm" component of the trifurcated farming sector. As suggested in Rausser and Foster, the most efficient means of implementing the direct-payment scheme is through negative income taxes. Additional improvements in the adaptable farm sector objective can be obtained by eliminating the current tax shelter provisions of investments in agricultural production. This would reduce the bias in resource allocation to agricultural production. It should also be noted that the conservation of resources objective would be enhanced by conditional storage and target prices which specifically address the overshooting phenomenon emanating from macroeconomic policies. Overshooting resulting from restrictive monetary policies provides little incentive for farmers to maintain the quality of their land resource. Insulation from the spillover effects of monetary policy would most certainly result in an improvement in the conservation of agricultural resources.

The above recommendations are prescriptive; their applicability depends on the specified objectives and goals of public policy for food and agriculture. Political feasibility or the positive aspects of governmental intervention in food and agriculture are not explicitly addressed by the analysis contained in this paper. As argued in Rausser and Foster, however, the implementation features of any designed food and agriculture policy must also be evaluated in terms of its effect on the probability of political or governmental failure.

FootnotesChapter 1

1/ Coming into the 1981 crop year, substantial quantities of stocks already existed in the farmer-held reserve. The addition in stocks from 1981 and 1982 record crops were considered excessive relative to the stabilizing and food-security objectives for the farmer-held reserves. With the accumulation of public stocks of more than 1 billion bushels of wheat and over 2.5 billion bushels of feed grains and the associated escalation and U. S. Treasury outlays, strong voices of criticism surfaced; and some stopgap, crises-driven policy provisions had to be enacted.

2/ The U. S. Treasury exposure of carrying public stocks became unbearable in the early 1970s. As a result, the "Soviet grain deal" appeared as a savior for the policy disequilibrium that existed; see Gordon C. Rausser, "Macroeconomic Environment for U. S. Agricultural Policy," American Enterprise Institute for Public Policy Research, Occasional Paper, Department of Agricultural and Resource Economics, University of California, Berkeley, 1985. The U. S. government liquidated public stocks which then exposed the economy to the risk of large agriculture commodity price increases. From the standpoint of officials who are struggling to contain inflation, governmental stocks were liquidated prematurely and thus failed to provide the stabilizing influence which taxpayers supposedly had been paying for so long.

3/ G/ Brandow, "Policy for Commercial Agriculture, 1945-1971, in A Survey of Agricultural Economics Literature, edited by L. Martin. Minneapolis: University of Minnesota Press, 1977.

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10/ Popular pressure frequently compels such measures as windfall profit taxes, price controls, rationing, export embargoes, and even confiscation.

11/ Accounting only for physical capital, not land, the U. S. agricultural sector is more than twice as capitalized as manufacturing on a per worker basis.

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APPENDIX A^{1/}1. Domestic Macroeconomy1.1. Aggregate Consumption

CN72: Personal consumption expenditures, nondurable goods, 1972 dollars. Billions of dollars seasonally adjusted at annual rates. U. S. Department of Commerce, Bureau of Economic Analysis, National Income and Product Accounts.

CD72: Personal consumption expenditures, durable goods, 1972 dollars. Billions of dollars seasonally adjusted at annual rates. Ibid.

CS72: Personal consumption expenditures, services, 1972 dollars. Ibid.

1.2. Aggregate Domestic Investment

IFIXR72: Gross private fixed residential investment, 1972 dollars. Billions of dollars seasonally adjusted at annual rates. U. S. Department of Commerce, Bureau of Economic Analysis, National Income and Product Accounts.

IFIXNR72: Gross fixed private nonresidential investment. Ibid.

INV72CH: Change in business inventories, total, 1972 dollars. Ibid.

1.3. Monetary Financial Sector (Domestic)

MNY1A: Money stock--currency plus demand deposits plus traveler's checks. Billions of dollars seasonally adjusted. U. S. Federal Reserve System, Board of Governors, Statistical Release H.6.

- BONDY: Average yield of Moody's AAA corporate bonds. Percent per annum not seasonally adjusted. U. S. Federal Reserve System, Board of Governors, Statistical Release G.13.
- RATECOMP: Money rate on three-to-six month commercial paper. Percent per annum not seasonally adjusted. Average of daily offering rates. Ibid.
- TBILL3: Average market rate on U. S. government three-month bills. Percent per annum not seasonally adjusted. Average of closing daily bid prices. Ibid.
- MONGRTH: Annual percentage change in the money stock (M1).

1.4. Phillips Curve Relationships ("Supply" Side of Model)

- CPNFINF: Percentage annual change in nonfarm commodities (all urban). Index base, 1967 = 1. Seasonally adjusted. U. S. Department of Labor, Bureau of Labor Statistics.
- WAGEINFL: Annual percentage change in index of hourly earnings of production workers and private nonfarm index of hourly earnings of production workers. Private nonfarm, 1967 = 1. Seasonally adjusted. Variable adjusted for overtime, etc., and for interindustry shifts in employment. Ibid.
- RU: Unemployment rate (all civilian workers). Percent seasonally adjusted. Ibid., "Employment and Earnings."
- WPI: Wholesale price index. All commodities. Unadjusted data adjusted seasonally by X-11 method. U. S. Department of Labor, Bureau of Labor Statistics.

1.5. Domestic Income Determination Sector

- GNP72: Gross national product for United States, 1972 dollars. Seasonally adjusted at annual rates. U. S. Department of Commerce, Bureau of Economic Analysis, National Income and Product Accounts.
- YD72: Disposable personal income, 1972 dollars. Billions of current dollars seasonally adjusted at annual rates. Ibid.
- YD: Personal disposable income at current prices.
- GNP: Gross national product at current prices.
- CPIU: Consumer price index, all urban. Includes nonfarm and agricultural farm sector, 1972 = 1.

1.6. Government Finance Sector

- ARESEFRBN: Changes in nonborrowed reserves of member banks. Billions of current dollars seasonally adjusted.^{2/} U. S. Federal Reserve System, Board of Governors.
- ΔGPDGF: Changes in gross public debt securities held by all holders (private investors, government, institutions, and the Federal Reserve System).² Billions of dollars seasonally adjusted.
- DEFGE: Gross deficit of federal government transformed into quarterly rates. Billions of dollars seasonally adjusted.
- TGF: Total tax collections by federal government. Billions of dollars.

1.7. Exogenous Variables (Domestic Sector)

- N: Total population including armed forces overseas, millions of persons. Estimates are for July 1, 1980. U. S. Department of Commerce, Bureau of the Census.

- SF72: Final sales, billions of 1972 dollars. Seasonally adjusted at annual rates. U. S. Department of Commerce, Bureau of Economic Analysis, National Income and Product Accounts.
- RUAD: Full employment-unemployment rate. Corrects for demographic labor force changes and effects of social programs on participation rate. Estimated by Data Resources, Inc.
- OILINFL: Annual rate of change in average acquisitory price of crude oil by refiners, dollars per barrel. U. S. Department of Energy, "Monthly Energy Review."
- PRODCH: Productivity variable measured as output of all persons per hour. Index for nonfarm business sector, 1977 = 1. Seasonally adjusted. U. S. Department of Labor, Bureau of Labor Statistics.
- RMSDME: Maximum effective interest rate on commercial bank savings and time deposits. Weighted average of all ceiling rates with weight based on ratio of type of deposits to total deposits and then compounded annually, percent per annum, not seasonally adjusted. Calculated by Data Resources, Inc.
- RESFRBR: Required reserves of Federal Reserve System. Billions of current dollars seasonally adjusted.
- ΔITEMS: Tax and loan accounts of the U. S. Treasury, other deficit finance sources, currency and gold appreciation, etc.
- ΔORT: Change in official reserves including foreign exchange, gold, special drawing rights, and position in the International Monetary Fund.
- PTAXR1: Implicit personal tax rate. Derived to balance the identity:
$$\text{GNP} (1 - \text{TAXR1}) = \text{YD};$$

hence,

$$\text{TAXR1} = \frac{\text{GNP} - \text{YD}}{\text{GNP}}.$$

RRDD: Required reserve ration on demand deposits. Calculated by Data Resources, Inc., as:

$$\frac{\text{Total required reserves} - .042 * \text{required reserves on time deposits}}{\text{Total demand deposits.}}$$

RMFRBNY: Discount rate, Federal Reserve Bank of New York, average daily bid closing basis. Percent per annum not seasonally adjusted. U. S. Federal Reserve System, Board of Governors, Statistical Release G.13.

CHMINW: Change in minimum wage set by federal government.

GEXPF: Total expenditures of federal government.

2. International Sector

2.1. Nonfarm Exports

EXNAG: Exports of nonagricultural merchandise in 1972 dollars. Calculated at $\text{EXNAG\$} / \text{PEXNAG}$ where EXNAG\$ are exports of nonfarm merchandise in current dollars international accounts basis and PEXNAG is export unit value index for nonagricultural merchandise, 1972 = 1.

DOLFOP: Dollar denominated weighted wholesale price index of 10 U. S. major trade partners. Dollar conversion was achieved by multiplying by the exchange rate. Same weights as the exchange rate.

PDEXNAG: Foreign currency denominated U. S. export price index for nonfarm items. Divided by the exchange rate to convert to foreign currency units.

2.2. Nonfarm Imports

EMNP: Imports of nonpetroleum merchandise, 1972 dollars. International Accounts Basis. U. S. Federal Reserve System, Board of Governors, Statistical Release 208.

2.3. Farm Exports

WHEXP: Wheat exports.

FGEXP: Feed grain exports.

