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Analyzing the Effects of U.S. Macroeconomic Policy on U.S. Agriculture Using the USAGMKTS Model

Richard Just

Countries that trade in agricultural commodities with the United States need to sort out the effect of U.S. macroeconomic policy on U.S. agriculture. This report describes the results of simulating the effects of U.S. macro policy on U.S. agriculture.

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This paper — a product of the Agricultural Policies Division, Agriculture and Rural Development Department — is part of a larger effort in PRE to understand the dependence of domestic agricultural markets on domestic macroeconomic policy and the macroeconomic and trade policies of major trading partners. Copies are available free from the World Bank, 1818 H Street NW, Washington DC 20433. Please contact Cicely Spooner, room N8-035, extension 30464 (34 pages with tables).

The USAGMKTS model was developed to determine the effects of potential changes in U.S. policy on the border prices of corn, sorghum, and soybeans.

It is part of a set of interlinked macroeconomic and sectoral models that link Mexico and the United States (with enough specification for the rest of the world to close the system).

The macroeconomic effects of monetary and fiscal policy are estimated using the FAIRMODEL model of the U.S. macroeconomy.

The results show that the effects of U.S. macroeconomic policies on pricing and exports can be substantial. Recent and pending macroeconomic policy adjustments can change prices 15 percent or more. Moreover, the response depends heavily on current economic circumstances.

This model helps countries that trade with the United States to sort out the effect of current economic circumstance on U.S. policies.

Analyzing the Effects of U.S. Macroeconomic Policy on U.S. Agriculture Using the USAGMKTS Model

by
Richard E. Just

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ANALYSIS OF THE EFFECTS OF U.S. MACROECONOMIC POLICY ON U.S. AGRICULTURE USING THE USAGMKTS MODEL

Introduction

This report describes the results of simulating effects of U.S. macroeconomic policy on U.S. agriculture using the USAGMKTS model. The primary purpose for which the USAGMKTS model was developed is to determine the effects of potential changes in U.S. policy on the border prices of corn, sorghum, and soybeans. The USAGMKTS model is a member of a set of interlinked models at macroeconomic and sectoral levels of Mexico and the U.S. (with enough specification of the rest of the world to close the system). The Mexican agricultural model is discussed in the companion report by O'Mara and Ingco (1989). The effects of macroeconomic policy variables on macroeconomic variables affecting the agricultural sector are derived from the FAIRMODEL of the U.S. macroeconomy (see Fair, 1984). These results will be used later to determine the effects of U.S. agricultural and macroeconomic policies on Mexican agriculture using the MEXAGMKTS model described by O'Mara and Ingco.

The USAGMKTS Model Structure

The USAGMKTS model is composed of several market components. The grain demand component disaggregates demands for feed grains and soybeans by consumption, market inventory, and exports following the specifications of Just and Chambers (1981). Demand for government stocks and the farmer owned reserve for feed grains follows the work of Rausser (1985) and Love (1987) with somewhat more structure to reflect the qualitative nature of policy instruments. Livestock supply is composed of three components corresponding to beef, pork, and poultry with each containing equations for livestock inventories, numbers on feed, and meat production. The meat demand component includes consumption demand equations for beef, pork, and broilers. The structure of the livestock model follows along lines used by Just (1981) with revisions to incorporate some refinements developed by Rausser and Love. The grain supply component uses logit equations to represent participation in the feed grain program following the spirit of the work by Chambers and Foster (1983) and later empiricized by Rausser and Love. The acreage equations in particular depart significantly from previous econometric practice and incorporate important aspects of the structural relationships among important program and market variables in the spirit of the intuitive and conceptual framework developed by Gardner (1988) and Lins (1988). The crop supply models are estimated using annual data while the crop demand models and meat supply and demand models are estimated using quarterly data.

The Crop Supply Structure

The basic form of the acreage equations is as follows. First, acreage in a market free of government programs is assumed to follow

(1) $A_f = A_f(\pi_n, \pi_a, A_{f,-1})$

where

A_f = free market acreage of the crop in question

π_n = anticipated short-run profit per acre from production of the crop in question with free market price

π_a = anticipated short-run profit per acre from production of competing crop(s)

$A_{f,-1}$ = lagged free market acreage (to represent production fixities, etc.).

Profit per acre is defined by price times yield less per acre production cost, e.g.,

(2) $\pi_n = P_m Y_a - C$

where

P_m = market price

Y_a = expected yield

C = short-run cost per acre.

When government programs are voluntary, the nonparticipating component of acreage is assumed to follow equation (1) on the nonparticipating proportion of the acreage so nonparticipating acreage is

(3) $A_n = (1 - \phi) A_f(\pi_n, \pi_a, A_{f,-1})$

where

A_n = nonparticipating acreage

ϕ = rate of participation in the relevant government program.

The participating acreage is largely determined by program limitations with

(4) $A_p = B \phi (1 - \theta) - D(G_a)$

where

B = program base acreage

θ = minimum diversion requirement for participation

D = additional diversion beyond the minimum

G_a = payment per acre for additional diversion.

The estimating equation for observed total acreage given the participation level is obtained by combining (3) and (4),

(5) $A_t = B \phi (1 - \theta) - D(G_a) + (1 - \phi) A_f(\pi_n, \pi_a, A_{f,-1})$,

where $D(\cdot)$ and $A_f(\cdot)$ follow linear specifications.

