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ALTERNATIVE SUBSIDY REDUCTION PATHS: THE ROLE OF FISCAL AND MONETARY POLICY LINKAGES

by

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and
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ALTERNATIVE SUBSIDY REDUCTION PATHS: COMMODITY, FISCAL, AND MONETARY POLICY LINKAGES

by

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Abstract

In the case of U. S. agricultural policy, this paper shows how governmental intervention can be formally incorporated in a conditional-vector-error-correcting model. From the resulting theoretical framework and empirical analysis, formal hypotheses are tested regarding both forward and backward linkages among money, exchange rates, and agricultural and nonagricultural markets. Consistent with the current Uruguay Round of the GATT negotiations, a number of policy simulations are conducted with the constructed with the constructed empirical model. Phased reductions in the degree of subsidization in the U.S. agricultural sector are shown, through these policy simulations, to alter the feedback effects from money to prices as well as the dynamic path for exchange rates.

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ALTERNATIVE SUBSIDY REDUCTION PATHS: COMMODITY, FISCAL, AND MONETARY POLICY LINKAGES

1. INTRODUCTION

There is much debate about the potential effects of phased reductions in governmental intervention in U. S. agriculture. Unfortunately, there is little evidence that this debate has taken into account the linkages of the agricultural sector with the balance of the U. S. and international economies. The purpose of the analysis presented in this paper is to give a structural interpretation to the macroeconomic linkages—both forward and backward—between the agricultural sector and the aggregate economy; to review and criticize the structural exploration of macroeconomic time series concerning the agricultural sector and the aggregate economy, and to draw out the implications of alternative macroeconomic shocks on the phased reduction of governmental intervention in agriculture.

The substantial variation in exchange rates, inflation rates, relative farm prices, and agricultural incomes since the early 1970s has induced a new stream of research on the relationships between macroeconomic policy and the agricultural sector [(Schuh 1974, 1976; Tweeten 1980; Gardner 1981; Chambers 1981, 1984; Chambers and Just 1982; Barnett, Bessler, and Thompson 1983; Bessler 1984; Rausser 1985; Rausser et al 1986). In all of these studies, the exchange rate has been recognized as an important determinant of real farm prices through its effects on the trade balance (Schuh 1974). A series of theoretical and empirical studies on the effect of exchange rates has shown, for instance, the importance of an overvalued currency on U. S. agriculture production and exports (Vellianitis-Fidal 1976; Chambers and Just 1979, 1982; Devadoss, Meyers, and Johnson 1986; Orden 1986).

Studies on relative prices and aggregate inflation have supported the hypothesis that the variability in real farm income and prices increases with the general price level variability (Vining and Elwertonski 1976; Parks 1978; Cukierman 1979; Cukierman and Wachtel 1979, 1982; Hercowitz 1981; Mussa 1982; Rotemberg 1982; Fischer 1982; Stockton 1988). At the core of this research is the idea that, if an unanticipated exogenous shock (e.g., monetary expansion) occurs, all the price and interest rate adjustments will happen in some sectors earlier than in others. Assuming prices adjust more quickly in competitive markets than in imperfectly competitive markets, farm prices can be expected to rise faster than nonfarm prices, provided of course that agricultural markets are indeed more competitive.

Various explanations for these relative price movements have included differences in the supply and demand elasticities of specific products (Cairnes 1873) and, more recently, the effects of contract length on the speed of adjustment (Bordo 1980). According to Bordo, a change in money supply causes a faster response for farm commodity prices than industrial prices and a faster response for nondurable than durable prices.

The existence of nominal influences on real variables in agricultural markets has been tested in a numerous studies (e.g., Tweeten, Gardner). In a more general setting, Fischer has studied three sets of hypotheses linking aggregate price changes to relative price variability: the adjustment cost hypothesis, the rational expectation unanticipated disturbance hypothesis, and the asymmetric price response hypothesis. The first two hypotheses imply that relative price variability is affected by macroeconomic disturbances; the third hypothesis implies that autonomous relative disturbances have macroeconomic effects. Under the first two hypotheses, both price level changes and relative price variability are caused by the same aggregate supply and demand interactions.

The third hypothesis is based on the assumption that prices respond asymmetrically to disturbance, for instance, they may be downward inflexible. Under this hypothesis, as Fischer notes (p. 180), "If the disturbances that move relative prices were primarily supply side, resources should be moving out of the industries where prices have risen towards the industries where prices have yet to fall. If the disturbance were demand side, resources should be moving towards the higher prices sectors." Hence, differential responses in prices in this case are due to more than price stickiness alone. In Fischer's empirical work, the available evidence is not totally supportive of the first two hypotheses and the third hypothesis could not be rejected.

A number of other studies address the broader macroeconomic scenario. In some cases, this broader perspective includes an examination of the linkages with agricultural commodity prices (Frankel 1986, Rausser, Rausser et al.). Stemming from Dornbusch's (1976) overshooting models of exchange rate determination, these studies attempt to capture the linkages among exchange rates, money, interest rates, and commodity prices. This work begins with the fixed/flex price specification (following Hicks 1974 and Okun 1975), modelling the farm sector as a set of auction markets while the nonfarm sector is characterized by gradual adjustment of prices. In this framework, agricultural market dynamics is studied, taking into account not only the real demand and supply forces directly related to the farm sector but also the effects of monetary and fiscal policies. The results show that monetary and fiscal policies can have substantial effects on prices and income in the agricultural sector over the short run, whereas sector-specific policies appear to have more significant influences in the long run. Regardless, both sets of policies can have dramatic effects on the dynamic path of the agricultural sector.

Unfortunately, the "state of the art" in examining macroeconomic linkages and the role of monetary, fiscal, and commodity-specific policies on the performance of the U. S. agricultural sector is still unsatisfactory. This is, in large part, because not all linkages have been either conceptually or empirically investigated. In particular, the fix/flex specification neglects the structure of commodity-specific policies which limit the downward movement in many agricultural prices. Moreover, the major emphasis in this work has been on what can be referred to as the *forward linkages*, i.e., those effects that run from the aggregate economy to the agricultural sector. The *backward linkages* have been almost completely neglected.

As noted above, one of the purposes of our analysis is to identify and analyze the backward linkages (from the agricultural sector to money and foreign exchange markets) in conjunction with the forward linkages. Although Gardner (p. 876) might have been correct when he stated, "A fully specified model is not necessary to identify macroeconomic effects upon agriculture; because agriculture is a small part of the general economy (when measured in terms of total value at the farm gate)," there are many other reasons why agriculture could have significant feedback effects on the monetary side of the economy. In particular, a sufficiently large subsidization program for some commodities can have a significant effect on governmental budgets and, thus, fiscal policy. A priori, the fiscal policy effect can in turn influence monetary policy, especially if the monetary authorities' reaction function is not completely exogenous.

With the above motivation as background, we first turn to a theoretical framework that formally incorporates the major features of agricultural policy in the dynamics of commodity, exchange rate, interest rate, money, and manufacturing good markets. This provides the basis for the specification of a vector error correction model with exogenous variables which is empirically estimated in section 3. Based on tests of specific hypotheses regarding identifying restriction as well as forward and backward linkage relationships, a policy simulation model is constructed. This policy simulation model is used to investigate different rates of reduction in governmental subsidization of commodity markets in the face of alternative macroeconomic shocks. From these policy simulation results, a number of concluding remarks and insights are offered in section 6.

2. THE THEORETICAL FRAMEWORK

The theoretical structural model developed here is a two-sector model in which a number of interactions between the money and foreign exchange markets and the goods market are potentially present. These interactions are both direct and indirect and operate through several different channels. In the analysis, the entire set of interactions are admitted—both direct and indirect and among money, exchange rate, and prices—in a full comprehensive model incorporating all the relevant exogenous variables. The major theoretical features of the model can be summarized as follows. Manufacturing output is demand determined, while farm output is partly demand determined and partly supply determined where the supply conditions depend on the degree of intervention of the government in agriculture. Prices adjust slowly to changes in money. A balance-of-payment equation determines the rate of accumulation of reserves as a fraction of the total money stock. Since capital mobility is imperfect, either the capital account or the current account balances can be nonzero in the short run.

The monetary authority intervenes on the foreign exchange market in order to keep the rate of depreciation of the exchange rate in line with the domestic trend of monetary growth. Total money supply growth is given by the rate of credit creation (controlled by the monetary authority) and the rate of accumulation of reserves (controlled through the foreign exchange intervention rule). Price inflation in the two sectors depends on excess demand pressures and on the money growth rate. In the long run, price inflation is equal in the two sectors (as well as output growth) and is equal to the rate of monetary growth. This is equal to the target rate of credit creation, as well as to the rate of exchange depreciation.

Price *inflation* and output *growth* in the two sectors, money *growth*, and the exchange *depreciation rate* are the endogenous variables. The money *stock*, the price *levels* in the two sectors, and the exchange rate *level,* as well as interest rates, foreign prices (we assume the home country is small), total farm stocks, and government expenditure in agriculture, are exogenously given.

Changes in the exchange rate have a direct effect on prices since they imply changes in relative prices. They also have indirect effects, through the foreign exchange intervention rule, since the latter implies a change in domestic supply; a consequent change in income; and, thus, a pressure on prices. Changes in money also have an effect on prices (although not a direct effect as prices are sticky in the short run), since they induce changes in domestic demand. Thus, money is nonneutral in the short run. Changes in money supply have an indirect effect also through the change in interest rates, the change in the capital account balance, the consequent pressures on the exchange rate, and therefore on relative prices. Finally, changes in money also have depreciating effects on the exchange rate through the nonsterilized foreign exchange intervention.

Autonomous changes in prices have an effect on both money and exchange rates. An exogenous supply shock to the entire economy (for example, an oil shock) which has stagflation effects, induces changes in the terms of trade (the real exchange rate and sectorial relative prices) and results in changes in the trade balance; in domestic output; and, hence, in money demand. An accommodating monetary policy and a "leaning against the wind" foreign exchange policy will let the changes in prices be fully reflected in changes in money and exchange rates. Sectoral changes in prices, due to autonomous supply shifts, also have effects on money and exchange rates through the trade balance and domestic demand.

Within the two-sector model, we incorporate the effects of government farm support programs on the dynamics of agricultural prices in response to changes in monetary and exchange rate policy. The effect of the target price is such that, if the government fully "protects" agriculture, then all downward changes in relative prices are paid back to domestic producers. Thus, changes in market prices are dampened; and the supply reduction measure helps producers adjust to exogenous falls in demand and to alleviate excessive stock accumulation. Reducing excess supply thus has dampening effects on inflation variability. In the limit, if the agricultural output is kept at the market-clearing level, price inflation in the farm sector is equal to general trend inflation. The two policy variables can be proxied by two variables whose actual effect turns out to be even more composite—total (private and public) farm stocks and government expenditure in agriculture.

With no intervention policy in agriculture, following an exogenous reduction in the foreign price of agricultural products we would have a shift of internal demand from domestic to foreign goods, a trade balance deficit, and thus depreciating pressure on the exchange rate. The monetary authority would then intervene on the foreign exchange market by contracting the supply of domestic money in the world market according to the intervention rule.

The devaluing pressure on the exchange rate would create an interest differential in favor of the foreign countries and a capital outflow which would increase the depreciating pressure on the exchange rate. Money supply growth would thus decrease proportionally and so would price inflation, at least initially. Real depreciation would then lead to an increase in demand (and output). The increasing output demand would raise inflation, and thus real money balances would start to fall. Nominal interest rates would then increase, thereby restoring the capital account. Ultimately, real depreciation of the exchange rate and falling real money balances would bring the system back to equilibrium.

With government intervention in agriculture, the government is able to "neutralize" any effect of foreign disturbances on domestic prices and demand. That is, the government can fix the target price at the existing domestic price level, allowing domestic producers to sell on the domestic (and world) market at the world price, with the latter below the former, and paying the difference. This kind of intervention amounts to a complete "sterilization" of foreign disturbances on the trade balance, the exchange rate, and on monetary growth and domestic inflation.

