Effects of Structural Changes in Macroeconomic Policy on Agricultural Prices*

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ABSTRACT

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To determine if behavior of agricultural prices changed when the macroeconomic environment changed in late 1979, a vector autoregression is constructed. The behavior of a group of agricultural prices under two policy regimes is examined. Lower grain and input prices, and higher hog prices are indicated by the response functions.

Effects of Structural Changes in Macroeconomic Policy on Agricultural Prices

In October 1979, the Federal Reserve Board switched from setting monetary policy based on changes in the federal funds rate, to setting monetary policies based on growth in money aggregates (Gilbert). This change affected the behavior of the real interest rate (Huizinga and Mishkin). At the same time, government borrowing increased dramatically (Kaufman). In the first quarter of 1979, government deficits were .4 percent of gross national product. By the same quarter of 1986, the deficit was 4.9 percent of gross national product.

Little research has investigated the effects of these changes in macroeconomic policy on agriculture. Real agricultural output prices have decreased in the 1980s. Some have voiced concern that these changes in macroeconomic policy have detrimentally affected agriculture.

This study seeks to determine the effect of the change in macroeconomic environment on agricultural input and output prices. Knowledge of the full effects of changes in the macroeconomic environment would aid policymakers in decisions about macroeconomic and agricultural policies. The results of this study may also be useful to farmers and agricultural bankers who must make decisions based on expectations of future agricultural prices.

The effect of the general economy on the farm sector is not a new topic. Schuh introduced the topic in the mid-seventies. Rausser, et al. recently emphasized macro linkages in a structural model for

agricultural prices. Tweeten and Starleaf, et al. have studied the effect of inflation on agricultural prices. This study differs from previous research by estimating how the system determining agricultural prices changed in response to changes in macroeconomic environment.

The next section of this paper presents how the general economy may affect the farm sector, and how a policy change affects the general economy. Following the theory, the time series approach is presented. Next, a short section explains the data used in this study. Finally, the results section examines the behavior of agricultural prices under the alternative macroeconomic environments.

Theory

This section provides the theoretical basis for the empirical model.

Farm Sector Reaction to Aggregate Changes

A change in the economy which changes aggregate income may cause real changes in agricultural output and input prices. On the demand side, the effects are on consumers who consider prices and income when purchasing goods. On the supply side, interest rates may shift the supply curve for agricultural products because its changes are the cost of borrowing capital.

Macroeconomic policy may also affect agricultural prices by increasing market uncertainty. Agents observe nominal price movements, not real price movements. Thus, a change in macroeconomic policy may have real effects since price signals may be confused (Lucas 1972).

Agricultural prices are linked to the exchange rate because of the importance of exports to U.S. agriculture. Therefore, any factor affecting the exchange rate causes changes in agricultural output prices. Exchange rates are responsive to macroeconomic policies that change the real income, inflation, or real interest rate.

The Effects of Macroeconomic Policy

This section uses macroeconomic theory to show the effects of a change in macroeconomic environment on income, inflation, and interest rates. The IS-LM framework provides a way to specify variables to be estimated.

The IS-LM model of the economy specifies a structural model which is then solved in terms of exogenous variables. Litterman and Wiess present a model of the economy with two equations. First, the IS curve gives the equilibrium relationship between income and the real interest rate.

$$(1)\quad Y_t = -\beta_1 r_t + \xi_t,$$

where Y_t is gross national product, r_t is the real interest rate, and ξ_t is a random shock. Their second equation (LM curve) gives equilibria in the money market.

$$(2)\quad m_t = \alpha_1 Y_t - \alpha_2 (r_t + \hat{\Pi}_t^{t+1}) + \phi_t,$$

where m_t is real money balances, $\hat{\Pi}_t^{t+1}$ is the expected inflation in period t+1 based on information available in period t, and ϕ_t is a random shock.

Solving equation (1) and (2) yields reduced form equations of the following general form

$$(3) \quad r_t = f_1(\xi_t, m_t, \phi_t, \hat{\Pi}_t^{t+1})$$

$$Y_t = f_2(\xi_t, m_t, \phi_t, \hat{\Pi}_t^{t+1}).$$

Therefore, current real interest rates and income are contemporaneously determined based on real shocks, real money balances and the expected inflation rate.

Completing the model requires an expression for expected inflation. A frequently used assumption is rational expectations. Under rational expectations agents do not waste information and the expectations process is unbiased. Therefore, the rational expectations hypothesis equates the agents expectation with mathematical expectation. The expectations mechanism from Litterman and Wiess is:

$$(4) \quad \hat{\Pi}_t^{t+1} = E[\Pi_{t+1} | Y_{t-s}, M_{t-s}, R_{t-s}, \Pi_{t-s}, s \geq 0]$$

where E is the expectations operator, M_t is the nominal money balance in period t, and R_t is the nominal interest rate.

Lucas (1976) noted that the optimizing behavior of agents in the economy change with a change in the way the monetary authority conducts

policy. The agents learn that the policy variable (money supply) no longer obeys the same rule (the Federal Reserve Board is using a different target). The agents then find it in their best interest to react differently. Therefore, changes in parameters associated with changes in macroeconomic policy may partially explain the change of behavior in agricultural prices.