2.4. Exchange Rate

EXCHFRB: Bilateral 10-country weighted exchange rate dollar price of foreign currency, 1972 = 100. Weights are average 1955-1976 bilateral shares of trade with United States. Exchange rate data taken from International Monetary Fund, "Finance Statistics."

<u>Country</u>	<u>Weight</u>
Canada	.251
Germany	.160
Japan	.160
United Kingdom	.104
France	.085
Italy	.068
The Netherlands	.061
Belgium	.055
Sweden	.028
Switzerland	.028

LOGUSMII: Logarithm of an index of U. S. money stock (M1) calculated so as to be comparable to available foreign money index, 1972 = 1.

2.5. Exogenous Variables (International Sector)

LOGWGNP: Logarithm of WFINC.

FINC: Bilaterally weighted foreign wholesale price index, 10-country weights the same as for exchange rate variable.

EXFORW: Forward exchange rate calculated as six-country weighted average using Federal Reserve System, Board of Governors, "Forward Premium Series."

<u>Country</u>	<u>Weight</u>
Canada	0.380
Belgium	0.084
Germany	0.234
The Netherlands	0.092
Switzerland	0.042
United Kingdom	0.158

FRSW: Bilaterally weighted short-term interest rate. Bilateral 10-country weights the same as for EXCHFRB variable.

WPIW: Foreign wholesale price index. Bilateral 10-country weights the same as for EXCHFRB variable.

FORM1: Foreign "M1" index of individual countries' liquid money. Bilateral 10-country weights the same as for EXCHFRB variable.

3. Agriculture Sector

3.1 Grain Production

- ACGS: Acreage planted: corn and grain sorghum. Millions of acres. U. S. Department of Agriculture, Economic Research Service, Feed: Outlook and Situation Report.
- AOBM: Acreage planted: oats and barley. Millions of hectares. Ibid.
- YLDCGS: Yield per planted acre: corn and grain sorghum. Bushels per acre. Ibid.
- YLDOBM: Yield per planted hectare: oats and barley. Metric tons per hectare. Ibid.
- PRDCGSM: Production: corn and grain sorghum. Million metric tons. Ibid.
- PRDOBM: Production: oats and barley. Million metric tons. Ibid.
- AW: Acreage planted: wheat. Million acres. U. S. Department of Agriculture, Economic Research Service, Wheat: Outlook and Situation Report.
- YLDW: Yield per planted acre: wheat. Bushels per acre. Ibid.
- PRDW: Production: wheat. Millions of bushels. Ibid.

3.2. Grain Utilization

- DLVKFG: Disappearance, feed, and residual: feed grains. Million metric tons. U. S. Department of Agriculture, Economic Research Service, Feed: Outlook and Situation Report.
- DINDFG: Disappearance, food, alcoholic beverages, and seed: feed grains. Million metric tons. Ibid.

DFW: Disappearance, food: wheat. Millions of bushels. U. S. Department of Agriculture, Economic Research Service, Wheat: Outlook and Situation Report.

3.3. Grain Inventories

KCGFGE: Ending inventory, government-owned and outstanding CCC loans: feed grains. Million metric tons. U. S. Department of Agriculture, Agricultural Stabilization Conservation Service.

KFORFGE: Ending inventory, farmer-owned reserve: feed grains. Million metric tons. Ibid.

KPRIFGE: Ending inventory, free stocks: feed grains. Million metric tons. Ibid.

KCGWE: Ending inventory, government-owned and outstanding CCC loans: wheat. Million bushels. Ibid.

KFORWE: Ending inventory, farmer-owned reserve: wheat. Million bushels. Ibid.

KPRIWE: Ending inventory, free stocks: wheat. Million bushels. Ibid.

3.4. Grain Price

PAFC: Price at farm: corn. Dollars per bushel. U. S. Department of Agriculture, Economic Research Service, Feed: Outlook and Situation Report.

PAFW: Price at farm: wheat. Dollars per bushel. Ibid.

3.5. Meat

DDBEEF: Disappearance: beef. Million pounds.

$$DDBEEF = PRDBEEF + MBEEF - XBEEF$$

DDPORK: Disappearance: pork. Million pounds.

$$DDPORK = PRDPORK + MPORK - XPORK$$

DDBR: Disappearance: broilers. Million pounds.

$$DDBR = PRDBR - XBR.$$

3.6. Meat Production

PRDBEEF: Commercial production: beef. Million pounds. U. S. Department of Agriculture, Economic Research Service, Livestock and Poultry: Outlook and Situation Report.

PRDPORK: Commercial production: pork. Ibid.

PRDBR: Commercial production: broilers. Ibid.

3.7. Meat Animal Placements on Feed

CATPL: Placement of cattle on feed, 13 states, 1,000 head. Ibid.

PIGC: Pig crop, 10 states, 1,000 head. Ibid.

BRCH: Broiler chicks hatched. Thousands. U. S. Department of Agriculture, Crop Reporting Board, Eggs, Chickens, and Turkeys.

3.8. Meat Animal Breeding Inventories

ECOWINV: Inventory: cows and heifers that have calved. 1,000 head. U. S. Department of Agriculture, Economic Research Service, Livestock and Poultry: Outlook and Situation Report.

NBHOG: Inventory: breeding hogs on farms. 1,000 head. Ibid.

CPL: Broiler-type pullet chick placements for hatchery supply flocks. Thousands. U. S. Department of Agriculture, Crop Reporting Board, Eggs, Chickens, and Turkeys.

3.9. Meat Prices

PBEEF: Retail price: choice beef. Cents per pound. U. S. Department of Agriculture, Economic Research Service, Livestock and Poultry: Outlook and Situation Report.

PPORK: Retail price: pork. Cents per pound. Ibid.

PBR: Four-region average retail price: broilers. Cents per pound. Ibid.

3.10. Exogenous Variables (Agriculture Sector)

N: Total population; see macro sector.

FPC: Futures price: corn. March price for September contract. Commodity Research Bureau, Inc., Commodity Yearbook,

QFPC: Quarterly futures price: corn, for three months ahead. Ibid.

FPS: Futures price: soybeans. March price for September contract. Ibid.

FPW: Futures price: wheat. March price for September contract. Ibid.

POP4: Total population. Millions. U. S. Department of Agriculture, Economic Research Service, Livestock and Poultry: Outlook and Situation.

YD: Disposable personal income; see macrosector.

CPIU: Consumer price index, all urban; see macromodel.

- CPIAG: Consumer price index, agricultural commodities; see macro-model.
- CPINAG: Consumer price index, nonagriculture; see macro model.
- T: Time trend.
- RATECOMP: Money rate on three-to-six-month commercial paper; see macro-sector.
- PAFS: Price at farm: soybeans. Dollars per bushel. U. S. Department of Agriculture, Economic Research Service, Oil Crops: Outlook and Situation Report.
- DLVKW: Disappearance, feed, and residual: wheat. Millions of bushels. U. S. Department of Agriculture, Economic Research Service, Wheat: Outlook and Situation Report.
- MW: Imports: wheat. Millions of bushels. Ibid.
- MFG: Imports: feed grains. Million metric tons. U. S. Department of Agriculture, Economic Research Service, Feed: Outlook and Situation Report,
- Q1, Q2,
Q3, Q4: Quarterly dummy variables.
- COSTFG: Variable cost: feed grain. U. S. Department of Agriculture, Economic Research Service, Economic Indicators of the Farm Sector: Costs of Production; see macromodel.
- COSTW: Variable cost: wheat. Ibid.; see macromodel.
- R: Cropland rental rate. Dollars per acre. U. S. Department of Agriculture, Economic Research Service, Farm Real Estate Market Developments: Outlook and Situation.

- XBEEF: Exports: beef. Million pounds. U. S. Department of Agriculture, Economic Research Service, Livestock and Poultry: Outlook and Situation Report.
- MBEEF: Imports: beef. Million pounds. Ibid.
- XPORK: Exports: pork. Million pounds. Ibid.
- MPORK: Imports: pork. Million pounds. Ibid.
- XBR: Net exports: broilers. Million pounds. Ibid.

3.11. Exogenous Policy Variables (Agriculture Sector)

- DRW: Diversion requirement: wheat. U. S. Department of Agriculture, Economic Research Service, Wheat: Outlook and Situation.
- VDW: Voluntary additional diversion limit: wheat. Ibid.
- VDPW: Voluntary additional diversion payment, per acre: wheat. Ibid.
- DPW: Diversion payment, per acre: wheat. Ibid.
- BAW: Base acreage: wheat. Ibid.
- TPW: Target price: wheat. Ibid.
- SPW: Support price: wheat. Ibid.
- RELPW: Release price for the farmer-owned reserve: wheat. Ibid.
- SPFORW: Support price for the farmer-owned reserve: wheat. Ibid.
- YLDWP: Program yield for wheat used to calculate deficiency payments. Ibid.
- DRFG: Diversion requirement: feed grains. U. S. Department of Agriculture, Economic Research Service, Feed: Outlook and Situation.
- VDFG: Voluntary additional diversion limit: feed grains. Ibid.

VDPFG: Voluntary additional diversion payment, per acre: feed grains. Ibid.

DPFG: Diversion payment, per acre: feed grains. Ibid.

BAFG: Base acreage: feed grains. Ibid.

TPC: Target price: corn. Ibid.

SPC: Support price: corn. Ibid.

RELPC: Release price for the farmer-owned reserve: corn. Ibid.

SPFORC: Support price for the farmer-owned reserve: corn. Ibid.

YLDFGP: Program yield for feed grains used to calculate deficiency payments. Ibid.

ICCC: Interest rate charged by the CCC for nonrecourse loans. Ibid.