In the long run, this strategy would lead to unsustainable cumulative budget deficits; if the foreign price decrease is permanent, an increase in domestic taxes is then necessary in order to finance the deficit. This, however, would lead to a decrease in disposable income with the consequent deflationary effects. Therefore, we define an intervention mechanism that allows zero-sum deficits in the long run. We will assume all nonfarm government expenses are exactly balanced by tax revenues so that all government spending in agriculture amounts to a deficit in its budget. The resulting budget deficit must be either monetized or debt financed.

Both operations have obvious effects on the money market, the capital account, and the trade balance. Increases in government expenditures which are debt-financed directly increase domestic absorption and income but do not have any effect on the monetary base. Increases in government expenditure financed by money creation directly increase domestic absorption and income and obviously affect money supply. In the former case, the overall long-run effect depends on the degree of capital mobility and be either contractionary or expansionary. In the latter case there are no real long-run effects. Without ruling out any of the two possibilities, the budget deficit is specified to be debt financed and partly monetized.

The introduction of government expenditure in agriculture has several implications. First, the real effects of changes in money and in the exchange rate appear to be dampened. This accounts for the sluggishness of movements in prices, output, and the trade balance that occur because of "institutional" factors. In particular, by acting on the way agricultural output reacts to changes in the monetary variables, the standard model is modified and all price deflationary or inflationary effects are lessened. Under this new framework, money is still neutral in the long run; but it has nonneutral effects in the short run which are smaller than in the standard model, and the overshooting in the exchange rate is smaller as well.

Second, the entire dynamics of farm prices is altered. In the standard model, the differences in the dynamics of the two prices are ultimately due to their different degrees of stickiness and to the overall GNP share of the two sectors. These differences can, for instance, put the farm sector in a "cost-price" squeeze if manufacturing prices increase more than farm prices in the short run. With government intervention, farm prices are more protected; and if the degree of intervention is high, the overall real effect on farm prices of monetary contractions or of exchange rate appreciations can be nil, and thus the differential speed effect can turn in favor of farm prices.

Third, several feedback effects other than the ones already present in the standard model can occur in the new formulation. Since the main scope of government intervention is to counter unfavorable movements in relative prices and to dampen the negative effects of monetary shocks on the farm sector, the impact on the money market and on the entire economy resulting from the financing of the budget deficit now represents one more channel of feedback from prices to money and the exchange rate.

2.1 Government Intervention

In order to introduce explicitly government intervention in agriculture, we assume that agricultural producers have a notional supply function of the type defined by Barro and Grossman (1976). This supply function depends mainly on two types of forces: a combination of policy indicator variables and excess demand pressures. The policy indicator variables represented here are target price, q, and a land reduction premium (proxy for set-aside acreage programs), v. Regardless of the market prices, agents who participate in government programs are assured a certain price of q. The second policy indicator serves to lessen the financial burden of accumulating stocks resulting from target prices well above market prices, e.g., under current legislation, an acreage reduction program is employed to assist in reducing producers' supply.[1]

From the point of view of total aggregate domestic supply of sector A, the two government instruments work in opposite ways. The higher q, the higher producers' supply. The higher v, the lower the actual supply. For sector A, the policy forces are represented by G, leaving the form of the function unspecified as G(q, v). Hence, aggregate supply of sector A, Y_A, will depend positively on the policy function G(•, •), on relative prices $(p_A - e - p_A^*)$, and on demand pressures $(1nD_A)$, i.e.,

$$y_A = (1-\omega)\left[\psi G(q,v) + \zeta\left(p_A - e - p_A^*\right)\right] + \omega\left[1nD_A\right]. \tag{1}$$

We restrict the model to satisfy the following assumptions:

$$G_q > 0 \quad ; \quad G_v < 0. \tag{1a}$$

In the long run, goods markets clear; and, hence, supply is entirely determined by policy variables and relative prices. In the short run, however, supply depends also on excess demand pressures.

The coefficients $(1-\omega)$ and ω measure the weight that producers attach to the two arguments in the supply function. If ω is close to one, agricultural output is essentially demand determined. Alternatively, if ω is close to zero, supply would be essentially determined by policy variables and relative prices.

In a competitive world (we have a small country that faces given world prices), if foreign prices (in domestic currency) fall below a certain level, then domestic producers will be paid the price given by q fixed at that level (excluding operating trade barriers). The difference between the target price, q, and the world price, $e+p_A^*$, is paid to domestic producers by the government. Target prices set above market prices create excess supply and large government expenditures to finance the implied level of subsidy.

In order to reduce wide excess supply accumulations from target price incentives, the government affects producers' decisions through the acreage reduction program. The higher stock accumulation, the stronger will be the action of the government to reduce output supply. Although inventories are exogenous in our framework, it is clear that it is the interaction between the inventories and production costs (and revenues) on one side and between the inventories and interest rates on the other that plays a major role in determining the amount of acreage reduction intervention in agriculture.

The workings of commodity program interventions can be embedded in a macroeconomic model by first examining the case of G(q, v) $\approx$ 0, and the equilibrium conditions, $\bar{p}_A=\bar{e}+p_A^*, y_A=\bar{y}_A, \dot{p}_A=\dot{p}=\dot{m}=\dot{e}=\dot{c}, B = T = 0$. Given no trade barriers, an exogenous reduction in the foreign price of agricultural products would result in a shift of internal demand from domestic to foreign goods; a trade balance; and, thus, depreciating pressure in the exchange rate. With no intervention policy in agriculture, the monetary authority would then intervene by contracting the supply of domestic money on the world market.

The pressure on the exchange rate would create an interest differential in favor of the foreign countries and a capital outflow which would increase the pressure on the exchange rate. Money supply growth would thus decrease proportionately, as would price inflation (at least initially). Real depreciation would lead to an increase in demand (and output). The increasing output demand would raise inflation, and thus real money balances would start to fall. Nominal interest rate would then increase, thus restoring the capital account. Ultimately, real depreciation of the exchange rate and falling real money balances would bring the system back to equilibrium.

With government intervention in agriculture, we can have a quite different scenario. Suppose that, in the extreme case, the government wants to neutralize any effect of foreign disturbances on domestic prices and demand. That is, suppose the government fixes the target price, q, at the existing level, p_A, and allows domestic producers to sell on the domestic (and world) market at the world price, $e + p_A^*$, where $e + p_A^* < p_A$ and pays them the difference (per unit of product). This kind of intervention amounts to a complete "sterilization" of foreign disturbances on the trade balance, the exchange rate, and on monetary growth and domestic inflation.

However, this could not last forever since, in the long run, this would lead to unsustainable cumulative budget deficits. If the foreign price decrease is permanent, an increase in domestic taxes would then be necessary in order to finance the deficit, but would lead to a decrease in disposable income with the consequent deflationary effects. Therefore, we need to define an intervention mechanism that would allow zero-sum deficits in the long run.

In what follows, it is assumed that G(q, v) = G(q) + G(v).

$$G(q) = g_1(\dot{p}_A - \dot{e}) \qquad g_1 \geq 0, \tag{2}$$

$$G(v) = g_2(y_A - \bar{y}_A) \qquad g_2 \geq 0, \tag{3}$$

and that world price inflation is zero. Hence, whenever the increase in domestic agricultural prices is greater than the increase in foreign prices (due only to the exchange rate component in this case), the target price will increase at the rate given by difference of the two rates and proportionately to the intervention coefficient, g_1. This formulation ensures that, in the long run,

$$G(q) = 0 \tag{2a}$$

since $\dot{p}_A = \dot{e}$. Similarly, whenever we have an excess supply of farm products, the acreage reduction subsidization will increase at the rate given by the difference between money growth and domestic farm price inflation.[2] Even in this case, in the long run,

$$G(v) = 0. \tag{3a}$$

Notice also that the two rules are not symmetric. Only if $\dot{p}_A > \dot{e}$, will $G(q) > 0$, which means that favorable conditions for the home country imply the lack of any need for government intervention. Similarly, if $\dot{p}_A > \dot{m}$, $G(v) = 0$; this means that, with excess demand pressures having inflationary and output-expanding effects, there is no need for supply reduction incentive programs.

These equalities highlight the relationships among the farm policy instruments. The two types of intervention can be interpreted as follows: The rate of increase in government-financed price-target programs is guided by a rule that relates to the excess of the domestic price increase over the increase of the exchange rate. The higher the "support" (intervention) coefficient, the higher the response in the rate of growth of government expenditure in price-target programs. Hence, in the limit, as g_1 tends to infinity, the rate of increase in domestic agricultural prices is kept equal to the rate of depreciation.

In the above case, the rate of increase of relative prices would be basically zero. What such an intervention rule shows is that the higher government support is, the lower will be the gains (or, alternatively, the losses) in competitiveness due to movement in the exchange rate and/or in foreign prices. However, although temporary shifts in competitiveness are minimized, the negative effects of the increase in the government expenditure for agriculture will have impacts on the government budget deficit and, ultimately, on the money market.

On the other hand, the rate of increase in government-financed supply-reduction programs is guided by a rule that relates it to the excess of money supply growth over farm price inflation. The higher the intervention coefficient, g_2, the higher the response of government expenditure in supply-reduction programs. In the limit, all excess supply is "absorbed" by government intervention so that, ultimately, any excess supply is eliminated and the price growth rate is kept equal to the money supply growth rate. This amounts to assuming, in the limit, that agriculture supply is kept at the market-clearing level. It is clear, however, that even in this case all the budget effects of the supply-reduction programs will have an impact on the money market, depending on the magnitude of the intervention coefficients.

2.2 Trade Linkages

In order to incorporate all the potential linkages, the relationship between the government budget deficit and other variables in the model must be specified. Assume first that domestic taxes exactly match government spending except for the portion of the government expenditure that is allocated to agriculture. In other words, assume that the whole budget *deficit* is spent in farm-support programs. The rate of increase in the budget deficit is actually the cumulative deficit (since in equilibrium it is zero).

Secondly, we know from simple national account identities that the current account balance (CAB) can be associated with the gap between disposable income and private domestic absorption and the gap between taxes and government spending

$$CAB \equiv (Y - TX - A) - (G - TX) \qquad (4)$$

where Y - TX is disposable income, A is private domestic absorption (Y - E + M), and G - TX is the government budget deficit. Hence, the government budget deficit is equal to that part of the trade deficit (assuming unilateral transfers are zero) that exceeds total private domestic excess demand.

An increase in government spending naturally affects domestic aggregate demand. It affects only investment and savings if the increased spending is financed by the sale of government bonds. The sale of bonds does not affect the domestic money supply since the funds obtained by the government from the bond sale returns to the public as the government spends it. Thus, the LM curve is not directly affected by the changes in government debt-financed spending. Of course, if the increase in government expenditure is financed by the issuance of money, then both aggregate demand and demand for money will be affected.

Increases in government expenditure which are debt financed directly increase domestic absorption and income but do not have effects on the monetary base. However, the increase in income heightens the demand for money, driving interest rates up. At the same time, all else constant, the increase has a negative impact on the trade balance, raising the demand for imports. The rise in the interest rates attracts capitals from abroad, restoring the capital account and counterbalancing the current account. Whether the balance of payments will be in surplus or in deficit will depend ultimately on the degree of capital mobility, the magnitude of the income multiplier, the willingness to save, and the propensity to import.

If capital mobility is low, an increase in government expenditure has a negative effect on the balance of payments. Money supply decreases over time, due to the decumulation of international reserves, inducing income to decrease and partially offsetting the initial expansionary effect. If capital mobility is high, a balance of payment surplus will arise and money supply will increase, generating an additional income expansion over time.