Determining the level of participation in this framework is crucial. Each farmer is assumed to participate if his/her perceived profit per acre is greater under participation than under nonparticipation $\pi_p^i > \pi_n^i$. Assuming that individual perceived profits differ from an aggregate by an amount characterized by an appropriate random distribution across farmers, the participation rate can be represented by a logistic relationship with

$$(6) \quad \ln\frac{\phi}{1-\phi} = \phi^*(\pi_n, \pi_p)$$

where

π_p = the profit per acre under compliance.

Given the qualitative nature of numerous agricultural policy instruments, a conceptually plausible specification of short-run profit per unit of land (producing plus diverted) on complying farms follows

$$(7) \quad \pi_p = (1 - \theta - \mu)\pi_z + \theta \cdot G_m + \mu \cdot \max(G_v, \pi_p)$$

where μ is the maximum proportion of base acreage that can be diverted in addition to minimum diversion, G_m is the payment per unit of land for minimum diversion (zero is no payment is offered for minimum diversion), G_v is the payment per unit of land for voluntary diversion beyond the minimum, and π_z is the short-run profit per unit of producing land under compliance. The latter term suggests no voluntary additional diversion if $G_v < \pi_z$ and voluntary additional diversion to the maximum if $G_v < \pi_z$.

Conceptually, π_z follows

$$(8) \quad \pi_z = [\max(P_t, P_m) \cdot Y_p + \max(P_s, P_m) \cdot \max(Y_a - Y_p, 0) + \max(r_m - r_g, 0) \cdot P_s \cdot Y_a - C]$$

where P_t is the government target price, Y_p is the program yield, P_s is the price support, r_m is the market rate of interest, and r_g is the government subsidized rate of interest on commodity loans under the program (Love). Equation (8) reflects the complicated relationship through which a participating farmer is entitled to at least the target price on his program yield, at least the (lower) support price on all of his production, and gains an additional interest subsidy on a loan against his stored crop (at harvest time) evaluated at the support price. These benefits must be balanced against the opportunity loss of having to divert some of land from production reflected by equation (7).

Once acreage is determined in this framework, it is simply multiplied by yield and added to carryin to determine crop supply. Of course, the relationships in (7) and (8) do not necessarily apply exactly. For example, an uncertain anticipated market price may be discounted by a farmer compared to a target or support price which is known with certainty at the time of acreage decisions. Also, not all farmers place their crop under federal loan to take advantage of the interest subsidy. Nevertheless, intuition and experience implies that equations (7) and (8) apply as reasonable approximations and, furthermore, the approximations apply in a global sense. By comparison, the large number of variables with numerous qualitative relationships involved in these relationships suggests significant problems with objective econometric identification of functional form and makes the possibility of obtaining even plausible signs remote with estimation of ad hoc or flexible forms. See Just (1989) for further details.

The Crop Demand Structure

Following numerous previous studies, the demand for crops is broken into food, feed, export, and inventory components for purposes of specification and estimation of a quarterly model. The inventory component is further broken into farmer owned reserve, government owned, and market components for crops with government programs. The demand system for a given crop is thus of the form

$$
\begin{aligned}
&Q_i = Q_i(P_m, X_i), \quad X_i = (Q_{i,-1}, Y_c, T_j)\\
&Q_f = Q_f(P_m, X_f), \quad X_f = (Q_{f,-1}, F_j, P_j, T_j)\\
&Q_x = Q_x(P_m, X_x), \quad X_x = (Q_{x,-1}, E, T_j)\\
(9)\quad &Q_r = Q_r(P_m, X_r), \quad X_r = (Q_{r,-1}, P_s, P_r, r_m - r_g, D, T_j)\\
&Q_g = Q_g(P_m, X_g), \quad X_g = (Q_{g,-1}, P_s, D, T_j)\\
&Q_m = Q_m(P_m, X_m), \quad X_m = (Q_{m,-1}, Q_r, Q_g, r_m, D, T_j)
\end{aligned}
$$

$$Q_{r,t-1} + Q_{g,t-1} + Q_{m,t-1} + A_t \cdot Y_a = Q_i + Q_f + Q_x + Q_r + Q_g + Q_m$$

including the supply-demand identity where

Q_z = quantity demanded (z = i for industry or food, z = f for feed, z = x for export, z = r for farmer owned reserve, z = g for government stocks, z = m for market stocks)

P_m = market price

X_z = exogenous variables which determine the relevant demand

Y_a = actual average yield

Y_c = per capita consumer income

T_j = quarterly shift terms

F_j = numbers of various types of livestock on feed

P_j = prices of various types of livestock meat

E = trade weighted exchange rate

P_s = support price

P_r = release price

D = shift term reflecting the 1983 PIK program.

The demand system was not estimated in the form of (9) because a system that determines price through an identity equation tends to produce erratic price estimates particularly when demands are inelastic. Alternatively, a demand equation in (9) can be solved for price,

(10) $P_m = Q_i^{-1}(Q_i, X_i)$,

and then the identity can be used to determine Q_i. This approach suffers in practice because the coefficient estimates of exogenous variables in the inverted equation are susceptible to spurious correlations with other factors in the system. This can lead to an unreasonably large contribution of these variables relative to other exogenous variables in the system in determining price predictions in practice. The approach used in this study is to solve the system in (9) for a partial reduced form price equation which is then used to replace one of the demand equations in (9). This partial reduced form equation can be regarded as a convex combination of equations such as (10) which essentially produces a composite price forecasting equation in the sense of Johnson and Rausser (1982) where the weights are estimated simultaneously with the coefficients of the price equation. The number of such equations to combine in this manner is roughly determined by the tradeoff between increased forecasting accuracy of combining more forecasting equations and reduced identification as the total number of variables in the composite forecasting equation increases.