1. Estimated Equations: Domestic Macroeconomy

1.1. Aggregate Consumption

Nondurable Goods

$$\begin{aligned} \left(\frac{CN72}{N}\right)_t &= \frac{.088096}{(.04493)} + \frac{.85044}{(.07528)} * \left(\frac{CN72}{N}\right)_{t-1} + \frac{.03251}{(.01653)} * \left(\frac{YD72}{N}\right)_{t-1} \\ &+ \frac{.13946}{(.03273)} * \left(\frac{DYD72}{N}\right) \end{aligned}$$

$$\bar{R}^2 = .988.$$

Durable Goods

$$\begin{aligned} \left(\frac{CD72}{N}\right)_t &= - \frac{.09478}{(0.022511)} + \frac{0.78813}{(0.05488)} * \left(\frac{CD72}{N}\right)_{t-1} \\ &+ \frac{.27569}{(.046013)} * \frac{DYD72}{N} - \frac{.002878}{(.0007283)} * TBILL_3 \end{aligned}$$

$$\hat{p} = -.36365$$

$$\bar{R}^2 = .914.$$

Services

$$\begin{aligned} \left(\frac{CS72}{N}\right)_t &= \frac{.000335}{(.01451)} + \frac{.9800}{(.02521)} * \left(\frac{CS72}{N}\right)_{t-1} \\ &+ \frac{.01051}{(.0136)} * \left(\frac{YD72}{N}\right)_{t-1} + \frac{.06186}{(.01999)} * \left(\frac{DYD72}{N}\right)_t \end{aligned}$$

$$\bar{R}^2 = .99931.$$

1.2. Aggregate Domestic InvestmentResidential Investment

$$\begin{aligned} \text{IFIXR72}_t = & .12962 + .71087 * \text{IFIXR72}_{t-1} + .033162 * \text{YD72}_{t-1} \\ & (2.4) \quad (.0752) \quad (.01017) \\ & + .03110 * \text{DYD72}_t - 1.6681 * \text{BONDY}_t \\ & (.03110) \quad (.5429) \end{aligned}$$

$$\bar{R}^2 = .989$$

$$\hat{p} = .3801.$$

Nonresidential Investment

$$\begin{aligned} \text{IFIXNR72}_t = & .10414 + .97536 * \text{IFIXNR72}_{t-1} + .12764 * \text{FGNP72}_{t-1} \\ & (2.360) \quad (.0317) \quad (.0243) \\ & - .5598 * \text{BONDY}_{t-1} + .08176 * \text{FGNP72}_{t-2} \\ & (.329) \quad (.02460) \\ & + 1.8095 * \text{AV23DIV} \\ & (.76085) \end{aligned}$$

$$\bar{R}^2 = .990.$$

Inventory Investment

$$\text{INV72CH}_t = 4.1125 + 0.6551 * \text{INV72CH}_{t-1} - 0.24172 * \text{TBILL3}_t \\ (2.5035) \quad (0.09102) \quad (0.29446)$$

$$\bar{R}^2 = 0.449.$$

1.3. Monetary Financial Sector (Domestic)Money Demand

$$\begin{aligned} \log\left(\frac{\text{MNY1A}}{\text{CPIV}}\right)_t = & .964 * \log\left(\frac{\text{MNY1A}}{\text{CPIV}}\right)_{t-1} + .03327 * \log(\text{GNP72})_t \\ & (.01768) \quad (.014387) \\ & - .02555 * \log(\text{RATECOMP})_t \\ & (.008068) \end{aligned}$$

$$\hat{p} = .1974$$

$$\bar{R}^2 = 0.99.$$

Three-Month Treasury Bill Rate

$$\begin{aligned} \text{TBILL}_3 = & 1.051 + .051672 * \text{RMSDNE} - .6697 * \text{RESFRBN} \\ & (.4988) \quad (-.03465) \quad (.17732) \\ & + .6134 * \text{RESFRBR} + .95544 * \text{RMFRBNY} \\ & (.17886) \quad (-.05832) \end{aligned}$$

$$\bar{R}^2 = 0.907$$

$$\hat{p} = .22810.$$

Three-Six Month Commercial Paper Rate

$$\begin{aligned} \text{RATECOMP} = & 2.2124 + .03179 * \text{RMSDME} - 1.2564 * \text{RESFRBN} \\ & (.48329) \quad (.03321) \quad (.16694) \\ & + 1.16322 * \text{RESFRBR} + 1.0220 * \text{RMFRBNY} \\ & (.16845) \quad (.05590) \end{aligned}$$

$$\hat{p} = .26905$$

$$\bar{R}^2 = 0.937.$$

Long-Run Interest Rate

$$\begin{aligned} \text{BONDY}_t = & .47718 + .70292 * \text{BONDY}_{t-1} + \sum_{j=0}^5 a_j * \text{RATECOMP}_{t-j} \\ & (.05785) \quad (.04185) \\ & + .018595 * \text{MONGRFIT} + \sum_{j=0}^2 b_j * \text{DGNP}_{t-j} \\ & (.02283) \end{aligned}$$

$$\bar{R}^2 = .982$$

where

$$a_0 = 0.0599 \\ (.0095)$$

$$a_1 = 0.0499 \\ (.0080)$$

$$a_2 = 0.0299 \\ (.0048)$$

$$a_3 = 0.0399 \\ (.0064)$$

$$a_4 = 0.0200 \\ (.0032)$$

$$a_5 = 0.0100 \\ (.0016)$$

$$b_0 = 0.0058 \\ (.0012)$$

$$b_1 = 0.0039 \\ (.0008)$$

$$b_2 = 0.0019 \\ (.0004).$$

Inflationary Expectations

$$\begin{aligned}
 \text{MONGRFIT} = & - 1.35760 + 0.87652 * \text{MONGRTH}_{t-1} - 0.21899 * \text{MONGRTH}_{t-2} \\
 & (1.20696) \quad (0.12775) \quad (0.17107) \\
 & - 0.30855 * \text{MONGRTH}_{t-3} + 0.12586 * \text{RATECOMP}_{t-1} \\
 & (0.12513) \quad (0.0723) \\
 & + 0.00479 * \text{GNP72}_{t-1} - 0.23128 * \text{CPIVINFL}_t \\
 & (0.00137) \quad (0.07222)
 \end{aligned}$$

$$\bar{R}^2 = .771.$$

1.4. Phillips Curve Relationships ("Supply" Side of Model)Nonfarm Price Inflation

$$\begin{aligned}
 \text{CPINF2} = & 1.906419 + .068747 * \text{MONGRFIT} \\
 & (.94374) \quad (.06915) \\
 & + \sum_{j=0}^4 m_j * \text{WPRODIF}_{t-j} + \sum_{j=0}^3 y_j * \text{OILINFL}_{t-j}
 \end{aligned}$$

$$\hat{p} = .8918$$

$$\bar{R}^2 = .548$$

where

$$m_0 = 0.0832 \quad m_1 = 0.0854 \quad m_2 = 0.0875$$

(0.0580) (0.0401) (0.0284)

$$m_3 = 0.0897 \quad m_4 = 0.0918$$

(0.0310) (0.0456)

$$y_0 = 0.0286 \quad y_1 = 0.0140 \quad y_2 = 0.0101$$

(0.0065) (0.0040) (0.0040)

$$y_3 = 0.0168$$

(0.0072).

Wage Inflation

$$\text{WINFL} = 3.50078 + \sum_{j=0}^6 \pi_j * \text{CPIUINF}_{t-j} + \sum_{j=0}^3 q_j * \text{CHMINW}_{t-j} \\ + \sum_{j=0}^3 s_j * \frac{1}{(\text{RU} - \text{RUAD}_j)_{t-j}}$$

$$\hat{p} = .72953$$

$$\bar{R}^2 = .546$$

where

$$\pi_0 = 0.0982 \\ (0.0184)$$

$$\pi_1 = 0.0842 \\ (0.0157)$$

$$\pi_2 = 0.0702 \\ (0.0131)$$

$$\pi_3 = 0.0561 \\ (0.0105)$$

$$\pi_4 = 0.0421 \\ (0.0079)$$

$$\pi_5 = 0.0281 \\ (0.0052)$$

$$\pi_6 = 0.0140 \\ (0.0026)$$

$$q_0 = 0.0190 \\ (0.0093)$$

$$q_1 = 0.0142 \\ (0.0069)$$

$$q_2 = 0.0095 \\ (0.0046)$$

$$q_3 = 0.0043 \\ (0.0023)$$

$$s_0 = 1.4785 \\ (0.0043)$$

$$s_1 = 0.8745 \\ (0.8697)$$

$$s_2 = 0.4268 \\ (1.9762)$$

$$s_3 = 0.1353 \\ (0.9181).$$

Unemployment

$$\text{RV}_t = 3.7629 + \sum_{j=1}^4 t_j * \text{INCGAP}_{t-j} + .1414 * \text{WINFL}_t \\ (.47230) \quad (.06371)$$

$$\hat{p} = 0.786$$

$$\bar{R}^2 = 0.682$$

where

$$t_1 = -0.0111 \\ (0.0009)$$

$$t_2 = -0.0083 \\ (0.0006)$$

$$t_3 = -0.0056 \\ (0.0004)$$

$$t_4 = -0.0028 \\ (0.0002).$$

Wholesale Price Index

$$WPI = .02268 + \sum_{j=0}^3 c_j \text{CPIU}_{t-j}$$

$$\hat{p} = .6443$$

$$\bar{R}^2 = .765$$

where

$$c_1 = \begin{matrix} 0.4142 \\ (0.0186) \end{matrix} \quad c_2 = \begin{matrix} 0.3107 \\ (0.0139) \end{matrix} \quad c_3 = \begin{matrix} 0.2071 \\ (0.0039) \end{matrix}$$