Increases in government expenditure financed by money creation directly increase domestic absorption and income and also affect money supply. The income effect generates a trade balance deficit through the increased demand for imports. The excess supply of money will be spent on foreign goods and also on foreign assets, thereby generating a capital account deficit. Complete adjustment will occur over time by means of net purchases of foreign goods. This slow adjustment will be reflected by trade deficits. In essence, the increase in the money supply through the printing of money will induce both the balance of trade and the balance of payments to worsen over the short run.

If no other disturbances occur, however, these payments and trade deficits will be eliminated over time without any major real consequence. The initial adjustment of the balance of payments represents mostly a portfolio-composition move, operating through the capital account, while the subsequent adjustment represents mostly a move to reduce the portfolio size, operating through the trade balance.

2.3 Debt Financing and Money Creation

In the framework presented here, the government budget deficit is presumed to be partly debt financed and partly monetized through money creation. Since the trade balance is a linear function of the log of real income and the log of relative prices, the budget deficit as an explicit determinant of the trade balance, in addition to real income and relative prices, can be represented as

$$T = -(\alpha_A - \beta_A)(e - p_A + p_A^*) - (\alpha_B - \beta_B)(e - p_B + p_B^*) - \tau y - \tau_g G(g,v). \qquad (5)$$

For a 1 percent increase in the budgeted deficit, the trade deficit is assumed to increase proportionately (not considering the income effect). Money growth is now given by

$$\dot{m} = \dot{c} + \frac{\dot{R}}{M} + sG(q,v) \qquad (6)$$

where sG(q,v) is the fraction of the cumulative budget deficit which is monetized, $\dot{c}$ is the rate of domestic credit creation, $\dot{R}$ is the rate of change of reserves, and M is the money stock. Since G(q,v) = G(q) + G(v) from the *intervention rules in agriculture* defined in (2) and (3), we have

$$G(q,v) = g_1(\dot{p}_A - \dot{e}) + g_2\left(\frac{\pi_B}{\pi\pi_A}\right)(\dot{m} - \dot{p}_A). \tag{7}$$

where π_B represents the degree of stickiness of prices in the sector, π_A is the degree of stickiness of prices in the agricultural sector, and π is the total degree of stickiness in prices

If the degree of intervention (g_i) is high, then the government response to any change in the rate of depreciation and/or in the rate of money supply growth will be such that farm price inflation will be brought to the same new rate. That is, the higher g_i, the more $d\dot{p}_A \to d\dot{e}$ and $d\dot{p}_A \to d\dot{m}$.

The effect on the overall economy of such rules can be sketched as follows: If the degree of intervention is high and $d\dot{p}_A / d\dot{e} \approx 1$, then

$$\frac{d\dot{p}}{d\dot{e}} = \rho\frac{d\dot{p}_A}{d\dot{e}} + (1-\rho)\frac{d\dot{p}_B}{d\dot{e}} = \rho + (1-\rho)\frac{d\dot{p}_B}{d\dot{e}} \tag{8}$$

where p_B represents the log of the domestic prices of the manufacturing sector and ρ represents the weight of the agricultural sector on gross national product. Similarly, since $d\dot{p} / d\dot{m} \approx 1$,

$$\frac{d\dot{p}}{d\dot{m}} = \rho\frac{d\dot{p}_A}{d\dot{m}} + (1-\rho)\frac{d\dot{p}_B}{d\dot{m}} = \rho + (1-\rho)\frac{d\dot{p}_B}{d\dot{m}}. \tag{9}$$

Now, money growth depends on domestic credit growth and on exchange rate growth (through accumulation of reserves and foreign exchange intervention). But, as shown in (6), if the government monetizes part of its budget deficit through money creation it also depends on budget growth which, in turn, depends on government intervention rules in agriculture. Therefore,

$$\dot{m} = \dot{c} - \theta(\dot{e} - \dot{c}) + sg_1(\dot{p}_A - \dot{c}) + sg_2\left(\frac{\pi_B}{\pi\pi_A}\right)(\dot{m} - \dot{p}_A). \tag{6a}$$

If both g_1 and g_2 are high (agriculture is fully protected), then all short-run discrepancies between $\dot{p}_A$ and $\dot{e}$ and $\dot{p}_A$ and $\dot{m}$ will be financed by government. Thus, the actual market price, $\dot{p}_A$, will increase at the same rate as $\dot{e}$ and $\dot{m}$, and the difference between *actual* and *potential* price will be fully paid by government. Money growth is given by

$$\dot{m} = (1+\theta)\dot{c} - \theta\dot{e} + s(g_1 - g_2)\dot{p}_A - sg_1\dot{e} + sg_2\left(\frac{\pi_B}{\pi\pi_A}\right)[(1+\theta)\dot{c} - \theta\dot{e}]$$

$$= \left[1 + sg_2\left(\frac{\pi_B}{\pi\pi_A}\right)\right][(1+\theta)\dot{c} - \theta\dot{e}] - sg_1\dot{e} + s\left[g_1 - g_2\left(\frac{\pi_B}{\pi\pi_A}\right)\right]\dot{p}A; \tag{6b}$$

where θ represents how active government intervention is in the foreign exchange market. Note that, if the budget deficit is fully monetized,

$$\dot{m} = \left[1 + g_2\left(\frac{\pi_B}{\pi\pi_A}\right)\right][(1+\theta)\dot{c} - \theta\dot{e}] - g_1\dot{e} + \left[g_1 - g_2\left(\frac{\pi_B}{\pi\pi_A}\right)\right]\dot{p}_A. \tag{6c}$$

2.4 Domestic Market Linkages

For agriculture, the equilibrium condition is

$$1nD_A = \delta\left(\frac{\delta_A}{\delta_B}\right)(e - p_A + p_A^*) + \gamma y - \sigma r \tag{10}$$

where δ, δ_A, and δ_B represent the elasticity of total demand, and the elasticity of demand for agricultural and manufactured products, respectively. If (10) is combined with (1), we have

$$y_A = (1-\omega)\left[\psi G(q,v) - (1-\omega)\zeta(p_A - e - p_A^*)\right] + \omega\delta\left(\frac{\delta_A}{\delta_B}\right)(e - p_A + p_A^*) + \omega\gamma y - \omega\sigma r. \tag{10a}$$

Given a similar expression for y_B, we have

$$y = \rho y_A + (1-\rho)y_B \tag{11}$$

and

$$y = \mu\rho\left\{(1-\omega)\psi G(q,v) - [1-\omega]\left[\delta\frac{\delta_A}{\delta_B} + \xi\right]\left[p_A - e - p_A^*\right] - (1-\omega)\gamma y + (1-\omega)\sigma r\right\} + \mu\delta\left(e - p + p^*\right) - \mu\sigma r \tag{11a}$$

where $\mu = 1(1-\gamma)$, as before. If agricultural producers do not place any weight on supply conditions ($\omega = 1$), then (11a) reduces to

$$y = \mu\delta\left(e - p + p^*\right) - \mu\sigma r \tag{11b}$$

where total aggregate output is a function of relative prices and real interest rate. Therefore, if no weight is put on supply conditions, we are back to the case we have analyzed above. Recall that we are now dealing with a different framework: business sector output is still demand determined (and market B clears), whereas agricultural output is now both supply and demand determined.

Specifying the real interest, r, as the difference between the nominal interest rate, i, and the expected rate of inflation, $\dot{p}^e$, which, under perfect foresight, is equivalent to $\phi y - \lambda(m-p) - \dot{p}$, in long-run-deviation terms, (11b) becomes

$$\begin{aligned} y - \bar{y} = {} & \mu\rho(1-\omega)\left\{\psi G(q,v) - \left[\delta\frac{\delta_A}{\delta_B} + \xi\right]\left[x_A - \bar{x}_A\right]\right. \\ & -\mu\left[\sigma\phi - \rho(1-\omega)(\sigma\phi - \lambda)\right](y - \bar{y}) + \mu\left[\sigma\lambda - \rho(1-\omega)\sigma\lambda\right]\left(h - \bar{h}\right) \\ & +\mu\left[\sigma - \rho(1-\omega)\sigma\right]\left(\dot{p} - \dot{c}\right) + \mu\sigma(x - \bar{x}) \end{aligned} \tag{12}$$

where $\bar{h}$ represents the steady-state real money balances, i.e., h = m - p, and $\bar{x}$ represents the steady-state real exchange rate, i.e., x = e - p. Now, if agricultural producers do not place any weight on supply conditions ($\omega = 1$), then (12) reduces to

$$y - \bar{y} = \mu\delta(x - \bar{x}) - \mu\sigma\phi(y - \bar{y}) + \mu\sigma\lambda\left(h - \bar{h}\right) + \mu\delta(\dot{p} - \dot{c}). \tag{12a}$$

Conversely, if farmers do not place any weight on demand conditions ($\omega = 0$), that is, agricultural output is completely supply determined, then (12) reduces to

$$y - \bar{y} = \mu\rho\left\{\psi G(q,v) - \left[\delta\frac{\delta_A}{\delta_B} + \xi\right](x_A - \bar{x}_A)\right\} - (1-\rho)\mu\sigma\phi(y - \bar{y})$$
$$-\mu\rho\gamma(y - \bar{y}) + (1-\rho)\mu\sigma\lambda(h - \bar{h}) + (1-\rho)\mu\sigma(\dot{p} - \dot{c}) + \mu\sigma(x - \bar{x}) \qquad (12b)$$

since $\delta(x - \bar{x}) = \rho\delta(\delta_A / \delta_B)(x_A - \bar{x}_A) + (1-\rho)\delta(\delta_B / \delta_A)(x_B - \bar{x}_B)$. Rearranging

$$y - \bar{y} = \rho[y - \bar{y}_A] + (1-\rho)[y_B - \bar{y}_B]. \qquad (12c)$$

Equation (12c) makes it clear that, even in this case ($\omega = 0$) total output is equal to the weighted average of the sectoral outputs. However, the significant difference here is that agricultural output is completely supply determined [as can be seen by looking at the first term in (12c)] while nonfarm output is completely demand determined [second bracketed term in (12c)]. Going back to (12) and substituting for $\dot{p}$, we have

$$y - \bar{y} = \frac{1}{S}\left\{\mu\rho(1-\omega)\left\{\psi G(q,v) - \left[\delta\left(\frac{\delta_A}{\delta_B}\right) + \xi\right](x_A - \bar{x}_A)\right\} + \mu\delta(x - \bar{x})\right.$$
$$\left. + \mu[\sigma\lambda - \rho(1-\omega)\sigma\lambda](h - \bar{h}) + \mu[\sigma - \rho(1-\omega)\sigma](\dot{m} - \dot{c})\right\} \qquad (13)$$

where $S \equiv 1 + \mu\sigma(\phi - \pi) - \mu\rho(1-\omega)[\sigma(\phi - \pi) - \gamma]$. Substituting the monetary intervention equation, $\dot{m} - \dot{c} = -\theta(\dot{e} - \dot{c})$, we get

$$y-\bar{y}=\frac{1}{D}[\mu\rho(1-\omega)]\Bigg\{-\psi G(q,v)-\xi(x_A-\bar{x}_A)$$

$$-\left[\delta\frac{\delta_A}{\delta_B}(x_A-\bar{x}_A)\right]-\gamma(y-\bar{y})+\sigma(\phi-\pi)(y-\bar{y}) \tag{14}$$

$$-\sigma\lambda(h-\bar{h})+\sigma\theta(\dot{e}-\dot{c})-\Bigg\}+\frac{1}{D}(y-\bar{y})_D$$

where $D\equiv 1+\mu\sigma(\phi-\pi)$ and $(y-\bar{y})_D=\mu\left[\delta(x-\bar{x})+\sigma\lambda(h-\bar{h})+\sigma\theta(\dot{e}-\dot{c})\right]$. Here $(y-\bar{y})_D$ is just the long-run deviation aggregate output when both outputs are demand determined. Also, as

$$r-\bar{r}=(\phi-\pi)(y-\bar{y})-\lambda(h-\bar{h})+\theta(\dot{e}-\dot{c}),$$

we have

$$y-\bar{y}=\frac{1}{D}[\mu\rho(1-\omega)]\{\psi G(q,v)-\xi(x_A-\bar{x}_A)-(y_A^d-\bar{y}_A^d)+\frac{1}{D}(y-\bar{y})_D$$

since

$$y_A^d-\bar{y}_A^d=\delta\left(\frac{\delta_A}{\delta_B}\right)(x_A-\bar{x}_A)-\gamma(y-\bar{y})-\sigma(r-\bar{r})$$

where y_A^d indicates demand for good A. Hence (14) reduces to

$$y-\bar{y}=\left[\frac{1}{D}(\mu\rho)\right]\left[(y_A^s-\bar{y}_A^s)-(y_A^d-\bar{y}_A^d)\right]+\frac{1}{D}\left[(y-\bar{y})_D\right]. \tag{14a}$$

But, since $\bar{y}_A^d=\bar{y}_A^s$,

$$y-\bar{y}=\left[\frac{1}{D}(\mu\rho)\right]\left[y_A^s-y_A^d\right]+\frac{1}{D}(y-\bar{y})_D. \tag{14b}$$

Now, we can write (14a) as

$$y - \bar{y} = \frac{\mu}{D}\left[\rho\left(y_A^s - \bar{y}_A^s\right) + (1-\rho)\left(y_B^d - \bar{y}_B^d\right)\right]. \tag{14c}$$

This is the reduced-form equation for output, given by a weighted average of long-run deviations of agricultural output (supply determined) and long-run deviations of business sector output (still demand determined). In the long run, supply matches demand in both sectors. In the short run, deviations from the long-run equilibrium values are due to producers' decisions in the agricultural sector and in the nonfarm sector they are due to demand pressures.