To capture the qualitative nature of government market involvement on the demand side, the government inventory demand equation is estimated including a qualitative relationship between market and support price. For example, the government inventory demand for feed grains equation is of the form

$$Q_g = Q_g(\max(0, (P_s - P_m)\phi), Q_{g,-1}, D, T_j).$$

This equation captures the qualitative relationship whereby stocks are not turned over to the government until the market price falls to the government support level but are increasingly turned over as the market price falls below the support (note that only grain produced under voluntary compliance with the program is supported so the market price can fall below the support price).

The Livestock Supply Structure

The supply of livestock accounts for the dynamic nature of breeding herd adjustment and the long lags in breeding and raising livestock to market weight. The basic form of the model for each species is as follows. First, a stock equation is included for the size of the national breeding herd of the form

(11) $H_i = H_i(P_c/P_i, H_{i,-1}, r_m, T_j)$

where H_i is herd size for species i (e.g., i = cattle), P_c is the price of corn, P_i is the price of meat from species i (e.g., beef for i = cattle), and T_j represents quarterly shift terms. Next, an equation is included for numbers on feed of the form

(12) $F_i = F_i(H_{i,-k}, P_c/P_i, T_j)$

where k is the number of quarters required to reach feeding age in species i. Finally, a meat production equation is included of the form

(13) $M_i = M_i(F_i, H_i - H_{i,-1}, P_c/P_i, r_m, T_j)$

where M_i is the production of meat from species i. The term $H_i - H_{i,-1}$ is included to capture the addition to meat production caused by culling breeding herds.

The livestock production model consists of a set of equations similar to (11)-(13) for cattle, hogs, and poultry.

<u>The Meat Demand Structure</u>

The meat demand system is considered independently of the crop demand systems since meats and grains are not very closely related except as grain prices affect meat supply. Each demand equation is estimated in price dependent form with

$$P_i/Y = P_i(P_j/Y_c, P_o/Y_c, C_i/N, T_j)$$

where Y is per capita income, P_j represents prices of other meats (included individually), P_o is a price index for non-farm prices, C_i is domestic consumption of meat i, and N is population. The meat demand system is completed by net import/export equations of the form

$$I_i = I_i(P_i, I_{i,-1}, E, T_j)$$

where I_i is net imports (negative for net exports) and E is a trade weighted exchange rate and identities of the form

$M_i + I_i = C_i$.

Detailed Specification

The structure of the model is evident from the discussion above and the variable definitions given in Tables 1 through 4. Endogenous variables determined in the various components of the USAGMKTS model are listed in Table 1. Exogenous agricultural policy variables are listed in Table 2. Macro-economic variables affecting the USAGMKTS model are listed in Table 3. These variables are determined endogenously by the FAIRMODEL. Table 4 lists the other exogenous variables which consist of time, population, and a world production variable.

The feed grain supply component consists of a logistic equation that explains program participation, an equation that explains nonparticipating feed grain acreage and variation from program acreage (base acreage less minimum diversion requirements) on participating farms, an equation that represents feed grain yield, and an equation that explains how per acre costs of feed grain production respond to feed grain prices. The participation equation follows (6) with a dummy variable added to represent years when diversion was not required to receive program benefits. The acreage equation follows (5) with soybeans as the competing crop. The yield equation is a simple time trend modified to represent response of yields to diversion which presumably removes poorer acreage from production first. The cost equation specifies cost of production as a function of output price following the arguments of Gardner (1984) whereby the prices of inputs are bid up to exhaust rents. Finally, a production identity is included which expresses production as the product of acreage and yield.

The soybean supply component has a structure similar to feed grains except that no participation equation is included since there has been no voluntary program. Hence, the acreage equation follows the free market form in (1). The yield equation follows a simple time trend with variations in response to feed grain diversion (which presumably removes poorer acreage from soybean as well as corn production) and the ratio of profit per acre for feed grain production to that for soybean production (representing the shift of higher quality land toward the more profitable crop). The structure of the cost-of-production equation and the production identity is the same as for the feed grain supply component.

For purposes of estimation, the demand for feed grains is broken into the demand for feed, industry, exports, farmer owned reserve, government owned stocks, and feed grain price which implicitly determines free stocks through an identity. Feed demand depends on cattle, hog, and broiler numbers since all three types of livestock are heavy users of corn as well as on the ratio of corn price to meat price. Industry demand is driven primarily by consumer income and export demand depends heavily on the exchange rate. The demand for farmer owned reserves depends on the support and release prices and the interest rate subsidy with further alterations associated with the payment-in-kind (PIK) program. Government demand for stocks depends on the relationship of market and support prices and on the level of program participation. Market stocks are determined by a market supply-demand identity where the major determinants of feed grain prices are stock levels, the exchange rate and world market conditions, and the price of meat.

The soybean demand block contains equations for exports, crushings, and price with inventory determined implicitly by a supply-demand identity. The structure of the export equation is essentially the same as for feed grains.

Crushings are determined by livestock numbers, reflecting the feed use of soybean meal, and consumer income, reflecting demand for soybean oil. The major determinants of price are livestock numbers, stocks, world market conditions, and interest rates.

The structure of meat supply follows the earlier generic discussion of livestock supply with breeding-herd, numbers-on-feed, and production equations. The beef supply component has a breeding herd equation driven by the corn-beef price ratio and interest rates, a cattle-placed-on-feed equation driven by lagged breeding herd size and the corn-beef price ratio, and a beef production equation driven by cattle placed on feed, the change in breeding herd size, and the corn-beef price ratio. In addition, an equation is included to explain cattle on feed as a function of cattle placed on feed with appropriate lagging.