Procedures

Vector autoregression (VAR) is an empirical technique which we use to model the variables in the economic system discussed in the theory section. The method relates current values in an economic system with past values for the same variables.

The specific model estimated is:

$$(5)\quad \begin{bmatrix} d_t \\ m_t \\ \Pi_t \\ r_t \\ y_t \\ i_t \\ c_t \\ s_t \\ h_t \end{bmatrix} = \begin{bmatrix} \\ A_{01} \\ \\ A_{02} \\ \\ \end{bmatrix} + \sum_{j=1}^{N} \begin{bmatrix} & & \\ A_{11} & 0 & \\ & & \\ A_{21} & A_{22} & \end{bmatrix}_j \begin{bmatrix} d_{t-j} \\ m_{t-j} \\ \Pi_{t-j} \\ r_{t-j} \\ y_{t-j} \\ i_{t-j} \\ c_{t-j} \\ s_{t-j} \\ h_{t-j} \end{bmatrix} + \begin{bmatrix} \\ B_{01} \\ \\ B_{02} \\ \\ \end{bmatrix} + \sum_{j=1}^{N} \begin{bmatrix} & \\ B_{11} & 0 \\ & \\ B_{21} & 0 \\ & \end{bmatrix}_j \begin{bmatrix} d_{t-j} \\ m_{t-j} \\ \Pi_{t-j} \\ r_{t-j} \\ y_{t-j} \\ i_{t-j} \\ c_{t-j} \\ s_{t-j} \\ h_{t-j} \end{bmatrix}$$

where m_t is the growth rate of money aggregates, d_t is government surplus as a percent of gross national product, p_t is the continuous rate of change in the general price level, r_t is the real interest rate, y_t is the rate of growth in real gross national product, h_t is the

growth rate in real hog prices, s_t is the growth rate in real soybean prices, c_t is the growth rate in real corn prices, i_t is the rate of change in farm input prices, and N is the number of lags.

A_{01} and A_{02} are the intercept vectors for the macroeconomic and agricultural variables respectively. Submatrix A_{11} contains the parameters for the effect of lagged macroeconomic variables on current macroeconomic variables. The parameters in A_{21} relate the effects of past macroeconomic variables on current agricultural prices, and A_{22} is the effect of past agricultural prices on current agricultural prices.

The B parameters represent changes which occur with change in macroeconomic policy. Prior to 1979:3 the B parameters are assumed to be zero. B_{01} and B_{02} are the post 1979:3 intercept changes for macroeconomic and agricultural variables, respectively. B_{11} is the change in the effect of past macroeconomic variables on the current macroeconomic variables. B_{21} is the change in the effect of macroeconomic variables on agricultural input and output prices. To test for a change in the behavior of agricultural prices is to test for all these change parameters equal to zero.

To model the shift in the process associated with the change in macroeconomic policy regimes which occurred in October 1979, dummy variables are introduced to allow intercepts and certain slope variables to change with the change in macroeconomic policy regimes. The

coefficients for the effect of macroeconomic variables on other macroeconomic variables (B_{11}) and the effect of macroeconomic variables on agricultural prices (B_{12}) are allowed to change. The effect of agricultural prices on other agricultural prices are held constant between macroeconomic environments.

Once the variables in the VAR are specified, the order of the model (the number of lags, N) is determined. Conceptually, selection of the order of the autoregressive model is a trade-off of the additional information gained by adding a lag against parsimony. Using the AIC criteria proposed by Akiake, the data indicate a second order model.

When interpreting econometric results, researchers are interested in the direction of effect, and magnitude or importance of the effect. A step response function gives information about the size and direction of the effect by summarizing the system's response to a one time shock on one of the variables(Sims). Response functions depict the change for a variable in the system associated with a shock to some variable.

Finally, the steady state or particular solution will give the mean path or the values of the system over the extremely long run. The steady state is derived from the autoregressive model:

$$(6) \quad Y_t = a_o + A(L)\, Y_{t-1} + \epsilon_t,$$

where Y_t is the vector of endogeneous variables in equation 5, a_o is a vector of constants from the regression, A(L) is the matrix of coefficients on the lagged variables, and ϵ_t is the vector of random

shocks. Solving this equation such that E_t is zero for all periods gives,

$$(7) \quad Y_t = (I - A(L))^{-1} a_o.$$

Data

The macroeconomic variables used in this study are seasonally adjusted data from the U.S. Department of Commerce with the exception of money aggregates which are from the Federal Reserve Bank of St. Louis. The annual growth in nominal money balances are computed by the change in logarithm of levels of money aggregates. The government surplus is the seasonally adjusted annual government surplus and is measured as a percentage of gross national product. Inflation is the continuous growth rate of PCE. The real interest rate is based on the 3 month T-Bill rate. Real income growth is the difference in logs of real gross national product. The real gross national product is computed using the seasonally adjusted annual rate of gross national product and deflating by the PCE.