$$c_4 = \begin{matrix} 0.1036 \\ (0.0046) \end{matrix}$$

Consumer Price Index

$$\begin{aligned} \text{CPIU}_t - \text{CPIU}_{t-1} = & 0.2616 * (\text{CPIAG}_t - \text{CPIAG}_{t-1}) \\ & + \begin{matrix} 0.7384 \\ (0.0796) \end{matrix} * (\text{CPNAG}_t - \text{CPNAG}_{t-1}) \end{aligned}$$

$$\bar{R}^2 = .6689.$$

Food Component of CPI

$$\begin{aligned} \log(\text{CPIAG}) = & - \begin{matrix} 0.4377 \\ (0.1337) \end{matrix} - \begin{matrix} 0.0014 \\ (0.0024) \end{matrix} * Q1 - \begin{matrix} 0.0011 \\ (0.0032) \end{matrix} * Q2 - \begin{matrix} 0.0047 \\ (0.0032) \end{matrix} * Q3 \\ & + \begin{matrix} 0.0135 \\ (0.0374) \end{matrix} * \text{LPBEEF} + \begin{matrix} 0.0283 \\ (0.0334) \end{matrix} * \text{LPPORK} \\ & + \begin{matrix} 0.0656 \\ (0.0260) \end{matrix} * \text{LPBR} + \begin{matrix} 0.0147 \\ (0.0208) \end{matrix} * \text{LPAFC} + \begin{matrix} 0.0141 \\ (0.0187) \end{matrix} * \text{LPAFVC} \\ & + \begin{matrix} 0.8572 \\ (0.0451) \end{matrix} * \text{LWAGE} + \begin{matrix} 0.00012 \\ (0.00008) \end{matrix} * \text{OILINFL} \end{aligned}$$

$$\hat{p} = 0.945$$

$$\bar{R}^2 = 0.849.$$

1.5. Domestic Income Determination SectorAggregate Demand Identities

$$\text{GNP72} = \text{CS72} + \text{CN72} + \text{CD72} + \text{IFIXR72} + \text{FIXNR72} + \text{INV72CH} + \text{G72} \\ + \text{EXAG} + \text{EXNAG} - \text{EMNP}.$$

Personal Disposable Real Income

$$\text{YD72} = 363.664 + .6794 * \text{GNP72}_t + .053687 * \text{GNP72}_{t-1} \\ (34.7183) \quad (.04387) \quad (0.43746) \\ - 1,079.599 * \text{PTAXR1} - 273.0770 * \text{PTAXR1}_{t-1} \\ (74.0586) \quad (79.278)$$

$$\hat{p} = .6463$$

$$\bar{R}^2 = .993.$$

1.6. Government Finance Sector

$$\Delta \text{MONBASE} = \Delta \text{DEFGF} + \Delta \text{GPDGF} + \Delta \text{ORT} + \Delta \text{ITEMS}$$

$$\Delta \text{GPDGF} = \Delta \text{DEFGF} + \Delta \text{MONBASE} + \Delta \text{ORT} + \Delta \text{ITEMS}$$

$$\text{DEFGF} = \text{EXPGF} - \text{TGF}$$

$$\text{TGF} = - 8.5065 + \sum_{j=0}^3 z_j * \text{GNP}_{t-j} \\ (11.6149)$$

$$\bar{R}^2 = .982$$

where

$$z_0 = 0.0828 \\ (0.0025)$$

$$z_1 = 0.0621 \\ (0.0018)$$

$$z_2 = 0.0414 \\ (0.0012)$$

$$z_3 = 0.0207 \\ (0.0006).$$

2. Estimated Equations: International Sector

2.1. Nonfarm Exports

$$\begin{aligned} \log(\text{EXNAG})_t = & -3.390342 + \sum_{j=1}^8 d_j * \log(\text{PDEXNAG})_{t-j} \\ & + \sum_{j=1}^8 e_j * \log(\text{FORWPI})_{t-j} + \sum_{j=0}^2 h_j \log(\text{BILWGNP})_{t-j} \end{aligned}$$

$$\hat{p} = .4831$$

$$\bar{R}^2 = .721$$

where

$d_1 = 0.0291$ (0.1091)	$d_2 = -0.0661$ (0.0622)	$d_3 = -0.1351$ (0.0332)
$d_4 = -0.1780$ (0.0320)	$d_5 = -0.1947$ (0.0420)	$d_6 = -0.1853$ (0.0463)
$d_7 = -0.1497$ (0.0412)	$d_8 = -0.0879$ (0.0259)	
$e_1 = -0.0405$ (0.1892)	$e_2 = 0.0623$ (0.0972)	$e_3 = 0.1372$ (0.0409)
$e_4 = 0.1842$ (0.0547)	$e_5 = 0.2032$ (0.0813)	$e_6 = 0.1943$ (0.0913)
$e_7 = 0.1575$ (0.0814)	$e_8 = 0.0927$ (0.0511)	
$h_0 = 0.7009$ (0.0985)	$h_1 = 0.4673$ (0.0656)	$h_2 = 0.2336$ (0.0328).

2.2. Nonfarm Imports

$$\begin{aligned} \log(\text{EMNP})_t = & -7.52573 + \sum_{j=1}^8 k_j * \log(\text{WPI})_{t-j} \\ & + \sum_{j=1}^9 l_j * \log(\text{DOLFOR})_{t-j} + 1.6699 * \log(\text{GNP72})_t \end{aligned}$$

$$\hat{p} = .6048$$

$$\bar{R}^2 = .664$$

where

$$\begin{array}{lll}
 k_1 = 0.0661 & k_2 = 0.1157 & k_3 = 0.1488 \\
 (0.0199) & (0.0348) & (0.0448) \\
 k_4 = 0.1653 & k_5 = 0.1653 & k_6 = 0.1488 \\
 (0.0498) & (0.0498) & (0.0498) \\
 k_7 = 0.1157 & k_8 = 0.0661 & \\
 (0.0448) & (0.0199) & \\
 l_1 = -0.0385 & l_2 = -0.0674 & l_3 = -0.0866 \\
 (0.0108) & (0.0190) & (0.0244) \\
 l_4 = -0.0962 & l_5 = -0.0962 & l_6 = -0.0866 \\
 (0.0271) & (0.0271) & (0.0244) \\
 l_7 = -0.0674 & l_8 = -0.0385 & \\
 (0.0190) & (0.0108) &
 \end{array}$$

2.3. Farm Exports

Wheat Exports

$$\begin{aligned}
 \text{WHEXP}_t = & -502.2574 - 50.2437 * Q1 - 107.414 * Q2 + 97.499 * Q3 \\
 & (145.6241) \quad (22.6341) \quad (21.641) \quad (20.952) \\
 & - 0.9121 * \text{PRDWRW}_t + 761.873 * \text{EXR}_t - 19.903 * \text{RPAFC}_{t-1} \\
 & (0.4113) \quad (262.938) \quad (57.019) \\
 & + 15.013 * \text{RPAFS}_{t-1} - 3.881 * \text{RPAFW}_{t-1} + 1.329 * \text{WGNP}_t \\
 & (11.040) \quad (29.639) \quad (0.925)
 \end{aligned}$$

$$\bar{R}^2 = 0.79.$$

Feed Grain Exports

$$\begin{aligned}
 \text{FGEXP}_t = & -21.257 - 1.345 * Q1 - 4.002 * Q2 + 2.518 * Q3 \\
 & (6.023) \quad (0.911) \quad (0.871) \quad (0.865) \\
 & - 0.0099 * \text{RWPRDFG}_t + 8.258 * \text{EXR}_t - 1.767 * \text{RPAFC}_{t-1} \\
 & (0.233) \quad (10.511) \quad (2.401) \\
 & - 0.0596 * \text{RPAFS}_{t-1} + 0.906 * \text{RPAFW}_{t-1} + 0.153 * \text{WGNP}_t \\
 & (0.4425) \quad (1.233) \quad (0.0504)
 \end{aligned}$$

$$\bar{R}^2 = 0.849.$$

2.4. Exchange Rate

$$\begin{aligned}
 \log(\text{EXCHFRB}) = & - 2.2132 + 0.4423 * \log(\text{MNY1IND}) \\
 & (1.6766) \quad (0.2401) \\
 & - 0.1087 * \log(\text{FORM1}) + 0.0127 * \text{COMPR} \\
 & (.2155) \quad (0.00392) \\
 & - 0.0068 * \text{FRSW} - 0.6307 * \log(\text{GNP72}) \\
 & (0.00462) \quad (0.451) \\
 & + 1.7797 * \log(\text{BILWGNP}) \\
 & (0.5268)
 \end{aligned}$$

$$\bar{R}^2 = .573.$$

3. Estimated Equations: Agricultural Sector3.1. Grain ProductionAcreage Planted: Corn and Grain Sorghum

$$\begin{aligned}
 \text{ACGS}_t = & 54.9197 + .0476 * (\text{NPFNG}_t - \text{NPFGP}_t)/R_t - .0283 * \text{NPSN}_t/R_t \\
 & (11.085) \quad (.0213) \quad (.02933) \\
 & - .04149 * (\text{NPWN}_t - \text{NPWP}_t)/R_t + .1883 * \text{AFGPA}_t \\
 & (.0400) \quad (.0657) \\
 & - .0391 * \text{VPDFG}_t/R_t + .2915 * \text{ACGS}_{t-1} \\
 & (.0277) \quad (.0970)
 \end{aligned}$$