The hog supply component has a breeding herd equation driven by the corn-pork price ratio and interest rates, a pig crop equation driven by breeding herd size and the corn-pork price ratio, and a pork production equation driven by the pig crop, the change in breeding herd size, the corn-pork price ratio, and the interest rate.

The poultry supply component has an equation for pullets placed in broiler hatchery flocks driven by previous placements and the corn-broiler price ratio, an equation for broilers hatched depending on the corn-broiler price ratio and hatchery flock size (represented as a linear combination of previous pullet placements), and an equation determining broiler production as a function of broilers hatched and the corn-broiler price ratio.

The meat demand component has three sets of equations. The first is a system of domestic demand equations where each demand equation is represented in price dependent form with each demand depending on the prices of the other two meat types and the price of all other goods. Consumer income is included and homogeneity is imposed by expressing all prices relative to consumer income. The second set of equations determines net trade demand for each meat type as a function of the exchange-rate modified (world) price. The third set of equations are supply-demand equations which close the system.

The exchange rate equation is a simple partially reduced form equation designed to reflect the effects on exchange rates of major changes in macroeconomic policy. Since the major macroeconomic policies of interest are monetary and fiscal policy, the two variables most commonly used as measures of the corresponding effects are included -- the real interest rate and the federal deficit.

The FAIRMODEL

The FAIRMODEL of the U.S. macroeconomy is described in detail by Fair (1984). The model contains 128 equations consisting of 30 stochastic equations and 98 identities. The specification of these equations bases macroeconomic phenomena on microeconomic foundations, allows for possible disequilibrium in some of the markets some of the time, and incorporates balance sheet and flow-of-fund constraints explicitly. The data base is quarterly beginning in 1952. The model is estimated by two stage least squares.

The FAIRMODEL consists of six sectors: a household sector, a firm sector, a financial sector, a federal government sector, a state and local government sector, and a foreign sector. The household sector consists of nine stochastic equations including three consumption equations, one residential investment equation, four labor supply equations, and a demand for money equation. Consumption tends to follow the Keynesian paradigm when employment is low but tends to follow the classical paradigm as full employment is reached. The demand for money depends on income and the short term interest rate.

The firm sector consists of twelve stochastic equations determining production, plant and equipment investment, employment demand, the price level, the wage rate, and the firm sector demand for money. The price level depends heavily on the import price deflator. The demand for money depends on sales and the short term interest rate.

The financial sector contains five stochastic equations determining bank borrowing from the Federal Reserve, the bond interest rate, the mortgage interest rate, the change in stock prices, and the demand for currency.

The federal government sector contains two stochastic equations explaining interest payments by the federal government and the three-month Treasury bill rate. Interest payments are a function of the amount of government securities outstanding and the short and long term interest rates. The three-month Treasury bill rate is determined by inflation, labor market tightness, real growth, and lagged money supply growth. This interest rate is normally endogenous in the model but can alternatively be handled as an exogenous policy instrument.

The state and local government and foreign sectors are simple containing one stochastic equation each. The first has an equation explaining unemployment insurance benefits while the second has an equation explaining demand for imports. Demand for imports follows the standard specification depending on prices and income.

The FAIRMODEL is designed to simulate a variety of alternative U.S. macroeconomic policy scenarios. Four policy scenarios are selected here to represent a plausible set of alternative adjustments in U.S. macroeconomic policy instruments. They include the following:

1. A change in the U.S. Treasury bill rate.

2. A change in U.S. government expenditures.

3. A change in the U.S. personal income tax rate.

4. A change in the U.S. federal deficit.

Each of these alternatives represent major changes that have taken place in the U.S. macroeconomy over the past decade. Conceivably, major adjustments in these policy instruments could again be exercised. For example, the present U.S. federal deficit that is looming so large in political debate in Washington could be resolved by any one or a combination of these measures.

The first step in the calculation of macroeconomic effects on agriculture here is to simulate the FAIRMODEL to determine the effect of increasing each of these policy instruments on the various macroeconomic transmission variables that affect the agriculture sector. These transmission variables include inflation (as reflected by the GNP price deflator), the interest rate (the three-month U.S. Treasury bill rate), disposable income, the price level of nonfarm sales (the GNP price deflator for nonfarm total sales), and the U.S. federal deficit.

Estimated Effects of U.S. Macroeconomic Policy on U.S. Agriculture

Using the estimated effects of U.S. macroeconomic policy variables on the macroeconomic transmission variables, the USAGMKTS model is used here to calculate the resulting effects on major U.S. agricultural prices and trade. To generate estimates that can be interpreted as elasticities, the macroeconomic simulations are done with each of the alternative macroeconomic policy instruments increased by 1.0 percent from historically observed levels. The resulting effects on macroeconomic transmission variables are then fed directly into the USAGMKTS model to estimate effects on U.S. agricultural prices and trade which have elasticity interpretations. Note, however, that the elasticities are general equilibrium elasticities rather than partial elasticities since they estimate responsiveness given all adjustments in related markets.

The results holding U.S. agricultural policies constant at their historical levels are reported in Tables 5 through 8. Table 5 reports estimated price elasticities and Table 6 reports estimated trade elasticities where macroeconomic policies are altered beginning with the first quarter of 1981. Tables 7 and 8 report corresponding estimates where macroeconomic policies are altered beginning with the first quarter of 1984. The estimates in each case are reported for a two year horizon with quarterly responses summarized by yearly averages. The main purpose in presenting a two year time horizon is to illustrate effects in the short-run before production has a chance to respond (the first crop following the change in policy is harvested near the end of the first year) as well as in a longer-run period after production has been able to respond.