Appreciation of the exchange rate by increasing money growth (through the balance of payments and the intervention rule) raises inflationary expectations, reduces the real rate of interest, and therefore expands aggregate demand in both sectors. Equation (14a) shows that a real expansion in the money stock raises output in the nonfarm sector (which is demand determined) and raises demand in the farm sector. According to ω, output will rise proportionally in the farm sector also. However, real depreciation has the opposite effect on agricultural supply, whose elasticity is given by $(1-\omega)\xi$.

Hence, when the economy is away from the stationary equilibrium, a change in relative prices (or in the real exchange rate) has an ambiguous effect on the supply of agricultural output. While an improvement in the domestic relative agricultural price will directly induce higher output, it could also indirectly lead to its reduction through the effect on demand. The total effect of a change in relative prices on the supply of agricultural output will depend on the relative size of these effects.

2.5 Model Solution

Turning to the solution of the model, the balance-of-payments equation, together with the foreign-exchange intervention rule, is now given by

$$-\theta(\dot{e}-\dot{c}) = \eta(i-\dot{e}-i^*) - (\alpha-\beta)(e-p+p^*) - \tau y - \tau_g G(q,v), \tag{15}$$

where η is the degree if capital mobility; α, β are trade balance elasticities; τ is the trade balance elasticity of income; and τ_g is the proportional change in the trade balance from changes in the governmental budget deficit. From this we get

$$\dot{e} = \left[\frac{1}{\theta-\eta}\right]\left[\dot{c} + \eta\lambda h + \eta i^* - (\alpha-\beta)(e-p+p^*) + (\tau-\eta\phi)y - \tau_g G(q,v)\right]. \tag{15a}$$

In the long run, $\dot{e} = \dot{c}$ and G(q,v) = 0. Hence

$$\dot{e} - \dot{c} = \left[\frac{1}{\theta-\eta}\right]\left[(\tau-\eta\phi)(y-\bar{y}) + \eta\lambda\left(h-\bar{h}\right) + (\alpha-\beta)(x-\bar{x}) + \tau_g G(q,v)\right]. \tag{15b}$$

Long-run deviations of output are given by (14), rewritten as

$$y - \bar{y} = a_1(x-\bar{x}) + a_2(h-\bar{h}) + a_3(\dot{e}-\dot{c}) + a_4 G(q,v) + a_5\left(x_A - \bar{x}_A\right) \tag{16}$$

where now

$$a_1 = \frac{\mu\delta}{S} > 0; \quad a_2 = \frac{\mu\delta\lambda R}{S} > 0; \quad a_3 = -\frac{\mu\sigma R\theta}{S} < 0;$$

$$a_4 = \frac{\mu\psi(1-R)}{S} > 0; \quad a_5 = -\frac{\left[\mu\left(\delta\frac{\delta_A}{\delta_B} + \xi\right)(1-R)\right]}{S} < 0; \tag{16a}$$

$$R = 1 - \rho(1-\omega); \quad S = 1 + \mu\sigma(\phi-\eta)R + \mu\gamma(1-R).$$

Similarly, rewrite (15a) as

$$\dot{e} - \dot{c} = b_1\left(y-\bar{y}\right) + b_2\left(h-\bar{h}\right) + b_3(x-\bar{x}) + b_4 G(q,v) \tag{17}$$

where

$$b_1 = \frac{\tau - \eta\phi}{\theta - \eta} > 0; \quad b_2 = \frac{\eta\lambda}{\theta - \eta} > 0;$$
$$b_3 = \frac{\alpha - \beta}{\theta - \eta} < 0; \quad b_4 = \frac{\tau_g}{\theta - \eta} > 0. \tag{17a}$$

Thus, substituting for $\dot{e} - \dot{c}$ from (17) into (16) yields

$$y - \bar{y} = \left[\frac{1}{1 - a_3 b_1}\right]\left[(a_1 a_3 b_3)(x - \bar{x}) + (a_2 a_3 b_2)(h - \bar{h})\right]$$
$$+ (a_4 a_3 b_4)G(q, v) + a_5(x_4 - \bar{x}_A). \tag{18}$$

Two of the four coefficients are unambiguously signed. The first is positive, and the fourth is negative. The second coefficient (the coefficient of real money balances) will depend, again, on the sign of the term, $\theta - \eta - \eta\theta$. Thus, if $\theta - \eta - \eta\theta > 0$, then $\theta / (1 + \theta) > \eta$; that is, the intervention coefficient is greater than the coefficient that measures the degree of capital mobility. Hence, $(a_2 + a_3 b_2) / (1 - a_3 b_1)$ will be positive.

Similarly, the coefficient of the budget deficit term will depend on the sign of $(a_4 + a_3 b_4)$ and, therefore, on various parameters of the model. If $R \to 0$, then $(a_4 + a_3 b_4) > 0$; but, if $R \to 1$, the whole coefficient will be negative. A value of R close to 1 is either due to a small value of the GNP share of the agricultural sector, ρ, or to a high value of ω, regardless of ρ.

Thus, if agricultural producers attach a greater weight to the supply conditions in their supply function ($\omega \to 0$) but the agricultural sector has little importance in the national economy, then the budget deficit will have a negative impact on the domestic output. The positive effect on the agriculture is, in fact, more than offset by negative effect on the rate of depreciation.

Equation (17) now becomes

$$\dot{e}-\dot{c}=\frac{a_1b_1+b_3}{1-a_3b_1}(x-\bar{x})+\frac{a_2b_1+b_2}{1-a_3b_1}\left(h-\bar{h}\right)+\frac{a_4b_1+b_4}{1-a_3b_1}G(q,v)+\frac{a_5b_1}{1-a_3b_1}\left(x_A-\bar{x}_A\right). \tag{19}$$

Again, three of the coefficients are ambiguously signed. The second and third are positive, and the fourth is negative (as is the first). This implies that a depreciation in the real exchange rate (either in one sector or in the aggregate) reduces the rate of depreciation as compared to the trend growth in domestic credit.

The novelty of the above results with respect to the existing literature is that output deviations now depend directly on policy intervention measures in agriculture (and therefore on the budget deficit) and on relative farm prices. Deviations in the rate of depreciation are positively associated with increasing intervention in agriculture and negatively associated with relative prices in the agricultural sector.

Also, since $\dot{h}\equiv\dot{m}-\dot{p}=-\pi(y-\bar{y})$, we have

$$\begin{aligned}\dot{m}-\dot{p}=&-\pi\frac{a_1+a_3b_3}{1-a_3b_1}(x-\bar{x})-\pi\frac{a_2+a_3b_2}{1-a_3b_1}\left(h-\bar{h}\right)\\&-\pi\frac{a_4+a_3b_4}{1-a_3b_1}G(q,v)-\frac{\pi a_5}{1-a_3b_1}\left(x_A-\bar{x}_A\right);\end{aligned} \tag{20}$$

and, noting that $\dot{m}=(1+\theta)\dot{c}-\theta\dot{e}+sG(q,v)$,

$$\dot{m}-\dot{p}=(1+\theta)\dot{c}-\theta\dot{e}+sG(q,v)-\dot{p}. \tag{21}$$

Substituting from (19a) for $\dot{c}$ and equating to (20) yields

$$\begin{aligned}\dot{x}\equiv\dot{e}-\dot{p}=&\frac{(1+\theta)(a_1b_1+b_3)-\pi(a_1+a_3b_3)}{1-a_3b_1}(x-\bar{x})\\&+\frac{(1+\theta)(a_2b_1+b_2)-\pi(a_2+a_3b_2)}{1-a_3b_1}\left(h-\bar{h}\right)\\&+\frac{(1+\theta)(a_4b_1+b_4)-\pi(a_4+a_3b_4)+s}{1-a_3b_1}G(q,v)\\&+\frac{(1+\theta)a_5b_1-\pi a_5}{1-a_3b_1}\left(x_A-\bar{x}_A\right).\end{aligned} \tag{21a}$$

The signs of the coefficients are as follows: In (20), the first is negative, the fourth is positive, and the third can be either positive or negative. Also, if capital mobility is low and foreign exchange intervention is high, then $a_2 + a_3 b_2 > 0$; so the second coefficient is negative. In (21a), the first coefficient is certainly negative (it is the sum of two negative terms). The sign of the second coefficient is ambiguous. If $(a_2 b_1 + b_2)$ is positive, then real money balances will have a positive effect on real exchange rate growth if

$$(1+\theta)(a_2 b_1 + b_2) > \pi(a_2 + a_3 b_2).$$

We can also rewrite this inequality as

$$a_2[(1+\theta)b_1 - \pi] + b_2[(1+\theta) - \pi a_3] > 0.$$

Since the second term is positive, the inequality will hold depending on the magnitude and the sign of the first term. For the fourth coefficient in (21a)—assuming that the effects of $(x_A - \bar{x}_A)$ and of $(x - \bar{x})$ on the rate of real depreciation go in the same direction—as a_5 is negative, it will be negative only if $[(1+\theta)b_1 - \pi] > 0$. But then the coefficients of $(h - \bar{h})$ and $G(q,v)$ in (21a) will both be positive.

Notice that the relative price of agricultural products $(x_A - \bar{x}_A)$ has a negative effect on total domestic output in (18a) and a positive effect on real balance growth in (20), as opposed to the real exchange rate, whose effects are opposite in sign in the two equations. The reason for this is, since agricultural output is supply determined, the effect of relative prices are reversed. Conversely, both $(x_A - \bar{x}_A)$ and $(x - \bar{x})$ have a negative effect on the rate of real depreciation in (21a).

The effect of the budget deficit on output and real money balances can be either positive or negative. If the agricultural sector GNP share is small, the budget deficit effect is likely to be negative in either case. Alternatively, its effect on the rate of real depreciation is positive. This result is consistent with the characterization given of the relationships between budget deficit and balance of payments, whose changes are reflected primarily by movements in the exchange rate.