$$\text{D.W.} = 1.1506$$

$$\bar{R}^2 = 0.8417.$$

Acreage Planted: Oats and Barley

$$\begin{aligned}
 \text{AOBM}_t = & 48.8624 - 8.7332 * \text{DRFG}_t - 0.0023 * \text{VDFG}_t \\
 & (4.610) \quad (6.360) \quad (0.255) \\
 & - 3.5549 * \text{TPC}_t * (1 - \text{DRFG}_t - \text{SPC}_t) + 26.9913 \\
 & (2.589) \quad (75.28) \\
 & * \sum_{i=2}^5 .25 * \text{PAFC}_{t-1} * \text{EYLDOB}_t / \text{COSTFG}_t - 13.5105 * \sum_{i=2}^5 \\
 & \quad \quad \quad (14.4105) \\
 & * \text{PAFS}_{t-i} * \text{EYLDS}_t / \text{COSTS}_t - 10.6786 * \text{LOG}(T) \\
 & \quad \quad \quad (1.846)
 \end{aligned}$$

$$\text{D.W.} = 1.2146$$

$$\bar{R}^2 = 0.8904.$$

Yield Per Planted Acre: Corn and Grain Sorghum

$$\begin{aligned}
 \text{YLDCGS}_t &= 16.2335 + 1.7667 * T + .0549 * \text{NPFNG}_t \\
 &\quad (5.8971) \quad (.3267) \quad (.0544) \\
 &+ .1681 * \text{NPFGP}_t + 39.7564 * \text{DRFG}_t - 14.3800 * \text{D7480} \\
 &\quad (.0640) \quad (16.8134) \quad (3.4455) \\
 &\quad \text{D.W.} = 2.0907 \\
 &\quad \bar{R}^2 = 0.9190.
 \end{aligned}$$

Yield Per Planted Hectare: Oats and Barley

$$\begin{aligned}
 \text{YLDOBM}_t &= 0.3077 + .4443 + \text{LOG}_t + .0969 * \text{SPC}_t + .8035 * \text{DRFG}_t \\
 &\quad (1.328) \quad (.326) \quad (.069) \quad (.368) \\
 &- .1474 * \text{D74} - .2005 * \text{D80} - .0274 * \text{AOB}_{t-1} \\
 &\quad (.120) \quad (.117) \quad (.027) \\
 &\quad \text{D.W.} = 2.0451 \\
 &\quad \bar{R}^2 = 0.7392.
 \end{aligned}$$

Production: Corn and Grain Sorghum

$$\text{PRDFGM}_t = (\text{ACGS}_{t-2} * \text{YLDCGS}_{t-1}) * .0254 + \text{AOBM}_{t-1} * \text{YLDOBM}_t.$$

Acreage Planted: Wheat

$$\begin{aligned}
 \text{AW}_t &= - 28.2084 - .0387 * (\text{NPFNG}_t - \text{NPFGP}_t) / \text{R}_t \\
 &\quad (11.346) \quad (.0360) \\
 &+ - .0410 * (\text{NPSN}_t / \text{R}_t) + .1671 * (\text{NPWN}_t - \text{NPWP}_t) / \text{R}_t \\
 &\quad (.0409) \quad (.0498) \\
 &+ .5052 * \text{AW}_{t-1} + .2153 * \text{AWPA}_t - .0585 * \text{VDPW}_t / \text{R}_t \\
 &\quad (.1380) \quad (.0653) \quad (.0384) \\
 &\quad \text{D.W.} = 1.1920 \\
 &\quad \bar{R}^2 = 0.8850.
 \end{aligned}$$

Yield Per Planted Acre: Wheat

$$\begin{aligned}
 \text{YLDW}_t = & 15.953 + .4474 * T + .001 * \text{NPWN}_t + .0058 * \text{NPWP}_t \\
 & (.9580) \quad (.0755) \quad (.0167) \quad (.0315) \\
 & + 3.819 * \text{DRW}_t \\
 & (1.597)
 \end{aligned}$$

D.W. = 1.4774

$\bar{R}^2 = 0.8522.$

Production: Wheat

$$\text{PRDW}_t = \text{AW}_{t-1} * \text{YLDW}_t.$$

3.2. Grain UtilizationDisappearance, Feed and Residual: Feed Grains

$$\begin{aligned}
 \text{DLVKFG}_t = & 12.5911 + .0016 * \text{COF}_t + .00049 * \text{PIGOF}_t \\
 & (12.7454) \quad (.0006) \quad (.00027) \\
 & + .0000002 * \text{BROF}_t - 73.4626 * \text{RPFPM}_t \\
 & (.00001) \quad (277.303) \\
 & - 9.0054 * \text{Q1} - 22.969 * \text{Q2} - 14.8294 * \text{Q3} \\
 & (1.6775) \quad (2.3569) \quad (2.1969)
 \end{aligned}$$

D.W. = 1.9525

$\bar{R}^2 = 0.9296.$

Disappearance, Food, Alcoholic Beverages, and Seed: Feed Grains

$$\begin{aligned}
 \text{DINDFG}_t / \text{N}_t = & - .0429 + .0011 * T - .0052 * \text{YD}_t / (\text{CPIU}_t * \text{N}_t) \\
 & (.0110) \quad (.0002) \quad (.0044) \\
 & - .0013 * \text{PAFC}_t / \text{CPIU}_t + .0005 * \text{Q1} \\
 & (.0010) \quad (.0011) \\
 & - .0013 * \text{Q2} + .0102 * \text{Q3} \\
 & (.0011) \quad (.0011)
 \end{aligned}$$

D.W. = 2.2760

$\bar{R}^2 = 0.8264.$

Disappearance, Food: Wheat

$$\begin{aligned}
 DFW_t/N_t = & .7677 - .0237 * PAFW_t/CPIU_t + .2073 * CPIAG_t/CPIU_t \\
 & (.3166) \quad (.0135) \quad (.1587) \\
 & - .3737 * CPINAG_t/CPIU_t + .0260 * YD_t/(CPIU_t * N_t) \\
 & (.2579) \quad (.0523) \\
 & - .0358 * Q1 - .2728 * Q2 + .1860 * Q3 \\
 & (.0091) \quad (.0091) \quad (.0089)
 \end{aligned}$$

D.W. = 1.3834

 $\bar{R}^2 = 0.9803$

[70:1 - 83:4].

3.3. Grain InventoriesEnding Inventory, Government-owned and Outstanding CCC Loans:
Feed Grains

$$\begin{aligned}
 KCGFGE_t = & 13.722 + .7287 * KCGFGE_{t-1} - 4.5713 * PAFC_t \\
 & (2.4216) \quad (.0738) \quad (1.3795) \\
 & - SPW_t - .2098 * RATECOMPT_t - 3.2179 * Q1 \\
 & \quad (.1638) \quad (1.6962) \\
 & - 5.8965 * Q2 - 10.3576 * Q3 \\
 & (1.7346) \quad (1.7169)
 \end{aligned}$$

D.W. = 1.134

 $\bar{R}^2 = 0.8869.$ Ending Inventory, Farmer-Owned Reserve: Feed Grains

$$\begin{aligned}
 KFORGE_t = & 5.6604 + .7640 * KFORGE_{t-1} - 9.3060 \\
 & (7.1271) \quad (.2254) \quad (12.2109) \\
 & * (PAFC_t - SPFORC_t) + 1.1082 * (RELPC_t - PAFC_t) \\
 & \quad (3.1585) \\
 & + 1.5045 * (RELPC_{t-1} - PAFC_{t-1}) + 1.9008 \\
 & (2.1359) \quad (2.1561) \\
 & * (RELPC_{t-2} - PAFC_{t-2}) + 2.2972 * (RELPC_{t-3} - PAFC_{t-3}) \\
 & \quad (3.1996) \\
 & + .3889 * RATECOMP_t - .8829 * Q1 - 7.3794 \\
 & (.7510) \quad (4.7140) \quad (5.5433) \\
 & * Q2 - 6.2511 * Q3 \\
 & \quad (5.4290)
 \end{aligned}$$

D.W. = 2.0620

 $\bar{R}^2 = 0.8326.$

Ending Inventory, Free Stocks: Feed Grains

$$\begin{aligned} \text{KPRIFGE}_t &= \text{KPRIFGE}_{t-1} + \text{KFORFGE}_{t-1} + \text{KCGFGE}_{t-1} + \text{PRDFG}_t + \text{MFG}_t \\ &\quad - \text{XFG}_t - \text{DIVKFG}_t - \text{DINDFG}_t - \text{KFORFGE}_t - \text{KCGFGE}_t \end{aligned}$$

Ending Inventory, Government-Owned and Outstanding CCC Loans: Wheat

$$\begin{aligned} \text{KCGWE}_t &= 183.2667 + .7689 * \text{KCGWE}_{t-1} + 2.1825 * (\text{RATECOMP}_t - \text{ICCC}_t) \\ &\quad (76.5321) \quad (.0819) \quad (7.8591) \\ &\quad - 54.4548 * (\text{PAFW}_t - \text{SPW}_t) - 4.1765 * \text{RATECOMP}_t \\ &\quad (21.0149) \quad (4.9031) \\ &\quad - 47.4747 * \text{Q1} - 37.4148 * \text{Q2} + 3.4470 * \text{Q3} \\ &\quad (33.1795) \quad (33.6121) \quad (33.9378) \end{aligned}$$

$$\text{D.W.} = 1.3446$$

$$\bar{R}^2 = .8899$$

[70:1-83:4].