<u>An Increase in Interest Rates</u>. The results show that an increase in interest rates (the Treasury bill rate) has a depressing effect on agricultural prices with a mixed effect on agricultural trade. These effects occur along two avenues. On the macroeconomic side, the higher interest rates attract capital inflows that bid up the price of the dollar in terms of foreign currency (EXR, which is the inverse of the price of the dollar, declines in Table 5). This makes U.S. exports more expensive abroad and thus weakens demand for U.S. grain exports and puts downward pressure on feed grain and soybean prices. On the agricultural side, the higher interest rates increase costs of carrying livestock inventories. This results in selling off herds which puts downward pressure on meat prices and [illegible] demand for feed which, in turn, puts downward pressure on feed grain and soybean prices.

Given the magnitude of interest rate adjustments that were occurring in the early 1980s, these effects can be substantial. For example, using the estimates from Table 5, a doubling of interest rates (100 percent increase) produces a 27 percent decline in the price of feed grains in the first year and a 37 percent decline in the second year. The effects for soybeans are of almost the same percentage magnitudes. These effects are not unlike what was observed in the early 1980s. Corn price declined from $3.09 per bushel in the fourth quarter of 1980 to $2.39 a year later and $2.12 two years later.

The reasons for the mixed effects on agricultural trade are as follows. The effects on livestock feeding activity are mixed because the lower meat prices are offset by lower feed prices. For example, the corn price declines by more in relative terms than beef price which implies according to the estimated model that cattle numbers and beef production increases. On the other hand, the price of pork declines by more in relative terms than corn price which implies according to the estimated model that hog numbers and pork production declines. The increase in beef production and decline in pork production account for the reduction in beef imports and increase in pork imports in Table 6. Similarly, broiler price declines by less than corn price which tends to increase broiler production which explains the increase in broiler exports in Table 6. [The reader should bear in mind that trade in meats by the U.S. is small particularly for pork. Thus, a small change in the production-consumption balance can produce a large percentage change in meat trade.]

The increase in soybean exports is somewhat difficult to explain but is apparently due to several factors. First, soybean exports are less exchange rate sensitive than corn. Second, soybean price declines somewhat less than corn price which leads to a shift in acreage toward soybean production.

Third, the feed demand equations appear to reflect relatively more feeding of corn compared to soybeans in the price and livestock numbers situation caused by higher interest rates.

Turning to the results in Tables 6 and 7, which correspond to the 1984-85 period rather than 1981-82, the effects of an increase in interest rates are qualitatively identical. However, the magnitude of effects is considerably less. The reason for the smaller effects is largely explained by the smaller exchange rate effects generated by the state of the macroeconomy. This difference is due to the relative effects of the Treasury bill rate on the rate of inflation and the government deficit generated by the FAIRMODEL. The FAIRMODEL is nonlinear and given the more extreme real interest levels and budget tightness in 1984-85, a given change in the Treasury bill rate generates a greater change in inflation (smaller change in the real interest rate) and smaller change in the budget deficit.

<u>An Increase in Government Expenditure</u>. The results in Tables 5 and 6 show that an increase in government expenditures has a positive effect on most agricultural prices immediately but that the effect can turn negative for some commodities in the second year. These effects occur through two important channels. First, increased government expenditures cause higher consumer income and, thus, higher domestic demand for agricultural commodities. The higher demand for meat is reflected in livestock numbers and feed demand and prices more in the second year after more herd size adjustment is possible. Second, the increased expenditure by government causes inflation which results in a decline in the value of the dollar (EXR increases in Table 5). This tends to increase the demand for exports for feed grains and soybeans as reflected by Table 6.

The differing effects on beef and pork imports are again explained by the differing effects on the corn-meat price ratios. The corn-beef price ratio increases while the corn-pork price ratio declines. As a result, beef production declines and beef imports increase while hog numbers and, thus, pork production increases and pork imports decline. The decline in broiler exports is explained by an increase in demand for poultry resulting from the higher pork price. This effect outweighs the positive effect of the declining corn-broiler price ratio on broiler production. The decline in livestock prices in the second year is apparently a dynamic effect of increased herd size motivated by the higher livestock prices of the first year.

Turning to the effects of increasing government expenditure in 1984-85 in Tables 7 and 8 (as opposed to the effects in 1981-82), the effects on feed grain markets are again qualitatively the same. However, the magnitude of many effects is larger and even the qualitative effects differ for soybeans and livestock. The reason for the difference in effects is due to the different state of the feed grain program in 1984 compared to 1981. In 1981, there was no program participation requirement so program benefits were available without planting restrictions. In 1984, participants were required to plant 10 percent less than base acreages to be eligible for program benefits. The result is that a given increase in market price in 1984 causes a decline in program participation which results in a larger increase in acreage than in 1981. This both moderates the feed grain price increases and stimulates the feed grain export effects. The smaller feed grain price effects give more strength to livestock markets in the second year and permit the positive meat and soybean price effects to be sustained.

An Increase in the Personal Income Tax Rate. The effects of an increase in the personal tax rate are, broadly speaking, the mirror image of effects of increasing government expenditure. That is, according to the standard national accounts equation, increasing government expenditure has the same effect on the government deficit as reducing income taxes. Indeed, the results in Tables 5 through 8 verify that, aside from a few minor cases, the qualitative effects are exactly the opposite. The same intuitive explanation follows accordingly. Basically, the effects of an increase in the tax rate are a reduction in consumer disposable income and inflation, an increase in the value of the dollar, and a resulting decline in feed grain prices and exports.