The characterization of the steady state is given by $\dot{p}_A = \dot{p}_B = \dot{p} = \dot{e} = \dot{m} = \dot{c}$. This implies that $y_A = \bar{y}_A, y_B = \bar{y}_B, y = \bar{y}, B = 0, T = 0, x = \bar{x}, h = \bar{h}, \dot{x} = 0, \dot{h} = 0, and\ G(q,v) = 0$. The long-run values of x and h are still given by

$$\bar{h} = \left(\frac{\phi}{\lambda}\right)\bar{y} - \left(\frac{1}{\lambda}\right)(i^* + \dot{c}) \tag{22}$$

$$\bar{x} - \left[\frac{1}{\beta - \alpha}\right]\left[\eta\dot{c} + (\tau - \eta\phi)\bar{y} + \eta\lambda\bar{h} + \eta i^*\right] + p^*. \tag{23}$$

The long-run value of y can be recovered from (12), viz.,

$$\bar{y} = \left[\frac{\mu}{1 + \mu\sigma\phi R + \gamma - \gamma R}\right] \left[-(1-R)\left(\delta\left(\frac{\delta_A}{\delta_B}\right) + \xi\right)(\bar{x}_A + p_A^*) + \delta(\bar{x} + p^*) + \mu\sigma\lambda R\bar{h} + \mu\sigma R\dot{c}\right] \tag{24}$$

where $R = 1 - \rho(1-\omega)$ as before. Therefore, $\bar{x}$, $\bar{h}$, and $\bar{y}$ are functions of $\bar{x}_A$, p_A^*, i^*, p^*, and $\dot{c}$, all of which are exogenously given. The three endogenous variables, $\dot{m}$, $\dot{p}$ and $\dot{e}$ can be derived in terms of $\bar{x}$, $\bar{h}$, and $\bar{y}$. The long-run steady-state representation of $\bar{y}_A$ is given by

$$\bar{y}_A = \left[\omega\delta\left(\frac{\delta_A}{\delta_B}\right) - (1-\omega)\xi\right](\bar{x}_A + p_A^*) - \omega\left[(\sigma\phi - \gamma)\bar{y} - \sigma\lambda\bar{h} - \sigma\dot{c}\right]. \tag{25}$$

3. Empirical Estimation

The structural model representing all of the above interactions and feedback effects can be written as

$$A_0 Y_t = A(L)Y_{t-1} + B(L)Z_t + \epsilon_t$$

$$\epsilon_t = C(L)\epsilon_{t-1} + \eta_t \tag{26}$$

and its reduced form as

$$A_0 Y_t = \{C(L)A_0 + [1 - C(L)]A(L)\}Y_{t-1} + [1 - C(L)]B(L)Z_t + \eta_t \tag{27}$$

or, equivalently,

$$Y_t = D(L)Y_{t-1} + E(L)Z_t + \xi_t \tag{28}$$

where

$$D(L) = A_0^{-1}\{C(L)A_0 + [1 - C(L)]A(L)\} \tag{28a}$$

$$E(L) = A_0^{-1}[1 - C(L)]B(L)] \tag{28b}$$

$$\xi_t = A_0^{-1}\eta_t, \tag{28c}$$

and A_0 is assumed to be nonsingular. The stacked vector of exogenous variables incorporates the interest rate, foreign agricultural prices, farm stocks, and government expenditure in agriculture. Our ultimate concern is not only about the own and cross dynamics of prices, exchange rates, and money—that is, about A_0, A(L), and the covariance matrix of η—but also about B(L). Also, if C(L) is diagonal, all structural disturbances depend only on their respective lagged values and not on the lagged values of the other disturbances.

A standard VAR approach to (27) would not include the Z variables and, instead, would focus only on the (unconditional) four-variable representation of Y. To be sure, the unconditional multivariate distribution of Y is likely to be different from the conditional distribution of Y given Z, implying a dependence of the data-generating process of Y on the set, Z. The set, Z, is a set of weakly exogenous variables which we assume to be *jointly* exogenous.[3] In other words, we look at the set, Z, in its interactions with Y without considering all the possible interactions within the set.[4] Thus, if the Z's are indeed relevant, there would be no way to recover the E(L) matrix polynomial from the unconditional VAR. In contrast, by estimating a four-variable VAR representation of Y conditional on Z, we can recover the E(L) matrix polynomial.

The issue of exogeneity is a delicate one. To formally test, some hypothesis on the joint distribution of the four endogenous variables and the set, Z, is required. As we know, the implications of exogeneity vary, depending on the actual context in which the variables are jointly specified. In the present context in which the money supply variable is endogenously defined, the interest rate, which has already been determined in the model and has been equalized to the foreign rate (small country assumption), can be taken as exogenous. Foreign farm prices are the counterpart of domestic farm prices in the trade balance equation and are also assumed to be exogenous. Due to the endogeneity of prices and output, farm stocks also are taken as exogenous. Finally, government expenditure in agriculture is defined as exogenous, in that it is operated as a policy instrument to achieve some policy target.

A VAR representation of Y_t conditional on Z_t, cannot be directly implemented since the issues of nonstationarity and cointegration must be examined. Since the four endogenous variables have been shown to be nonstationary and cointegrated (Ardeni and Rausser 1990), the correct specification is then that of a *Conditional Vector Error Correcting Model*, i.e., a VEC model in the four endogenous variables, Y_t conditional on a set of exogenous variables Z_t, as represented in

$$\Delta Y_t = D^*(L)\Delta Y_{t-1} + \gamma U' Y_{t-1} + E(L) Z_t + \xi_t. \tag{29}$$

This representation is the *full* model, i.e., the more general formulation of the conditional VEC model. Our ultimate interest is not only the effect of those exogenous variables on the system but also how they affect its dynamic behavior. Thus, we will look at the MA representations of the model conditional on a set of exogenous variables and compare them to the unconditional MA representations of the basic model.

The interval period chosen for the estimates will be of quarterly data from 1972:1 to 1988:3. The endogenous variables will be LM2 (log of money supply as proxied by M2), LER (log of exchange rate)., LNP (log of nonfarm price), and LFP (log of farm price). The exogenous variables will be IR (90-day Treasury Bill), LAIP (log of foreign agricultural prices), LAS (log of farm inventories), and LGEA (log of government expenditure in agriculture).

As far as the lag structure of the model is concerned, the evidence from Table 1 shows that IR and LGEA should enter the model with current values, whereas LAIP and LAS should not. This result is sensible because both the money supply and the exchange rate are expected to react quickly to changes in the interest rate brought about by changes in the domestic and foreign capital markets. Government expenditure, as a policy variable, is expected to counter expected movements in prices, not only to accommodate them. Finally, both foreign prices and farm stocks enter with lagged values since they tend to anticipate (predict) future values of actual market prices. Therefore, IR and LGEA will enter the model with their current and lagged values while LAIP and LAS will only enter with lagged values.

Several different models were estimated, all with a fourth-order lag structure (both in the endogenous and in the exogenous variables), with different sets of exogenous variables. The results of the estimation of every single model are not reported here. Here, we report only the MA representations of the full model. The impulse response functions of the full model are shown in Table 2. The model is estimated with the four exogenous variables, IR, LAIP, LAS, and LGEA. Here, we focus on only the MA representations obtained from the orthogonalized model (with a money-to-prices ordering). In most of the cases, in fact, the innovation correlation matrix remains almost unaltered and nearly diagonal.

TABLE 1

TESTS OF SIGNIFICANCE OF CURRENT VALUES
OF THE EXOGENOUS VARIABLES
(Fourth-order VEC Model)

Variables	χ^2(k)	Significance Value
	k=4	
current IR	10.522	.032
current LAIP	3.845	.427
current LAS	3.620	.459
current LGEA	10.198	.037
	k=8	
current IR and LAIP	8.110	.422
current IR and LAS	5.580	.694
current IR and LGEA	31.266	.000
current LAS and LGEA	15.979	.042
current LAIP and LAS	6.967	.540
current LAIP and LGEA	21.452	.006
	k=12	
current IR, LAIP, and LAS	8.772	.722
current IR, LAIP, and LGEA	27.718	.004
current IR, LAS, and LGEA	22.782	.029
current LAIP, LAS, and LGEA	18.084	.113
current LAIP, LAS, and LIP	18.078	.113
	k=16	
current IR, LAIP, LAS, and LGEA	20.668	.191

TABLE 2

MA REPRESENTATION - VEC MODEL - EXOGENOUS VARS: IR,LAIP,LAS,LGEA
Orthogonalized Innovations (Ordering: DLM2-DLER-DLNP-DLFP)

Effects of shocks to ξ_{M2} on:					Effects of shocks to ξ_{ER} on:			
LM2	LER	LNP	LFP	Quarter	LM2	LER	LNP	LFP
1.00	-.011	-.180	-.122	1	.000	1.00	.063	-.252
1.27	-.022	-.153	.167	2	.169	1.32	-.053	-.366
1.42	-.298	-.398	.447	3	.412	1.33	-.258	-.651
1.48	-.212	-.477	.505	4	.525	1.27	-.285	-.667
1.30	.135	-.609	.607	5	.372	1.14	-.584	-.494
1.30	.465	-.765	.566	6	.429	1.13	-.848	-.551
1.22	.828	-.716	.467	7	.349	1.39	-.982	-.632
1.08	1.02	-.749	.401	8	.377	1.60	-1.09	-.711
.993	1.07	-.830	.374	9	.375	1.76	-1.03	-.745
.823	1.12	-.913	.343	10	.250	1.80	-.973	-.781
.732	1.17	-1.07	.276	11	.173	1.75	-1.01	-.787
.705	1.26	-1.19	.199	12	.077	1.72	-1.05	-.794
.672	1.35	-1.24	.146	13	.030	1.74	-1.12	-.822
.660	1.39	-1.25	.096	14	.050	1.78	-1.16	-.882
.625	1.38	-1.24	.076	15	.067	1.81	-1.16	-.904
.575	1.35	-1.24	.073	16	.074	1.79	-1.14	-.911
.546	1.32	-1.26	.064	17	.068	1.75	-1.11	-.903
.529	1.31	-1.27	.049	18	.045	1.71	-1.10	-.893
.536	1.31	-1.27	.035	19	.042	1.68	-1.11	-.887
.550	1.30	-1.25	.028	20	.048	1.68	-1.11	-.892

Effects of shocks to ξ_{NP} on:					Effects of shocks to ξ_{FP} on:			
LM2	LER	LNP	LFP	Quarter	LM2	LER	LNP	LFP
.000	.000	1.00	-.427	1	.000	.000	.000	1.00
-.222	-.254	1.51	-.217	2	-.483	.173	.104	.782
-.111	-.957	1.87	-.188	3	-.529	.472	-.135	.742
-.135	-1.51	2.12	.036	4	-.742	.914	-.154	.625
.027	-1.95	2.11	-.012	5	-.842	1.17	-.174	.719
.438	-2.17	2.12	.149	6	-.992	1.32	-.156	.469
.657	-2.27	2.33	.197	7	-1.07	1.35	-.267	.478
.962	-2.42	2.49	.329	8	-1.22	1.35	-.373	.436
1.07	-2.54	2.71	.426	9	-1.27	1.37	-.492	.422
1.12	-2.68	2.82	.621	10	-1.32	1.45	-.571	.296
1.15	-2.74	2.87	.673	11	-1.29	1.50	-.630	.284
1.21	-2.71	2.87	.735	12	-1.33	1.52	-.597	.241
1.25	-2.64	2.86	.736	13	-1.35	1.49	-.582	.243
1.32	-2.58	2.87	.762	14	-1.39	1.45	-.572	.222
1.32	-2.54	2.89	.764	15	-1.40	1.42	-.579	.242
1.32	-2.53	2.87	.791	16	-1.41	1.40	-.579	.222
1.29	-2.50	2.84	.794	17	-1.39	1.40	-.577	.218
1.27	-2.46	2.79	.795	18	-1.38	1.39	-.557	.210
1.26	-2.40	2.76	.769	19	-1.36	1.36	-.537	.224
1.25	-2.35	2.73	.755	20	-1.36	1.33	-.517	.228

Money innovations have a persistent decreasing effect on manufacturing prices, more than proportional to the increase in money supply in the long run. The effect on farm prices is increasing in short run but nil in the long run. Money supply expands in the short run but not in the long run. Thus, money does not appear to be neutral, both in the short and in the long run with respect to manufacturing prices, but is neutral with respect to farm prices. Farm prices increase faster than manufacturing prices in the short run, which means that farm prices appear to be less sticky than nonfarm prices. Finally, following a monetary unanticipated expansion, the exchange rate depreciates in the short run but appreciates in the long run.