Ending Inventory, Farmer-Owned Reserve: Wheat

$$\begin{aligned} \text{KFORWE}_t &= - 360.5308 + .4907 * \text{KFORWE}_{t-1} \\ &\quad (155.0032) \quad (.0984) \\ &\quad - 379.6828 * (\text{PAFW}_t - \text{SPFORW}_t) + 505.6394 \\ &\quad (149.1098) \quad (117.7975) \\ &\quad * [(\text{RELPW}_t * .2 + \text{RELPW}_{t-4} * .4 + \text{RELPW}_{t-8} * .3 \\ &\quad + \text{RELPW}_{t-12} * .1) - \text{PAFW}_{t-1}] + 507.3979 * (\text{PAFW}_t - \text{SPW}_t) \\ &\quad (142.3806) \\ &\quad + 253.6989 * (\text{PAFW}_{t-1} - \text{SPW}_{t-1}) + 40.5651 \\ &\quad (71.1903) \quad (13.4085) \\ &\quad * (\text{RATECOMP}_t - \text{ICCC}_t) - .2665 * \text{RATECOMP}_t \\ &\quad (10.5174) \\ &\quad + 89.9374 * \text{Q1} + 85.0353 * \text{Q2} - 40.9991 * \text{Q3} \\ &\quad (47.5672) \quad (51.9541) \quad (47.8824) \end{aligned}$$

$$\text{D.W.} = 1.8509$$

$$\bar{R}^2 = .9244$$

[70:1 - 83:9].

Ending Inventory, Free Stocks: Wheat

$$\begin{aligned} \text{KPRIWE}_t = & \text{KPRIWE}_{t-1} + \text{KFORWE}_{t-1} + \text{KCGWE}_{t-1} + \text{PRDW}_t + \text{MW}_t \\ & - \text{XW}_t - \text{DFW}_t - \text{DLVKW}_t - \text{KFORWE}_t - \text{KCGWE}_t. \end{aligned}$$

3.4. Grain PricesPrice at Farm: Corn

$$\begin{aligned} \text{PAFC}_t = & 4.8720 + .8535 * \text{SPC}_t + .4225 * (\text{QFPC}_t - \text{PAFC}_t) \\ & (.6380) \quad (.1240) \quad (.4533) \\ & - \text{PAFC}_t * \text{TBILL3}_t/100 - .02366 * \text{KPRIFGE}_t - .0011 \\ & \quad \quad \quad (.0052) \quad \quad \quad (.0047) \\ & * \text{KFORFGE}_t - .0476 * \text{KCGFGE}_t - 1.1583 * \text{Q1} \\ & \quad \quad \quad (.0036) \quad \quad \quad (.2950) \\ & - 1.8966 * \text{Q2} - 2.7328 * \text{Q3} \\ & \quad \quad \quad (.4246) \quad \quad \quad (.5596) \end{aligned}$$

D.W. = 1.2675

$\bar{R}^2 = 0.8366.$

Price at Farm: Wheat

$$\begin{aligned} \text{PAFW}_t - \text{SPW}_t = & 2.6731 + .4023 * \text{PAFW}_{t-1} - .0017 * \text{KPRIWE}_t \\ & (.5958) \quad (.1172) \quad \quad \quad (.0003) \\ & - .0020 * \text{KFORWE}_t - .0027 * \text{KCGWE}_t + .0005 \\ & \quad \quad \quad (.0002) \quad \quad \quad (.0004) \quad \quad \quad (.0003) \\ & * \text{EDW}_t + .0320 * (\text{RATECOMP}_t - \text{ICC}_t) - .0207 \\ & \quad \quad \quad (.0378) \quad \quad \quad \quad \quad \quad \quad \quad \quad (.0306) \\ & * \text{RATECOMP}_t - .6590 * \text{Q1} - 1.0879 * \text{Q2} \\ & \quad \quad \quad (.2274) \quad \quad \quad (.3445) \\ & + .3278 * \text{Q3} \\ & \quad \quad \quad (.2513) \end{aligned}$$

D.W. = 1.7386

$\bar{R}^2 = .8762$

[70:1-83:4].

3.5. Meat ConsumptionDisappearance: Beef

$$DDBEEF_t = PRDBEEF_t + MBEEF_t - XBEEF_t.$$

Disappearance: Pork

$$DDPORK_t = PRDPORK_t + MPORK_t - XBEEF_t.$$

Disappearance: Broilers

$$DDBR_t = PRDBR_t - XBEEF_t.$$

3.6. Meat ProductionCommercial Production: Beef

$$\begin{aligned} PRDBEEF_t = & 4,185.068 + 16.4227 * Q1 - 187.9163 * Q2 \\ & (506.1477) \quad (91.6243) \quad (164.1059) \\ & - 76.5143 * Q3 - .2251 * (ECOWINV_t - ECOWINV_{t-2}) \\ & (92.1056) \quad (.0309) \\ & + .1074 * CATPL_{t-2} + 68,556.40 * (PAFC_{t-1}/PBEEF_{t-1}) \\ & (0.0713) \quad (11,972.43) \end{aligned}$$

D.W. = 1.2675

 $\bar{R}^2 = 0.7407$

[73:1-83:4].

Commercial Production: Pork

$$\begin{aligned} PRDPORK_t = & - 163.7924 + 347.6416 * Q1 + 352.7452 * Q2 \\ & (467.6178) \quad (104.9475) \quad (97.1138) \\ & + 545.9152 * Q3 + .1976 * PIGC_{t-2} \\ & (150.2064) \quad (0.1973) \\ & - .0161 * (NBHOG_t - NBHOG_{t-1}) + 1,342.606 \\ & (0.1564) \quad (8,494.163) \\ & * (PAFC_{t-1}/PPORK_{t-1}) \end{aligned}$$

D.W. = 1.4552

 $\bar{R}^2 = 0.7996.$

Commercial Production: Broilers

$$\text{PRDBR}_t = 596.4659 + 134.5693 * Q1 + 131.8571 * Q2 - 121.3435 * Q3$$

(99.2464) (25.9959) (25.6173) (26.4201)

$$+ .0032 * \text{BRCH}_{t-1} + 2,245.278 * (\text{PAFC}_{t-1}/\text{PBR}_{t-1})$$

(.00007) (1,378.037)

D.W. = 1.6987

$\bar{R}^2 = .9804$

[73:1-83:4].

3.7. Meat Animal Placements on Feed
Placement of Cattle on Feed, 13 States

$$\text{CATPL}_t = 1,475.963 - 1,901.682 * Q1 - 1,636.137 * Q2 - 1,582.410 * Q3$$

(1,293.466) (190.5938) (185.9975) (185.9567)

$$+ \sum_{i=6}^{10} \alpha_i * \text{ECOWINV}_{t-i} + \sum_{k=0}^4 \beta_k * (\text{PAFC}_{t-k}/\text{PBEEF}_{t-k})$$

D.W. = 1.5468

$\bar{R}^2 = 0.7976$

where

$\alpha_6 = .0099$
(.0019)

$\alpha_7 = .0198$
(.0037)

$\alpha_8 = .0296$
(.0056)

$\alpha_9 = .0395$
(.0075)

$\alpha_{10} = .0494$
(.0093)

$\beta_0 = -51,947.9095$
(8,642.0342)

$\beta_1 = -41,558.3276$
(6,913.6273)

$\beta_2 = -31,168.7457$
(5,185.2205)

$\beta_3 = -20,779.1638$
(3,459.8137)

$\beta_4 = -10,389.5819$
(1,728.4068).

Pig Crop, 10 States

$$\text{PIGC}_t = 7,552.537 - 2,456.050 * Q1 + 2,855.243 * Q2 - 172.4839 * Q3$$

(2,266.338) (479.3789) (478.9968) (479.2586)

$$+ \sum_{i=1}^4 \alpha_i * \text{MBHOG}_{t-1} + \sum_{k=0}^3 \beta_k * (\text{PAFC}_{t-k}/\text{PPORK}_{t-k})$$

D.W. = 0.6735

$\bar{R}^2 = .8304$

[73:1-83:4]

where

$$\begin{array}{llll} \alpha_1 = .8359 & \alpha_2 = .6269 & \alpha_3 = .4179 & \alpha_4 = .2090 \\ & (.1281) & (.0961) & (.0320) \\ \beta_0 = - 88,168.8723 & & \beta_1 = - 66,126.6542 & \\ & (19,140.1160) & (14,355.0870) & \\ \beta_2 = - 44,084.4361 & & \beta_3 = - 22,042.2181 & \\ & (9,570.0580) & (4,785.0290). & \end{array}$$

Broiler Chicks, Hatched

$$\begin{aligned} BRCH_t = & - 108,058.8 + 54,639.02 * Q1 + 112,972.3 * Q2 + 31,999.18 * Q3 \\ & (91,477.61) (19,376.64) (20,347.26) (19,385.41) \\ & + \sum_{i=0}^4 \alpha_i * CPL_{t-i} + \sum_{k=0}^2 \beta_k * (PAFC_{t-k}/PBR_{t-k}) \end{aligned}$$

$$D.W. = 0.3009$$

$$\bar{R}^2 = .8937$$

where

$$\begin{array}{lll} \alpha_0 = 25.4804 & \alpha_1 = 27.9307 & \alpha_2 = 26.6078 \\ & (8.8656) & (2.7834) \\ \alpha_3 = 21.5117 & \alpha_4 = 12.6424 & \\ & (4.2409) & (3.3640) \\ \beta_0 = 16,652.1767 & \beta_1 = 11,101.4511 & \beta_2 = 5,550.7256 \\ & (62,7443.59) & (418,295.7317) & (209,147.8658). \end{array}$$