An Increase in the Federal Deficit. Intuitively, the effect of the federal deficit would seem to be the same as government expenditures and opposite of the effect of income taxes. Indeed, the results for increasing the deficit in Tables 5 and 6 are qualitatively almost identical to the case of increasing expenditures and almost opposite to the case of increasing the tax rate. However, exogenous control of the deficit in the FAIRMODEL causes some substantive differences from the case where expenditures or taxes are controlled exogenously These differences are illustrated by Tables 7 and 8 where the effects of the deficit are qualitatively similar to the effects of the tax rate and almost the opposite of the effects of expenditures.

The contrast of results between the two time periods turns on the exchange rate effects. The reason for the different effects is that an increase in the deficit has offsetting effects on the exchange rate; which effect dominates depends on current circumstances. On one hand, an increase in the deficit (say, by an increase in expenditure) has a positive effect on inflation which tends to reduce the real interest rate and the real cumulated deficit. On the other hand, an increase in the deficit causes government to increase the demand for capital to finance the deficit which tends to bid up the real interest rate and increase the real cumulated deficit. When an expenditure increase is imposed exogenously (second column of Tables 5 through 8), inflation tends to cause a reduction in the real cumulated deficit and a reduction in the real interest rate both of which reduce government payments of interest. This effect tends to offset the increase in expenditure as it affects the deficit and tends to mitigate the increased demand for capital and upward effect on nominal interest rates that would otherwise occur. When the deficit is increased exogenously (fourth column of Tables 5 through 8), neither the effect on the deficit nor its capital demand effects on nominal interest rates can be mitigated.

In the results for 1981-82, the inflation effect on the real interest rate is strong enough to dominate the upward effect on nominal interest rates and the deficit effect on the exchange rate while in 1984-85 the deficit and nominal interest rate effects override the inflation effect. If these aspects of the FAIRMODEL and the exchange rate equation estimated here are realistic, the results have some interesting implications for effects on agriculture of reducing the U.S. federal deficit through a direct deficit control measure such as the Gramm-Rudman bill versus direct control of spending or taxes. The results in Table 7 illustrate that direct control (reduction) of the deficit is more likely to reduce the value of the dollar and stimulate agricultural export demand than direct control (reduction) of government expenditure or direct intervention to increase the tax rate.

The results in Tables 5 through 8 for controlling the federal deficit imply that pending U.S. federal deficit measures could have substantial effects on both prices and exports of major U.S. agricultural commodities. For example, if the flow deficit is reduced by 100 percent to achieve a balanced budget, the estimates show that feed grain prices could change anywhere from -15 percent to +4 percent depending on conditions in the rest of the economy at the time of the change. Feed grain exports could change by -16 to +9 percent with much larger effects after adjustment. Apparently, soybean prices could change by much greater percentages by the second year of adjustment. Thus, an ability to sort out the role of current economic circumstances appears to be important for trading partners of the U.S. in anticipating effects of U.S. fiscal policies on trade conditions and the necessity of enacting policies to deal with the effects.

Importance of Agricultural Policy Instruments

Another issue of critical importance in sorting out the effects of U.S. macroeconomic policies on U.S. agricultural prices is the role of U.S. agricultural policy instruments. For example, if an agricultural commodity price is supported at a sufficiently high level, then presumably a change in macroeconomic policy would not have an impact on the nominal commodity price. Since U.S. feed grain policy has a significant price support component, it is interesting to see how agricultural price responsiveness to macroeconomic policies is affected by the level of agricultural price policy instruments.

Table 9 estimates the effects corresponding to Table 5 where the level of U.S. agricultural support and target prices are reduced 10 percent from historical levels. The interesting results here are that agricultural price responsiveness to macroeconomic policy adjustments can be substantially greater when agricultural prices are not being supported as heavily. The elasticities of feed grain price responsiveness to the Treasury bill rate in Table 9 are about 20 percent greater; the elasticity is -.435 in the second year compared to -.368 in Table 5. The response of feed grain prices to the federal deficit are about 50 percent greater; the elasticity is .214 in the second year of Table 9 compared to .148 in Table 5.

These results reveal that the interactions of agricultural and macroeconomic policy are important. A careful analysis of the likely impacts of alternative U.S. policy options from the standpoint of trading partners requires joint consideration of both agricultural and macroeconomic policy alternatives.

Summary

This study reports the estimated effects of macroeconomic policy on U.S agriculture using a model of U.S. corn, sorghum, and soybeans (USAGMK1S) that includes the role of U.S. agricultural policies and related livestock markets. The macroeconomic effects of monetary and fiscal policy are estimated using the FAIRMODEL of the macroeconomy. The results show that the effects of U.S. macroeconomic policies on prices and exports can be substantial. Price effects of recent and pending macroeconomic policy adjustments on the order of 15 percent or more are not unreasonable. Furthermore, the extent of response depends heavily on current economic circumstances. Thus, a policy response capability for countries that trade with the U.S. requires an ability to sort out the effect of current economic circumstances on U.S. policy effects. This study has attempted to develop a model that can help to serve these purposes.

Table 1. Endogenous Variable Definitions for the USAGMKTS Model.