The effects of a monetary shock in the conditional model are quite different from those obtained with the unconditional model. The depreciation of the exchange rate lasts only a few quarters, whereas its long-run appreciation is more than proportional to the initial increase in money supply. However, as the theoretical model would predict, after an increase in money supply we have an initial depreciation in the exchange rate is experienced which is followed by an appreciation in the long run. Conversely, the effect of a monetary shock on prices is ambiguous. Farm prices increase in the medium term but are unchanged in the long run; manufacturing prices steadily decrease.

There are two possible explanations for this result. The first is that the initial advantage in relative prices over the foreign sector is turned in favor of the farm sector when there is government intervention in agriculture. The second, more plausible, explanation is that expansions in money supply are subsumed by the interest rate and the fall in domestic manufacturing prices correctly "anticipates" the exchange rate appreciation that will come in the long run. In any case, this result seems to contradict the hypothesis that monetary shocks put the farm sector in a cost-price squeeze.

Exchange rate innovations have the expected effect. Manufacturing prices increase initially (by a small amount) but then decrease in the long run. It seems that nonfarm prices are stickier, although this result is more attributable to the slow pass-through of exchange rate changes to prices.[5] As in the unconditional model, farm prices respond faster but decrease less in the long run. Money supply does change in the short run. This result is consistent with the view that the effect of an exchange rate shock is reflected in the interest rate only after a while, while it contracts in the long run. Hence, as the model would predict, exchange rate appreciation has a deflationary effect which is dampened by government intervention for farm prices. Also, money supply increases in the short run but not in the long run. Finally, the trade balance indeed appears to adjust slowly to movements in the exchange rate.

The effects of manufacturing price innovations on farm prices and on the exchange rate are also as expected. However, the final money supply increase tends to be more similar to the long-run increase in manufacturing prices. This confirms the proposition of a neutral effect of price movements on money. The negative effect on the exchange rate is strong and persistent, whereas the effect on farm prices is positive although small.

Farm price innovations have very unexpected effects. The resulting contractionary long-run decrease in money supply is more than proportional to the increase in farm prices so that farm prices are not neutral with respect to money. The decrease in manufacturing prices is, in any case, lower. In sum, price shocks are not neutral (in the sense that money supply does not increase proportionally in the long run), but regardless the agricultural sector does not seem to be pushed into a cost-price squeeze. Again, this is in line with the theoretical model of section 2 where movements in farm prices are fully reflected in movements in money and the exchange rate. However, the effects of the two prices are different, which seems to confirm that farm prices are supply driven and manufacturing prices are more demand driven.[6]

In conclusion, the analysis of the impulse response functions obtained with the conditional VEC model shows that, by explicitly accounting for the influence of relevant exogenous variables, some of the most important results already acknowledged in past studies are confirmed while some others are not. First, the neutrality proposition seems generally not to hold, particularly in the long run. Second, farm prices react more quickly to changes in money and the exchange rate; and, in the long run, their change is more than proportional to the change in manufacturing prices. Third, the backward effect from prices to money is less significant for manufacturing prices than for agricultural prices. Fourth, following a monetary shock, neither the exchange rate nor nonfarm prices overshoot their long-run value. Conversely, farm prices do overshoot their long-run value. These issues are explored more thoroughly in the next section through a set of specific hypotheses.

4. TESTS OF SPECIFIC HYPOTHESES

Both the *forward effect* and the *backward effect* hypotheses can be simply tested as linear restrictions on the block coefficients in the conditional VEC model. The *forward effect* hypothesis, i.e., the hypothesis that changes in money and in the exchange rates result in changes in prices, can be examined by testing the null hypothesis that lags in either money or the exchange rate do not affect prices. Similarly, the *backward effect* hypothesis, i.e., the hypothesis that changes in prices (output) result in changes in money and/or the exchange rate can be investigated by testing the null hypothesis that neither price effects money or the exchange rate. The first hypothesis encompasses a test of the *forward linkages*, whereas the second hypothesis encompasses a test of the *backward linkages*.[7]

We have computed the tests of the feedback and the feedforward hypotheses for two VEC models. The first is the VEC model with no exogenous variable included. The second is the VEC model with four exogenous variables (IR, LAS, LAIP, and LGEA). The tests for the first model are reported in Table 3. All of the dynamic interactions are analyzed in a "closed" system, with no intervening effect from the outside. The hypothesis that prices do not affect money or the exchange rate cannot be rejected at any reasonable significance level. This implies that we are not able to reject the null hypothesis that there is no feedback from either price to money or the exchange rate. The hypothesis that money and the exchange rate

TABLE 3

TESTS OF THE HYPOTHESIS OF NO FEEDBACK FROM PRICES TO MONEY AND EXCHANGE RATE

VEC Model - No Exogenous Variables

	Null hypothesis		Significance level
(1)	Lags in DLFP do not affect DLM2, DLER, DLNP	$\chi^2(12) = 36.13712$	.00
(2)	Lags in DLNP do not affect DLM2, DLER, DLFP	$\chi^2(12) = 29.08430$	.00
(3)	Lags in DLFP and DLNP do not affect DLM2 and DLER	$\chi^2(16) = 34.47610$	.00

TESTS OF THE HYPOTHESIS OF NO FEEDBACK FROM MONEY AND EXCHANGE RATE TO PRICES

VEC Model - No Exogenous Variables

	Null hypothesis		Significance level
(4)	Lags in DLER do not affect DLM2, DLNP, DLFP	$\chi^2(12) = 11.60462$	.47
(5)	Lags in DLM2 do not affect DLER, DLNP, DLFP	$\chi^2(12) = 11.76562$	.46
(6)	Lags in DLER and DLM2 do not affect DLNP and DLFP	$\chi^2(16) = 17.24337$	.37

do not affect prices, on the other hand, can be rejected. This implies that there is feedback from money or the exchange rate to prices.

Table 4 reports the results of the tests for the conditional VEC model. Here, the evidence does support both hypotheses. Both the hypothesis that lags in prices do not affect money and the exchange rate and the opposite hypothesis, that lags in money and in the exchange rate do not affect prices, can be rejected at any acceptable level.

In summary, while the evidence from these two sets of tests is mixed, it confirms that a proper test of the feedback hypotheses conducted with the fully conditional model would give different but more trustworthy results. In the unconditional case, we are expectedly led to the conclusion that money affects prices but not vice versa. In the conditional case, the conclusion is that, overall, the linkages are evident in both directions.

In moving from the estimated reduced form of the model to the structural form, one obvious issue that arises is simultaneity. If all the variables entered the right-hand side of the model in lagged form, then the form of the exogeneity tests reported above are appropriate for testing those restrictions in the reduced form needed to recover the structural form. However, because the matrix of the contemporaneous coefficients is not necessarily null, we must proceed by testing restrictions that enable us to recover the structural coefficient matrix.

In Tables 5 to 8, the four equations in our model are reported. In column (1) of each table, the coefficients are given for the reduced-form equation estimated with the conditional VEC model with four exogenous variables. If there were not simultaneity among the four endogenous variables, then each equation could be interpreted as a structural equation.

If we interpret the money equation as a structural equation, then it is not expected that the sum of the coefficients of nonfarm prices will be positive. By allowing for simultaneity, we can examine the robustness of this result. We can then re-estimate the same equation with contemporaneous values of the other endogenous variables and investigate the sum of the coefficients. If contemporaneous values are indeed irrelevant, then the sum of

TABLE 4

TESTS OF THE HYPOTHESIS OF NO FEEDBACK FROM PRICES TO MONEY AND EXCHANGE RATE

VEC Model - Exogenous Variables: IR, LAS, LAIP, LGEA

Null hypothesis		Significance level
(1) Lags in DLFP do not affect DLM2, DLER, DLNP	$\chi^2(12) = 13.17504$	.36
(2) Lags in DLNP do not affect DLM2, DLER, DLFP	$\chi^2(12) = 20.09229$	.07
(3) Lags in DLFP and DLNP do not affect DLM2 and DLER	$\chi^2(16) = 22.99380$	.11

TESTS OF THE HYPOTHESIS OF NO FEEDBACK FROM MONEY AND EXCHANGE RATE TO PRICES

VEC Model - Exogenous Variables: IR, LAS, LAIP, LGEA

Null hypothesis		Significance level
(4) Lags in DLER do not affect DLM2, DLNP, DLFP	$\chi^2(12) = 13.83154$	.31
(5) Lags in DLM2 do not affect DLER, DLNP, DLFP	$\chi^2(12) = 11.73416$	.47
(6) Lags in DLER and DLM2 do not affect DLNP and DLFP	$\chi^2(16) = 18.10038$	.32

TABLE 5

THE MONEY EQUATION

Variable	Lag	(1)	(2)
DLM2	1	.124	.243
DLM2	2	.385	.315
DLM2	3	-.078	-.042
DLM2	4	.024	-.004
DLER	0		-.001
DLER	1	.010	.001
DLER	2	.009	-.009
DLER	3	-.046	-.035
DLER	4	-.026	-.032
DLNP	0		-.383
DLNP	1	-.643	-.371
DLNP	2	.732	.687
DLNP	3	-.158	-.193
DLNP	4	.355	.225
DLFP	0		-.189
DLFP	1	-.424	-.406
DLFP	2	.009	-.003
DLFP	3	-.209	-.167
DLFP	4	-.038	.066

Sum of coefficients of

DLM2	.456	.512
DLER	-.052	-.087
DLNP	.273	-.035
DLFP	-.651	-.700

TABLE 6

THE EXCHANGE RATE EQUATION

Variable	Lag	(1)	(2)
DLM2	0		-.315
DLM2	1	-.068	.500
DLM2	2	-1.99	-1.63
DLM2	3	.768	.728
DLM2	4	.359	.256
DLER	1	.386	.340
DLER	2	-.007	-.085
DLER	3	.064	.066
DLER	4	-.017	.024
DLNP	0		-.460
DLNP	1	-1.27	-.836
DLNP	2	-3.26	-2.97
DLNP	3	-.389	-.413
DLNP	4	.245	-.279
DLFP	0		-1.16
DLFP	1	.831	.624
DLFP	2	1.24	1.33
DLFP	3	.897	1.02
DLFP	4	.372	.815

Sum of coefficients of

DLM2	-.943	.470
DLER	.433	-.346
DLNP	-4.784	-4.966
DLFP	3.439	2.632

TABLE 7

THE MANUFACTURING PRICE EQUATION

Variable	Lag	(1)	(2)
DLM2	0		-.174
DLM2	1	.108	.226
DLM2	2	-.281	-.157
DLM2	3	.097	.084
DLM2	4	-.049	-.062
DLER	0		-.006
DLER	1	-.016	-.022
DLER	2	-.021	-.031
DLER	3	.024	.017
DLER	4	-.045	-.036
DLNP	1	.593	.529
DLNP	2	-.072	.081
DLNP	3	-.112	-.129
DLNP	4	-.095	-.153
DLFP	0		-.238
DLFP	1	.067	-.023
DLFP	2	-.128	-.088
DLFP	3	.003	.007
DLFP	4	.089	.167

Sum of coefficients of

DLM2	-.125	-.083
DLER	-.058	-.080
DLNP	1.074	.328
DLFP	.041	-.175

TABLE 8

THE FARM PRICE EQUATION

Variable	Lag	(1)	(2)
DLM2	0		-.299
DLM2	1	.409	.520
DLM2	2	.309	.015
DLM2	3	-.051	.110
DLM2	4	-.074	-.068
DLER	0		-.010
DLER	1	-.035	-.037
DLER	2	-.060	-.056
DLER	3	.005	.011
DLER	4	.061	.009
DLNP	0		-.828
DLNP	1	.316	.396
DLNP	2	.073	.281
DLNP	3	.066	-.120
DLNP	4	-.506	-.472
DLFP	1	-.089	-.114
DLFP	2	.127	.095
DLFP	3	.165	.122
DLFP	4	.353	.415

Sum of coefficients of

DLM2	.600	.276
DLER	-.037	-.135
DLNP	.045	-.743
DLFP	.470	.518

coefficients at the bottom of columns (1) and (2) should be equal. Only for nonfarm prices does this not seem to be the case. Nonfarm prices appear to be simultaneously determined with money, at least to a degree. If contemporaneous values of money are significant in the nonfarm equation, then we should conclude that either money and nonfarm prices are simultaneously determined or both forward and backward linkages are present.