3.8. Meat Animal Breeding Inventories

Inventory: Cows and Heifers That Have Calved

$$\begin{aligned} ECOWINV_t - ECOWINV_{t-1} = & 2,928.789 + 699.8528 * Q1 + 710.7183 * Q2 \\ & (475.2997) (148.8296) (148.6613) \\ & - 8.7648 * Q3 + \sum_{i=1}^{12} \alpha_i * (PAFC_{t-i}/PBEEF_{t-i}) \\ & (148.5358) \\ & + \sum_{k=0}^{11} \beta_k * RATE_{t-k} \end{aligned}$$

$$D.W. = 1.801$$

$$\bar{R}^2 = .7321$$

$$[73:1-83.4]$$

where

$$\begin{array}{lll}
 \alpha_1 = -6,056.8653 & \alpha_2 = -11,149,6868 & \alpha_3 = -15,278.4646 \\
 (1,102.1727) & (1,933.7690) & (2,501.2361) \\
 \\
 \alpha_4 = -18,443.1986 & \alpha_5 = -20,643.8889 & \alpha_6 = -21,880.5355 \\
 (2,815.9028) & (2,899.2112) & (2,795.2339) \\
 \\
 \alpha_7 = -22,153.1383 & \alpha_8 = -21,461.6973 & \alpha_9 = -19,806.2126 \\
 (2,600.7781) & (2,520.0798) & (2,854.6541) \\
 \\
 \alpha_{10} = -17,186.6842 & \alpha_{11} = -13,603.1120 & \alpha_{12} = -9,055.4960 \\
 (3,770.4720) & (5,205.0854) & (7,056.9482) \\
 \\
 \beta_0 = -2.7770 & \beta_1 = -5.0588 & \beta_2 = -6.8984 \\
 (0.7429) & (1.3620) & (1.8573) \\
 \\
 \beta_3 = -8.2781 & \beta_4 = -9.1979 & \beta_5 = -9.6578 \\
 (2.2288) & (2.4764) & (2.6002) \\
 \\
 \beta_6 = -9.6578 & \beta_7 = -9.1979 & \beta_8 = -8.2781 \\
 (2.6002) & (2.4764) & (2.2288) \\
 \\
 \beta_9 = -6.8984 & \beta_{10} = -5.0588 & \beta_{11} = -2.7594 \\
 (1.8573) & (1.3620) & (0.7429)
 \end{array}$$

Inventory: Breeding Hogs on Farms

$$\begin{aligned}
 \text{NBHOG}_t &= 1,597.858 - 17.5981 * Q1 + 109.7032 * Q2 - 216.3907 * Q3 \\
 &\quad (536.7446) \quad (94.2561) \quad (94.2332) \quad (95.1376) \\
 &+ .8631 * \text{NBHOG}_{t-1} + \sum_{i=1}^5 \alpha_i * (\text{PAFC}_{t-i} / \text{PPORK}_{t-i}) \\
 &\quad (.0669) \\
 &+ \sum_{k=0}^5 \beta_k * \text{RATE}_{t-k}
 \end{aligned}$$

$$\text{D.W.} = 1.6234$$

$$R^2 = .8585$$

$$[73:1-83:4]$$

where

$$\begin{array}{lll}
 \alpha_1 = - 8,932.1284 & \alpha_2 = - 7,145.7027 & \alpha_3 = - 5,359.2770 \\
 (3,638.2642) & (2,910.6113) & (2,182.9585) \\
 \\
 \alpha_4 = - 3,572.8514 & \alpha_5 = - 1,786.4257 & \\
 (1,455.3057) & (727.6528) & \\
 \\
 \beta_0 = - 7.4763 & \beta_1 = - 6.2303 & \beta_2 = - 4.9842 \\
 (3.2020) & (2.6683) & (2.1347) \\
 \\
 \beta_3 = - 3.7382 & \beta_4 = - 2.4921 & \beta_5 = - 1.2461. \\
 (1.6010) & (1.0673) & (0.5337)
 \end{array}$$

Broiler-Type Pullet Chick Placement for Hatchery Supply

$$\text{CPL}_t = 3,330.181 - 40.1686 * Q1 + 210.0152 * Q2 - 919.8476 * Q3 \\
 (1,464.968) (302.6318) (305.8020) (319.9773)$$

$$+ .7230 * \text{CPL}_{t-1} + \sum_{i=1}^4 \alpha_i * (\text{PAFC}_{t-i} / \text{PBR}_{t-i}) + \sum_{i=0}^5 \beta_i * \text{RATE}_{t-k} \\
 (.1307)$$

$$D.W. = 2.1148$$

$$\bar{R}^2 = .6680$$

$$[73:1-83:4]$$

where

$$\begin{array}{lll}
 \alpha_1 = - 9,233.5097 & \alpha_2 = - 6,925.1323 & \alpha_3 = - 4,616.7549 \\
 (8,192.7726) & (6,144.5795) & (4,096.3863) \\
 \\
 \alpha_4 = - 2,308.3774 & & \\
 (2,098.1932) & & \\
 \\
 \beta_0 = 9.2132 & \beta_1 = 7.3706 & \beta_2 = 5.5279 \\
 (15.6189) & (12.4951) & (9.3714) \\
 \\
 \beta_3 = 3.6853 & \beta_4 = 1.8426 & \\
 (6.2476) & (3.1238). &
 \end{array}$$

3.9. Meat PricesRetail Price: Choice Beef

$$\begin{aligned}
 \text{PBEEF}_t/\text{CPIU}_t &= -59.3128 - 1.5352 * \text{DDBEEF}_t/\text{N}_t + .4202 * \text{PPORK}_t/\text{CPIU}_t \\
 &\quad (100.2706) \quad (0.6166) \quad (.1947) \\
 &+ 17.6721 * \text{YD}_t/(\text{CPIU}_t * \text{N}_t) + 107.4208 * \text{CPINAG}_t/\text{CPIU}_t \\
 &\quad (14.1179) \quad (94.5877) \\
 &+ .0698 * \text{Q1} + 1.6447 * \text{Q2} + 1.0661 * \text{Q3} \\
 &\quad (.9195) \quad (.9345) \quad (.5861)
 \end{aligned}$$

$$\hat{p} = .8476$$

$$t \text{ Statistic} = 9.9604$$

[73:1-83:4].

Retail Price: Pork

$$\begin{aligned}
 \text{PPORK}_t/\text{CPIU}_t &= 74.4804 - 4.0423 * \text{DDPORK}_t/\text{N}_t + .3041 * \text{PBEEF}_t/\text{CPIU}_t \\
 &\quad (54.5486) \quad (0.5215) \quad (0.1193) \\
 &+ .5111 * \text{PBR}_t/\text{CPIU}_t - 2.9860 * \text{YD}_t/(\text{CPIU}_t * \text{N}_t) + 32.1498 \\
 &\quad (0.2163) \quad (8.3542) \quad (46.8783) \\
 &* \text{CPINAG}_t/\text{CPIU}_t - 4.8488 * \text{Q1} - 7.2447 * \text{Q2} - 8.7364 * \text{Q3} \\
 &\quad (0.8784) \quad (0.8137) \quad (0.9824)
 \end{aligned}$$

$$\hat{p} = .5047$$

$$t \text{ Statistic} = 3.5645$$

[73:1-83:4].

Four-Region Average Retail Price: Broilers

$$\begin{aligned}
 \text{PBR}_t/\text{CPIU}_t &= 121.7004 - 3.7589 * \text{DDBR}_t/\text{N}_t + .2982 * \text{PBEEF}_t/\text{CPIU}_t + .1712 \\
 &\quad (66.4276) \quad (1.0461) \quad (.0644) \quad (.0708) \\
 &* \text{PPORK}_t/\text{CPIU}_t + 1.7521 * \text{YD}_t/(\text{CPIU}_t * \text{N}_t) - 105.1426 \\
 &\quad (6.4345) \quad (59.6668) \\
 &* \text{CPINAG}_t/\text{CPIU}_t + .7967 * \text{Q1} + 3.7001 * \text{Q2} + 4.4322 * \text{Q3} \\
 &\quad (0.6876) \quad (1.0318) \quad (0.9857)
 \end{aligned}$$

$$\hat{p} = .3122$$

$$t \text{ Statistic} = 1.9113$$

[73:1-83:4].

Footnotes to Appendix A

1/ Transformations of Endogenous Variables (logs, changes, etc.) constitute separate equations in the various simulations and are, by themselves, endogenous variables.

2/ The change in nonborrowed reserves; and the change in gross public debt, outstanding, can be specified either as endogenous variables to the government finance component or as exogenous policy variables depending on how federal government deficits are financed. For instance, if the deficit is not monetized, then the ΔGPDGF is endogenous in the government finance component while $\Delta\text{RESFRBN}$ is an exogenous policy variable.