Variable	Definition
Feed Grain Supply Component	
COMPFGA	Feed grain program participation of corn and grain sorghum in percent of acreage
ACGSN	Acreage of corn and grain sorghum in million acres
YLDCGS	Yield per planted acre of corn and grain sorghum in bushels per acre
COSTCGS	Variable costs per acre for corn and sorghum in dollars (includes seed, chemicals & labor) weighted by the respective acreages and deflated by the GNP price deflator
PRDFG	U.S. production of feed grains (corn, sorghum, oats, barley), million metric tons
Soybean Supply Component	
AS	Acreage of soybeans in million acres
YLDS	Yield per planted acre of soybeans in bushels per acre
RCOSTS	Variable costs per acre for soybeans in dollars (includes seed, chemicals & labor) deflated by the GNP price deflator
PRDSH	U.S. production of soybeans, million metric tons
Feed Grain Demand Component	
DLVKFG	U.S. feed and residual of feed grains (corn, sorghum, oats, barley), million metric tons
DINDFG	U.S. feed grain use by industry, million metric tons
XFG	U.S. exports of feed grains (corn, sorghum, oats, barley), million metric tons
KFORFGE	U.S. ending farmer owned reserve stocks of feed grains, million metric tons
KGOVFGE	Ending government owned feed grain stocks (total CCC inventory), million metric tons
KMKTFGE	Ending inventories controlled by market forces (privately held stocks plus stocks under CCC loan)
RPAFC	U.S. average price of corn at farm in dollars per bushel deflated by the GNP price deflator
RPAFSG	U.S. average price of grain sorghum at farm in dollars per bushel deflated by the GNP price deflator
Soybean Demand Component	
XSB	U.S. exports of soybeans, million metric tons
CRUSH	U.S. crushings of soybeans, million metric tons
KPRISBE	U.S. ending free soybean stocks, million metric tons
RPAFS	Soybeans, price at farm, U.S. average in dollars per bushel deflated by the GNP price deflator

Beef Supply Component

TCOWKE = Cows & heifers that have calved (cow inventory) in the U.S., 1,000 head
PRDBEEF = Commercial production of beef, million pounds
COF = Cattle on feed in 13-states, 1,000 head
CATPL = Cattle placed on feed in 13-states, 1,000 head

Hog Supply Component

BRHOGKE = Breeding hog inventory for 10-states, 1,000 head
PRDPORK = Commercial production of pork, million pounds
PIGC = Pig crop for 10-states, 1,000 head

Poultry Supply Component

PRDBR = Total production of young chicken, million pounds
CPL = Pullet chicks placed in broiler hatchery supply flocks in thousands
BRCH = Broiler-type chicks hatched, millions

Meat Demand Component

RPBEEF = Average retail price of choice beef in cents per pound deflated by the GNP price deflator
RPPORK = Average retail price pork in cents per pound deflated by the GNP price deflator
RPBR = Average retail price in 4-regions of broilers in cents per pound deflated by the GNP price deflator
PCDBEEF = Per capita disappearance of carcass weight of beef in pounds
PCDPORK = Per capita disappearance of carcass weight of pork in pounds
PCDBR = Per capita civilian disappearance of young chickens in pounds
MBEEF = U.S. net imports of beef, million pounds
MPORK = U.S. net imports of pork, million pounds
XBR = U.S. net exports of poultry, million pounds

Exchange Rate Component

EXR = Trade weighted Exchange rate index in dollars per unit of foreign currency, 1972 = 1.00

Table 2. Exogenous U.S. Agricultural Policy Variable Definitions for the USAGMKTS Model.

Variable	Definition
ICCCA	- Interest charged on CCC non-recourse loans in percent
BAC	- Base acreage of corn in million acres
BAGS	- Base acreage of grain sorghum in million acres
YLDFGP	- Program yield of feed grains (corn & grain sorghum) in bushels per acre
TPC	- Target price of corn in dollars per bushel (support price and additional support payment prior to 1973)
SPRC	- Support price of corn in dollars per bushel
DRFG	- Diversion requirement of feed grains in percent of base acreage
DPC	- Diversion payment for corn (paid diversion) in dollars per acre
VDFG	- Additional voluntary paid diversion for feed grains in percent of base acreage
VDPC	- Additional voluntary diversion payment for corn in dollars per acre
NOPROG	- Dummy variable, 1 if a feed grain program is in effect, 0 if not
SPRC	- Regular CCC support price of corn in dollars per bushel
SPFORC	- Support price for farmer owned reserve corn in dollars per bushel
RELFORC	- Release price for the farmer owned reserve corn in dollars per bushel
DMYPIK	- Dummy variable for PIK Program, 1 if third or fourth quarter of 1983, 0 if not
ICCC	- Interest rate charged for CCC non-recourse loans in percent

Table 3. Predetermined Macroeconomic Variable Definitions for the USAGMKTS Model (Variables Determined by the FAIRMODEL).

Variable	Definition
GNPD	GNP price deflator
RS	Three month U.S. Treasury-bill rate (percentage points)
YD	U.S. disposable income in billion dollars
PF	U.S. GNP price deflator for nonfarm total sales using 1982 dollars
SGP	U.S. federal deficit

Table 4. Other Exogenous Variable Definitions for the USAGMKTS Model.

Variable	Definition
YEAR	= Two digit year (e.g., 1985 = 85)
D70	= Dummy variable, 1 if 1970, 0 if not
D71	= Dummy variable, 1 if 1971, 0 if not
D72	= Dummy variable, 1 if 1972, 0 if not
D73	= Dummy variable, 1 if 1973, 0 if not
D74	= Dummy variable, 1 if 1974, 0 if not
Q1	= Quarterly dummy variable for first quarter
Q2	= Quarterly dummy variable for second quarter
Q3	= Quarterly dummy variable for third quarter
Q4	= Quarterly dummy variable for fourth quarter
WPRDFG	= World production of feed grains (corn, sorghum, oats, barley), million metric tons
N	= U.S. total population in millions
POP	= U.S. noninstitutional population over 16 years in millions from the FAIRMODEL

Table 5. Elasticities of Response to Major U.S. Agricultural Prices to Macroeconomic Policies, 1981-82