The analysis of Table 5 shows that lagged values of exchange rate and farm prices are significant in the money equation. This, by the way, confirms the findings of feedback from farm prices to money obtained above. Table 6 shows the results of the estimation of the exchange rate equation. The sum of the coefficients of farm prices do not have the expected sign. As it turns out, it appears to be fairly robust to the simultaneity assumption as it decreases but remains positive. On the contrary, the sum of money coefficients is very sensitive turning from negative to positive. Clearly, there is a simultaneity problem between money and the exchange rate.

Table 7 reports the results of the estimation of the manufacturing price equation. Here, money and exchange rate appear fairly robust to the assumption of simultaneity, while farm prices do not. Since manufacturing prices appear to have a significant impact on contemporaneous money, but money does not, we may conclude that there is a substantial feedback from money to prices. Finally, Table 8 shows the estimation results for the farm price equation. Here the sum of money coefficients is positive, but robust to simultaneity. Thus, feedback from money to prices is also confirmed.

In conclusion, both the exogeneity tests and the tests of identifying restrictions confirm the importance of the statistical implications of using the conditional VEC model, as opposed to the unconditional model. Through the latter, in fact, we would have rejected the hypothesis that there is any feedback from prices to money and the exchange rate in any case. However, as we have shown above, given that the endogenous variables of the model are jointly conditional on a given set of exogenous variables, any such unconditional model appears misspecified. Since the "unconditional" is the approach taken in most of the literature on

VAR models, the earlier results must be viewed suspiciously. The conditional model has a theoretical basis; without this basis, it would be difficult to justify any set of particular exogenous variables. As it turns out, in fact, the results from the conditional model confirm that much of evidence is being swept aside when relevant exogenous variables are omitted in the unconditional model. The tests of the forward and the backward hypotheses confirm that all such linkages are indeed present.

5. SOME POLICY SIMULATIONS

Another purpose of this study is the analysis of the effects of government intervention in agriculture; in particular, how the economy would react if such an intervention were reduced. Obviously, this is a matter of model "experimental" analysis involving a set of simulations of the possible effects of such changes. That is, we can simulate hypothetical values of government expenditure and examine the changes in the dynamic relationships among the endogenous variables. The scope of such an exercise is clear: tracing how the dynamic paths of the endogenous variables would have changed if government expenditure in agriculture had been different.

To implement such an exercise, we have to specify possible scenarios. Of course, it is not realistic to assume that government expenditure could have been different while the other variables remain unchanged. With no significant loss in realism, we have taken into account only the likely direct effect that a change in government expenditure would have on farm inventories. Since total farm stocks include stocks accounted for under loans to the Commodity Credit Corporation (part of total government expenditure in the farm sector), when specifying possible scenarios we have considered alternative effects of changes in government expenditure on farm inventories. Hence, the simulations we report are based on the effects that a combined action on government expenditure and farm inventories might have on the dynamic behavior of the model.

In particular, since our interest relates to how a *decrease* in government intervention would affect the farm sector, we have simulated the model under six different scenarios. We have considered the hypothetical situation in which, following the 1981 Farm Bill, the entire U. S. government policy toward the farm sector would have changed, causing a dramatic decrease in government expenditure on agriculture. The six scenarios, all beginning in 1981:1, can be summarized as follows:

1. Government expenditure in agriculture decreases $150 million a year, starting from $1,200 million in the first quarter of 1981 (approximately the trend value at that time), decreasing every year during the second and third quarters and rising again in the fourth quarter, and ending with almost no expenditure in 1988:3. Total farm inventories are unchanged.

2. Government expenditure follows the same pattern as above. Farm inventories are 1.5 percent less the first year (1981), 3.0 percent less the second year (1982), and so forth. In 1988 they are 12 percent less (assuming this is how much absence of government expenditure would affect farm inventories).

3. Government expenditure is 10 percent less than what it actually was in 1981, 20 percent less in 1982, 30 percent less in 1983, and so forth. Farm inventories are unchanged.

4. Government expenditure follows the same pattern as above. Farm inventories are 1.5 percent less the first year (1981), 3.0 percent less the second year (1982), and so forth. In 1988 they are 12 percent less (assuming this is how much absence of government expenditure would affect farm inventories).

5. Government expenditure falls to zero (approximately) by the end of 1981. Farm inventories are unchanged.

6. Government expenditure follows the same pattern as above. Farm inventories are 12 percent less than what they actually were from 1981:1 to 1988:3.

All scenarios represent policies of decreasing intervention in agriculture, where the patterns of such "withdrawal" are different. In the first four they are gradual; in the last two, they take effect almost immediately. Under the first scenario (results shown in Table 9), monetary shocks have a quite different impact (for all comparisons, see Table 2). The effect on the exchange rate is the same in the short run, but the long-run appreciation effect is less pronounced. Farm prices increase almost by the same amount in the short run, but their long-run value is now higher. Manufacturing prices, after an initial decrease, now increase. Thus, the gradual decrease in government expenditure would have made the long-run effect of monetary shocks on prices more pronounced. Exchange rate shocks have a persistent effect on money in the long run, a now positive but small effect on manufacturing prices, and the same decreasing effect on farm prices. Even in this case, the sign of nonfarm price changes is reversed.

Shocks to nonfarm prices have the same short-run effect but a different long-run effect. Money supply now contracts, while farm prices are basically unchanged. The exchange rate, instead of steadily depreciating, reverts to its initial level; thus, reduced government expenditure in agriculture would have made unexpected price increases less effective.

Shocks to farm prices have basically the same effect on money supply, in both the short and the long run. Conversely, the effect on the exchange rate is now basically nil, while it was actually much stronger. The effect on nonfarm prices is basically the same (deflationary) as is the own effect on farm prices.

In conclusion, it seems that having reduced government expenditure in agriculture beginning in 1981 would have had some significant effects. The feedbacks from money to prices would have been more evident and lasted longer, while those from the exchange rate

TABLE 9

MA REPRESENTATION - FULL MODEL - SIMULATION 1
Ordering: DLM2-DLER-DLNP-DLFP

Effects of shocks to ξ_{M2} on:					Effects of shocks to ξ_{ER} on:			
LM2	LER	LNP	LFP	Quarter	LM2	LER	LNP	LFP
1.00	-.044	-.110	-.143	1	.000	1.00	.111	-.242
1.24	.014	.109	.126	2	.210	1.44	.194	-.518
1.32	-.172	-.018	.323	3	.437	1.57	.269	-.743
1.43	-.184	.012	.474	4	.527	1.56	.361	-.826
1.13	-.073	.169	.457	5	.417	1.61	.345	-.724
1.12	.036	.163	.454	6	.350	1.63	.321	-.810
1.05	.104	.341	.443	7	.363	1.72	.297	-.942
.977	.105	.373	.412	8	.420	1.79	.297	-1.03
1.03	.101	.318	.405	9	.496	1.80	.322	-1.01
1.00	.121	.284	.434	10	.515	1.76	.365	-1.04
1.03	.154	.205	.389	11	.537	1.73	.349	-1.04
1.09	.199	.172	.364	12	.536	1.72	.347	-1.03
1.08	.216	.176	.354	13	.544	1.73	.353	-1.02
1.08	.207	.183	.355	14	.567	1.74	.368	-1.05
1.04	.193	.214	.355	15	.589	1.74	.379	-1.05
1.00	.177	.217	.355	16	.597	1.73	.393	-1.03
1.00	.172	.217	.352	17	.600	1.73	.401	-1.03
.997	.173	.216	.347	18	.597	1.73	.403	-1.03
1.01	.173	.204	.339	19	.602	1.74	.400	-1.03
1.03	.171	.197	.342	20	.605	1.74	.405	-1.03

Effects of shocks to ξ_{NP} on:					Effects of shocks to ξ_{FP} on:			
LM2	LER	LNP	LFP	Quarter	LM2	LER	LNP	LFP
.000	.000	1.00	-.265	1	.000	.000	.000	1.00
-.195	.056	1.58	-.241	2	-.595	-.121	.152	.836
-.034	-.240	1.86	-.127	3	-.677	-.100	-.248	.817
.003	-.411	1.97	.079	4	-.947	.061	-.338	.840
.235	-.381	1.78	-.025	5	-1.07	.197	-.427	.920
.637	-.153	1.57	.047	6	-1.11	.253	-.433	.677
.844	.023	1.58	-.000	7	-1.18	.214	-.526	.703
1.05	.125	1.61	-.010	8	-1.29	.138	-.593	.742
.996	.151	1.77	.008	9	-1.36	.109	-.636	.762
.839	.134	1.87	.088	10	-1.43	.102	-.683	.669
.695	.141	1.95	.062	11	-1.41	.086	-.751	.679
.607	.182	1.98	.026	12	-1.42	.062	-.735	.681
.620	.221	1.95	-.024	13	-1.42	.026	-.744	.681
.693	.251	1.91	-.039	14	-1.42	-.008	-.754	.683
.752	.264	1.88	-.065	15	-1.43	-.003	-.761	.715
.808	.268	1.84	-.062	16	-1.44	-.047	-.761	.715
.813	.271	1.83	-.057	17	-1.43	-.050	-.760	.717
.798	.274	1.84	-.057	18	-1.43	-.056	-.759	.720
.775	.275	1.86	-.066	19	-1.42	-.063	-.757	.732
.750	.270	1.88	-.066	20	-1.43	-.067	-.752	.735

would change only mildly. The feedbacks from prices to money, on the other hand, would have been just the same, while those from prices to the exchange rate would have been strengthened.

The second scenario is similar to the previous one, but now farm inventories are assumed to have decreased, although by a small amount, beginning in 1981 (results are shown in Table 10). A monetary shock now has a longer depreciating effect on the exchange rate. Nonfarm prices increase less than farm prices in the short run but more than farm prices in the long run. Thus, under this scenario, not only is the effect of money persistent, it tends to put the farm sector in a cost-price squeeze over the long run.

Exchange rate shocks have a persistent effect on money in the long run, a positive and persistent effect on manufacturing prices, and the same decreasing effect on farm prices. Simulating different values of farm inventories does not seem to have any significant additional effects in this case, as all the dynamic responses are the same as under the first scenario. Also, the same seems to be true for nonfarm price shocks, since they have the same short-run effect but a different long-run effect.

Conversely, under this scenario the effects of farm price shocks are quantitatively quite different from what they were over the simulated history. Money supply decreases, the exchange rate appreciates (but less), and nonfarm prices decrease (but more). Hence, a reduction in government expenditure in agriculture coupled with a reduction in total farm inventories would have had two combined effects. On one hand, the protection of the farm sector would have been lessened. Monetary shocks would have had a more pronounced effect; and while farm prices would have reacted faster in the short run, in the long run, the farm sector would have been pushed in a cost-price squeeze. On the other hand, while all the feedback from farm prices to money would have been just the same as they have actually been, the feedback to the exchange rate would have been stronger, accentuating the instability in the foreign exchange market.