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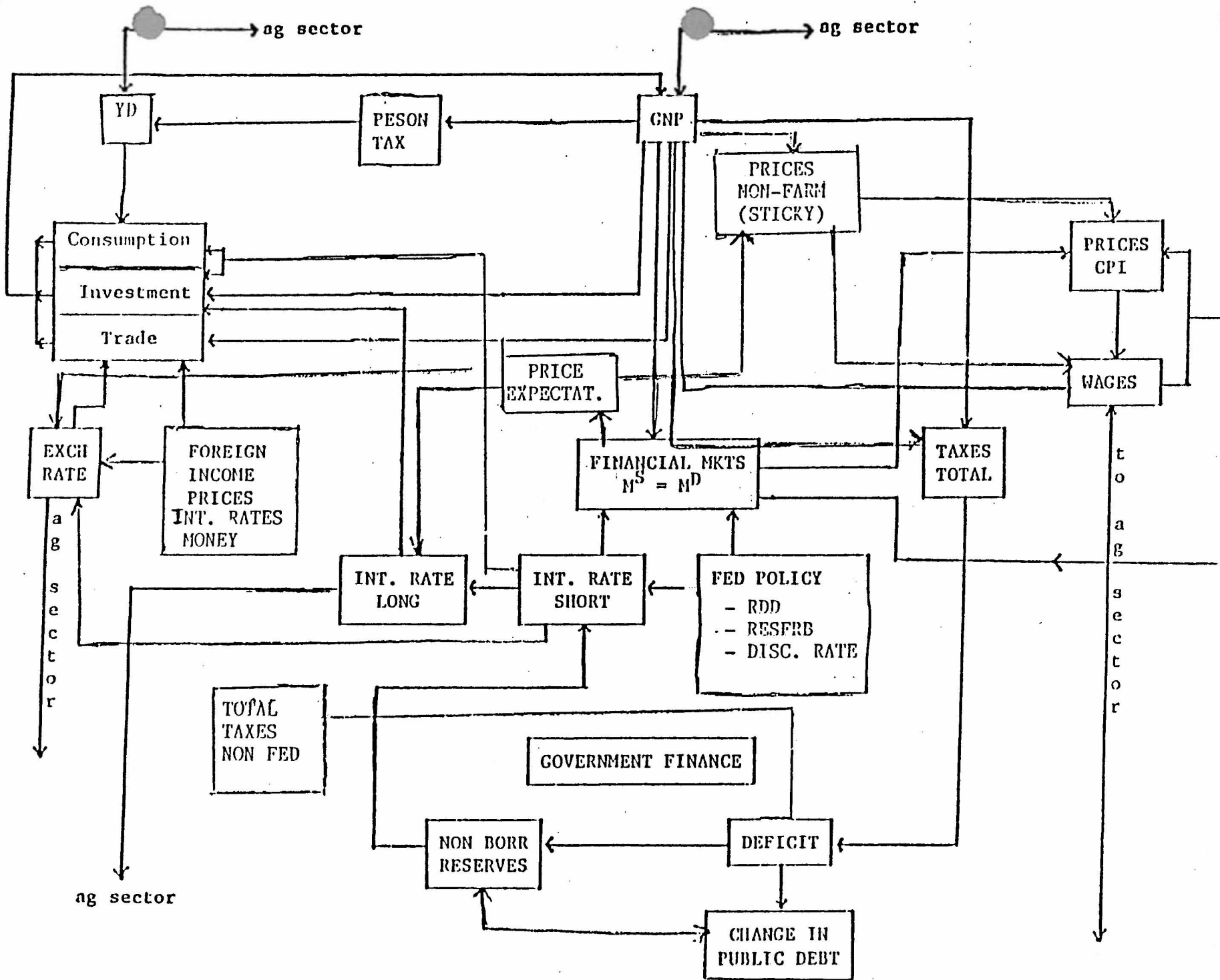
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Referred to on p.36.

Figure 1. Macrocomponent and international components flows

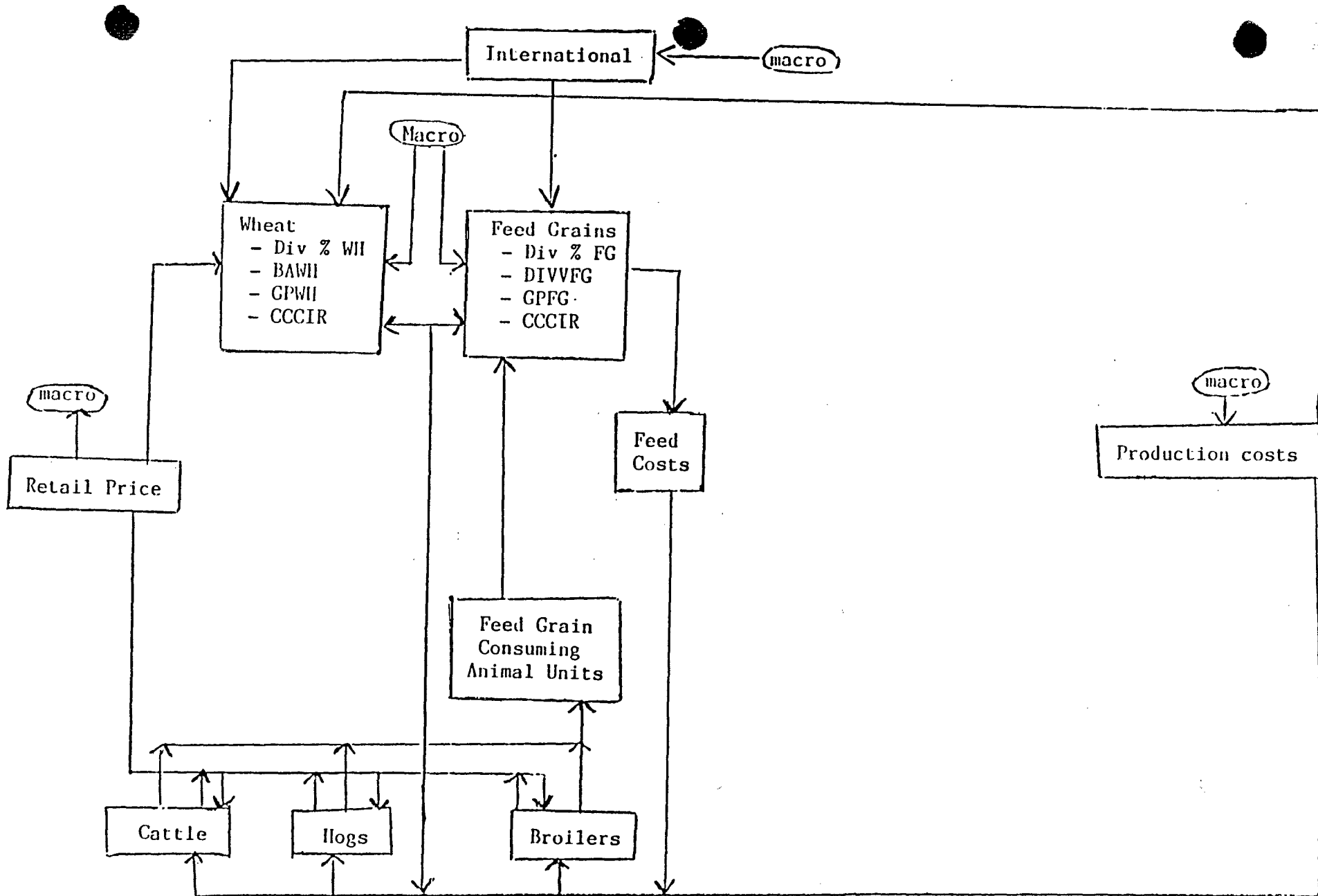


Figure 2. Agricultural sector causal flows

Summary

In the United States, nonmonetization of large federal government deficits over much of the 1980s can be interpreted as a restrictive monetary policy. Such a restrictive monetary policy leads to increases in the real rate of interest and the exchange value of the dollar and to decreases in the long-run equilibrium feed grain and wheat commodity price path. Because of slower adjustment in other segments of the macroeconomy, commodity prices in the short run add insult to injury by overshooting the new long-run equilibrium commodity price. With a very expansionary monetary policy, all of these factors run in the opposite direction.

The simulation results reported in this paper demonstrate that macroeconomic policies can easily dominate the short-run effects of agricultural policies on the price and income paths for U. S. agriculture. The implicit taxes resulting from overshooting that are imposed on U. S. agriculture are modified by the current form and shape of U. S. agricultural policy. In particular, price supports imply downward inflexibility of some commodity prices which, in turn, cause the incidence of the macroeconomic policy tax on agriculture to show up as an unexpected increase in the cost of maintaining price supports and the various forms of government stockholding. Overshooting agricultural commodity markets in the downward direction places some of the implicit tax on the private sector and some on the public sector. Due to the form and shape of current U. S. agricultural policies, the overshooting effects of expansionary monetary policies are asymmetric. Much, if not all, of the subsidy accrues to the private sector.

In the long run, because money is neutral, agricultural sector policies have a more significant influence on resource allocation to the U. S.

agricultural sector than do macroeconomic policies. The sector policies that provide incentives for overallocation of resources to agricultural production quite obviously make that sector especially vulnerable to macroeconomic policies that impose implicit taxes via overshooting. Such sector policies, when combined with macroeconomic policies that "subsidize" U. S. agriculture, must by definition lead to a financial crisis for both private and public sectors if and when macroeconomic policies begin to impose "taxes" via overshooting on agriculture. The dynamic path composed of a subsidy period followed by a tax period during which sector policies provide incentives for overallocation of resources to agricultural production can be expected to create crises.

Gordon C. Rausser

Professor and Chairman. Prior to arriving at Berkeley, Dr. Rausser held faculty appointments at the University of California, Davis; the University of Chicago; Iowa State University; and Harvard University. His awards include the 1976 and 1980 Best Published Research of the American Agricultural Economics Association, the 1982 Outstanding Journal Article of the American Agricultural Economics Association, and the 1978 Western Agricultural Economics Association Award for Quality of Research Discovery. He is currently coeditor of the American Journal of Agricultural Economics and has served on its Editorial Board, is Associate Editor of the Journal of the American Statistical Association, Associate Editor of the Journal of Economic Dynamics and Control, and Editor of Decision Making in Economics and Business (Elsevier/North-Holland Book Publishing Company).