Commodity Price	Macroeconomic Policy Instrument			
	Treasury Bill Rate	Government Expenditure	Income Tax Rate	Federal Deficit
<u>First Year</u>				
Corn (PAFC)	-.266	.014	-.051	.149
Sorghum (PAFSG)	-.266	.020	-.052	.151
Soybeans (PAFS)	-.246	.008	.019	-.047
Beef (PBEEF)	-.063	-.001	.045	-.077
Pork (PPORK)	-.307	.030	-.082	.463
Broilers (PBR)	-.146	.074	-.364	1.748
Exchange rate (EXR)	-.085	.038	-.090	.255
<u>Second Year</u>				
Corn (PAFC)	-.368	.021	-.018	.148
Sorghum (PAFSG)	-.368	.022	-.017	.148
Soybeans (PAFS)	-.319	-.001	.197	-1.265
Beef (PBEEF)	-.098	-.017	.230	-1.882
Pork (PPORK)	-.232	-.004	.145	-1.024
Broilers (PBR)	-.217	-.057	.022	.796
Exchange rate (EXR)	-.122	.084	-.161	1.038

Table 6. Elasticities of Response of U.S. Agricultural Exports to Macroeconomic Policies, 1981-82

	Macroeconomic Policy Instrument			
Export Commodity	Treasury Bill Rate	Government Expenditure	Income Tax Rate	Federal Deficit
First Year				
Corn & Sorghum (XFG)	-.035	.025	-.057	.160
Soybeans (XSB)	.095	.015	-.044	.114
Beef (MBEEF)	-.065	.015	- .022	.075
Pork (MPORK)	.950	-.443	1.016	-2.931
Poultry (XBR)	.028	-.012	.139	-.546
Second Year				
Corn & Sorghum (XFG)	-.059	.076	-.156	.895
Soybeans (XSB)	.062	.025	-.108	.632
Beef (MBEEF)	-.119	.029	.035	-.441
Pork (MPORK)	1.849	-1.250	2.397	-17.757
Poultry (XBR)	.157	.089	-.044	-.566

* Elasticities are for net imports in the case of beef and pork and net exports in the case of all other commodities.

Table 7. Elasticities of Response to Major U.S. Agricultural Prices to Macroeconomic Policies, 1984-85

Commodity Price	Macroeconomic Policy Instrument			
	Treasury Bill Rate	Gove: nent Expenditure	Income Tax Rate	Federal Deficit
<u>First Year</u>				
Corn (PAFC)	-.108	.010	-.013	-.020
Sorghum (PAFSG)	-.107	.009	-.012	-.020
Soybeans (PAFS)	-.143	.008	-.003	-.009
Beef (PBEEF)	-.032	-.013	.056	.082
Pork (PPORK)	-.128	.003	.002	.026
Broilers (PBR)	-.040	.035	-.140	-.117
Exchange rate (EXR)	-.065	.047	-.082	-.105
<u>Second Year</u>				
Corn (PAFC)	-.227	.025	-.029	-.039
Sorghum (PAFSG)	-.226	.025	-.029	-.039
Soybeans (PAFS)	-.166	.023	.031	-.025
Beef (PBEEF)	-.048	-.035	.132	.231
Pork (PPORK)	-.112	.000	.051	.059
Broilers (PBR)	-.081	.031	-.073	-.371
Exchange rate (EXR)	-.075	.096	-.146	-.168

Table 8. Elasticities of Response of U.S. Agricultural Exports to Macroeconomic Policies, 1984-85

	Macroeconomic Policy Instrument			
Export Commodity	Treasury Bill Rate	Government Expenditure	Income Tax Rate	Federal Deficit
<u>First Year</u>				
Corn & Sorghum (XFG)	-.033	.041	-.067	-.091
Soybeans (XSB)	.088	.034	-.060	-.100
Beef (MBEEF)	-.045	.016	-.011	-.008
Pork (MPORK)	.203	-.166	.273	.363
Poultry (XBR)	.035	-.026	.148	.207
<u>Second Year</u>				
Corn & Sorghum (XFG)	-.038	.103	-.159	-.174
Soybeans (XSB)	.058	.042	-.101	-.050
Beef (MBEEF)	-.066	.029	-.008	.031
Pork (MPORK)	.677	-.864	1.288	1.566
Poultry (XBR)	.107	-.028	.135	.469

* Elasticities are for net imports in the case of beef and pork and net exports in the case of all other commodities.

Table 9. Elasticities of Response of Major U.S. Agricultural Prices to Macroeconomic Policies with Ten Percent Lower Target and Support Prices, 1981-82

	Macroeconomic Policy Instrument			
Commodity Price	Treasury Bill Rate	Government Expenditure	Income Tax Rate	Federal Deficit
<u>First Year</u>				
Corn (PAFC)	-.291	.023	-.057	.171
Sorghum (PAFSG)	-.290	.015	-.058	.166
Soybeans (PAFS)	-.247	.008	.018	-.040
Beef (PBEEF)	-.065	.000	.040	-.052
Pork (PPORK)	-.312	.032	-.090	.508
Broilers (PBR)	-.153	.078	-.380	1.843
<u>Second Year</u>				
Corn (PAFC)	-.435	.025	-.025	.214
Sorghum (PAFSG)	-.433	.027	-.025	.213
Soybeans (PAFS)	-.312	-.001	.190	-1.254
Beef (PBEEF)	-.110	-.020	.221	-1.788
Pork (PPORK)	-.261	-.008	.132	- .883
Broilers (PBR)	-.256	-.067	.004	1.030

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