TABLE 10

MA REPRESENTATION - FULL MODEL - SIMULATION 2

Ordering: DLM2-DLER-DLNP-DLFP

Effects of shocks to ξ_{M2} on:					Effects of shocks to ξ_{ER} on:			
LM2	LER	LNP	LFP	Quarter	LM2	LER	LNP	LFP
1.00	-.063	-.057	-.143	1	.000	1.00	.116	-.263
1.19	-.034	.246	.139	2	.209	1.45	.191	-.560
1.27	-.269	.193	.359	3	.409	1.57	.274	-.780
1.37	-.330	.333	.558	4	.491	1.53	.373	-.856
1.08	-.271	.569	.560	5	.333	1.57	.384	-.781
1.11	-.189	.612	.573	6	.249	1.59	.359	-.882
1.09	-.135	.810	.604	7	.259	1.67	.353	-1.02
1.06	-.131	.857	.591	8	.319	1.72	.367	-1.12
1.17	-.120	.812	.604	9	.407	1.72	.389	-1.12
1.17	-.084	.794	.651	10	.442	1.67	.428	-1.14
1.22	-.036	.738	.622	11	.467	1.62	.422	-1.13
1.26	.024	.730	.605	12	.477	1.60	.436	-1.12
1.23	.053	.746	.597	13	.486	1.60	.468	-1.11
1.22	.058	.758	.594	14	.510	1.60	.506	-1.13
1.17	.059	.784	.586	15	.533	1.59	.540	-1.11
1.14	.058	.778	.574	16	.545	1.57	.569	-1.09
1.13	.063	.766	.562	17	.557	1.56	.588	-1.08
1.14	.071	.755	.549	18	.566	1.56	.601	-1.07
1.16	.074	.735	.537	19	.580	1.57	.610	-1.07
1.17	.073	.725	.537	20	.593	1.58	.624	-1.06

Effects of shocks to ξ_{NP} on:					Effects of shocks to ξ_{FP} on:			
LM2	LER	LNP	LFP	Quarter	LM2	LER	LNP	LFP
.000	.000	1.00	-.229	1	.000	.000	.000	1.00
-.231	.025	1.64	-.232	2	-.540	-.081	.119	.865
-.112	-.318	2.00	-.123	3	-.594	-.017	-.330	.840
-.083	-.551	2.22	.112	4	-.790	.184	-.505	.882
.155	-.594	2.19	.053	5	-.909	.382	-.676	.924
.558	-.446	2.12	.159	6	-.929	.515	-.801	.687
.821	-.345	2.21	.181	7	-1.03	.546	-.981	.681
1.05	-.290	2.33	.237	8	-1.17	.529	-1.13	.681
1.06	-.286	2.53	.306	9	-1.30	.553	-1.24	.643
.952	-.302	2.68	.410	10	-1.43	.582	-1.36	.518
.852	-.285	2.82	.416	11	-1.46	.585	-1.49	.478
.794	-.234	2.90	.398	12	-1.50	.570	-1.54	.442
.825	-.183	2.91	.368	13	-1.53	.540	-1.61	.406
.903	-.142	2.91	.367	14	-1.54	.502	-1.68	.387
.969	-.113	2.89	.354	15	-1.57	.467	-1.72	.393
1.02	-.089	2.85	.358	16	-1.58	.443	-1.75	.379
1.03	-.066	2.85	.361	17	-1.59	.424	-1.77	.373
1.01	-.047	2.87	.355	18	-1.60	.399	-1.78	.376
.994	-.034	2.89	.342	19	-1.60	.375	-1.78	.386
.965	-.032	2.91	.335	20	-1.61	.356	-1.78	.391

The third scenario does not generate any new insights. Apparently, little change would have occurred in the examined variables if the reduction in government expenditure in agriculture had been set very gradually, as the scenario hypothesizes. This is also interpreted as an indication of the significant influence that government intervention has on the dynamics of the model. For the fourth scenario, the same basic results are generated. In this case, it is the variation in the farm inventory variable that strengthens the feedback from farm prices to the exchange rate.

In the fifth scenario, government expenditures on agriculture would have been reduced to zero by the end of 1981 (results given are in Table 11). The effect of such a policy would have been dramatic. The effect of a monetary shock would have had almost no impact on both prices, in both the short and the long run, and the same unaltered effect on the exchange rate. Exchange rate revaluations would have had a more negative effect on farm prices in the medium term, but a stronger negative effect on manufacturing prices in the long run. Conversely, the effects of farm price innovations would have been dampened, particularly those on the exchange rate.

In conclusion, under this scenario, feedbacks from money to prices would have lessened as well as those from farm prices to the exchange rate, while feedbacks from the exchange rate to prices and those from farm prices to money would have been the same. The apparent contradiction with the results obtained under the first scenario can be explained in terms of how the public forms expectations about government policy. Under the first scenario, the reduction in the expenditure by the government is gradual and, therefore, its effects are anticipated. Under this scenario, the reduction is sudden and the interactions among the variables cannot adjust to this unanticipated change. For the sixth simulation, the same basic results are generated. Again, this confirms that the crucial policy variable is government expenditure and that inventory policies of the public sector are less crucial.

TABLE 11

MA REPRESENTATION - FULL MODEL - SIMULATION 5
Ordering: DLM2-DLER-DLNP-DLFP

Effects of shocks to ξ_{M2} on:					Effects of shocks to ξ_{ER} on:			
LM2	LER	LNP	LFP	Quarter	LM2	LER	LNP	LFP
1.00	-.048	-.174	-.222	1	.000	1.00	.102	-.242
1.26	.073	-.023	.024	2	.231	1.45	.135	-.562
1.26	-.046	-.069	.078	3	.478	1.63	.112	-.773
1.40	-.008	.011	.100	4	.561	1.57	.108	-.883
1.16	.040	.064	.064	5	.463	1.67	-.042	-.825
1.21	.092	.005	.053	6	.465	1.74	-.255	-.919
1.19	.148	.102	.005	7	.527	1.88	-.445	-1.03
1.19	.176	.102	-.050	8	.598	1.94	-.578	-1.14
1.27	.170	.101	-.042	9	.645	1.96	-.661	-1.12
1.23	.163	.111	-.019	10	.592	1.90	-.730	-1.09
1.26	.167	.081	-.056	11	.537	1.83	-.849	-1.04
1.28	.196	.072	-.055	12	.453	1.79	-.963	-1.01
1.28	.206	.063	-.069	13	.397	1.79	-1.05	-.999
1.31	.212	.063	-.078	14	.363	1.79	-1.10	-1.00
1.30	.209	.068	-.076	15	.332	1.77	-1.13	-.984
1.30	.200	.052	-.067	16	.288	1.71	-1.14	-.947
1.29	.198	.046	-.066	17	.234	1.66	-1.17	-.902
1.29	.203	.037	-.071	18	.181	1.63	-1.20	-.877
1.29	.207	.030	-.074	19	.149	1.62	-1.22	-.863
1.29	.207	.032	-.072	20	.129	1.61	-1.22	-.860

Effects of shocks to ξ_{NP} on:					Effects of shocks to ξ_{FP} on:			
LM2	LER	LNP	LFP	Quarter	LM2	LER	LNP	LFP
.000	.000	1.00	-.327	1	.000	.000	.000	1.00
-.235	.025	1.67	-.283	2	-.582	-.049	.105	.897
-.077	-.358	1.98	-.006	3	-.594	.041	-.124	.769
-.143	-.592	2.22	.220	4	-.874	.148	-.154	.657
-.074	-.510	2.31	-.031	5	-.937	.247	-.151	.644
.263	-.169	2.46	-.131	6	-.943	.302	-.067	.477
.473	.029	2.77	-.292	7	-.957	.236	-.134	.589
.771	.082	3.04	-.390	8	-1.00	.128	-.196	.646
.865	.039	3.24	-.372	9	-1.04	.132	-.246	.650
.894	.021	3.27	-.316	10	-1.06	.179	-.311	.598
.963	.120	3.30	-.411	11	-1.02	.202	-.340	.619
1.07	.299	3.32	-.552	12	-1.04	.184	-.315	.604
1.23	.426	3.36	-.662	13	-1.05	.152	-.319	.626
1.35	.472	3.44	-.699	14	-1.09	.114	-.336	.668
1.40	.461	3.48	-.715	15	-1.12	.096	-.362	.687
1.43	.455	3.45	-.703	16	-1.13	.107	-.375	.669
1.43	.483	3.41	-.723	17	-1.13	.120	-.379	.666
1.47	.543	3.38	-.776	18	-1.13	.114	-.370	.670
1.51	.595	3.37	-.821	19	-1.14	.099	-.358	.680
1.55	.607	3.37	-.832	20	-1.15	.082	-.357	.692

6. CONCLUSION

The major conclusion drawn from the set of simulations conducted here is that government intervention in agriculture has indeed mattered. The dynamics of the variable path responses to unanticipated shocks significantly change under altered values of the government expenditure variable. Having not had government intervention in the eight years from 1981 to 1988, or having had it gradually reduced to zero since 1981, would have pushed the farm sector in a cost-price squeeze in the long run and would have made it more vulnerable to money and exchange rate shocks.

A gradual decrease in government expenditure makes the long-run effect of monetary shocks on prices more pronounced and unexpected price increases less effective. The feedbacks from money to prices are stronger and last longer, while those from the exchange rate are unaltered. On the other hand, the feedbacks from prices to money do not change, while the feedbacks from prices to the exchange rate appear to be strengthened.

If the decrease in government expenditure is coupled with a reduction in total farm inventories, the effect of money is more persistent and the farm sector is pushed toward a cost-price squeeze in the long run. Monetary shocks have a more pronounced effect and farm prices react faster in the short run. On the other hand, while all the feedbacks from farm prices to money are basically unaltered, the feedback to the exchange rate would have been stronger, accentuating the instability of the foreign exchange market.

Two other conclusions can be drawn from the set of simulations and, more generally, from the theoretical and empirical analysis. First, not only has government intervention in agriculture mattered but it also has had some positive effects. Government support partially reduces the impact of unanticipated monetary shocks and prevents the farm sector from being pushed into cost-price squeezes, although it tends to make the feedbacks from farm prices to the exchange rate more pronounced. Secondly, by explicitly recognizing the existence of the forward and backward feedbacks among money, the exchange rate, and prices, we are able to account for the effects that government expenditure reductions can have on the monetary farm-sector linkages as well as farm price shock, money, and exchange rate linkages.

All past claims that reductions in government support of the agricultural sector would have made the sector more vulnerable to the negative impacts of monetary and exchange rate shocks have been based on forward linkages from money and the exchange rate to prices, while neglecting any backward linkages. In this study we have shown that feedbacks are significant in both directions and have also shown that money and exchange rate shocks affect prices. Thus, any reduction in government expenditure in agriculture affects the path by which price shocks feedback on money and the exchange rate. From a policy perspective, this is very important, since it implies that any change in government support of the farm sector should be evaluated from an integrated market point of view. This more integrated or global perspective is needed because expenditures and budget deficits, monetary, exchange rate, and farm policies are significantly related and their interactions far too strong to be neglected.

Footnotes

[1]In reality, set-aside acreage programs have been carried on a voluntary basis.

[2]Recall that the higher the excess supply in agriculture, the lower $\dot{p}_A$ is with respect to $\dot{m}$.

[3]We assume that the Z_t variables are weakly exogenous in the sense of Engle, Hendry, and Richard (1983). The nonweak exogeneity of the Z_t variables would, of course, pose problems of consistency of the estimates.

[4]There can be interactions between the variables either due to their joint distributions or due to some feedback from the Y. We do not take the latter feedback into account here.

[5]This is, in effect, a J-curve effect. A negative 1 percent shock, in fact, would have the opposite effect of an initial decrease followed by an increase.

[6]In the model, we specified agricultural output as supply determined and manufacturing output as demand determined.

[7]These tests are equivalent to those proposed by Sims (1980a, b); the issue of exogeneity is examined through tests of block restrictions; that is, the significance of a group of variables is tested against the null that the entire set of variables entering the equation is significant.

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