The agricultural prices are based on prices from the USDA's Crop Reporting Board. The hog, soybean, and corn prices are the changes in the logs of the real prices of hogs, soybean and corn. The index of prices paid is the continuous growth rate in prices paid by farmers less the inflation rate on an annual basis.

Results

The joint F-test for the null hypothesis that all the slope and intercept shifters equal zero is rejected at the 5% level of

significance. Thus, the change in macroeconomic environment in October 1979 has changed the system determining agricultural prices.

The steady state solutions in table 1 summarize the long run changes resulting from the change in the macroeconomic environment. Money aggregates are shown to have a lower growth rate and the deficit is a greater percentage of gross national product. The direction of change for the other macroeconomic variables also conform to a priori expectations: Inflation rate is lower, the real rate of interest has increased, and the growth in gross national product is greater.

The steady state solution in Table 1 shows mixed results for real agricultural input and output prices. On the bright side, real prices paid by farmers declined slightly in the current macroeconomic environment while the steady state growth rate in real hog prices increased. The corn and soybean prices declined significantly across the change in macroeconomic environment. The change in macroeconomic environments therefore benefited the swine producers, and was detrimental to the crop prices.

Figure 1 shows the step response functions for real prices paid by farmers. The response functions indicate that a positive innovation in government surplus (a decrease in the deficits) causes the real prices paid by farmers to increase in both macroeconomic environments. A move to balance the federal budget would therefore increase the real prices paid by farmers. The response of real prices paid by farmers to an innovation in the growth rate in money aggregates indicates that an

increase in the growth in money supply would increase real prices paid by farmers.

The response of corn and soybean prices to an innovation in government surplus is dependent on the macroeconomic environment. In the pre 1979:3 environment a decrease in the federal budget deficit would have resulted in higher real corn and soybean prices (figure 2 and figure 3). In the current macroeconomic environment, a decrease in the federal deficit causes real corn and soybean prices to fall in the short run. In the long run, however, the decreased federal budget deficit may cause real corn and soybean prices to increase. The response of real corn and soybean prices to an innovation in the growth in money aggregates is positive. In the current macroeconomic environment, a positive innovation in inflation increases real corn and soybean prices. In the pre October 1979 macroeconomic environment, however, an increase in inflation would cause a slight decline in real corn and soybean prices.

Real hog prices increase slightly in response to a decrease in the government deficit (figure 4). Real hog prices decrease with increase in the growth in money supply and inflation in the current macroeconomic environment. Under the pre October 1979 environment government deficits, money supply, and inflation have little effect on real hog prices.

Unfortunately, these results require some caveats. There have been several changes in environment between the seventies and the eighties in addition to changes in macroeconomic policy. Also, there have been

other shifts in macroeconomic policy during the sample period, notably, the collapse of Bretton Woods in 1973 and the adjustment of monetary policy that occurred in the U.S. in October of 1982. So it is impossible to attribute the change in agricultural prices to the change in U.S. macroeconomic monetary and fiscal policy in October 1979 alone.

Conclusions

The steady state solution indicates lower crop prices under the second macroeconomic environment since 1979:3. The post 1979:3 environment has been characterized by a lower rate of inflation than the first policy environment. This change led to lower corn and soybean prices while real hog prices increased. Further, the shift changed the way agricultural input and output prices react to macroeconomic variables. Most notably, the reaction of corn and soybean prices to government surpluses and inflation differs between macroeconomic policy environments.

Agricultural prices respond differently to changes in inflation and government deficits between macroeconomic policy environments. Prior to 1979:3 a reduction in the deficit caused higher grain prices. After 1979:3, however, a decrease in government deficits cause grain prices to fall in the short and intermediate run.

Similarly, in the pre 1979:3 macroeconomic environment innovations in inflation had little effect on prices paid by farmers, and caused real corn and soybean prices to decline. However, in the post 1979:3 macroeconomic environment an innovation in inflation has the opposite

effect increasing real prices paid by farmers, corn prices, and soybean prices.

Therefore, agricultural interest groups may prefer different macroeconomic policies in the 1980s. In particular, in the 1970s farmers benefited from lower rates of inflation and reduced government deficits. The results from this study indicate that farmers in the 1980s would prefer higher inflation rates and higher deficits.

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Table 1: The Steady State Solutions

Variable	Environment		
	Pre 1979:3	Post 1979:3	Change
Government Surplus	-.02250	-.05076	.02826
Growth in Money Supply	.08350	.06673	.01677
Inflation Rate	.07606	.00391	.07215
Real Interest Rate	-.00796	.05172	-.05968
Growth in Real GNP	.00730	.01438	-.00708
Growth in Real Prices Paid	.03117	-.04876	.07993
Growth in Real Corn Prices	-.05176	-.55405	.50229
Growth in Real Soybean Prices	-.01896	-.51330	.49434
Growth in Real Hog Prices	-.21288	-.03898	-.01730

[a]All figures are a continuous time rates based on annual periods.
[b]Post 1979:3 minus pre 1979:3.

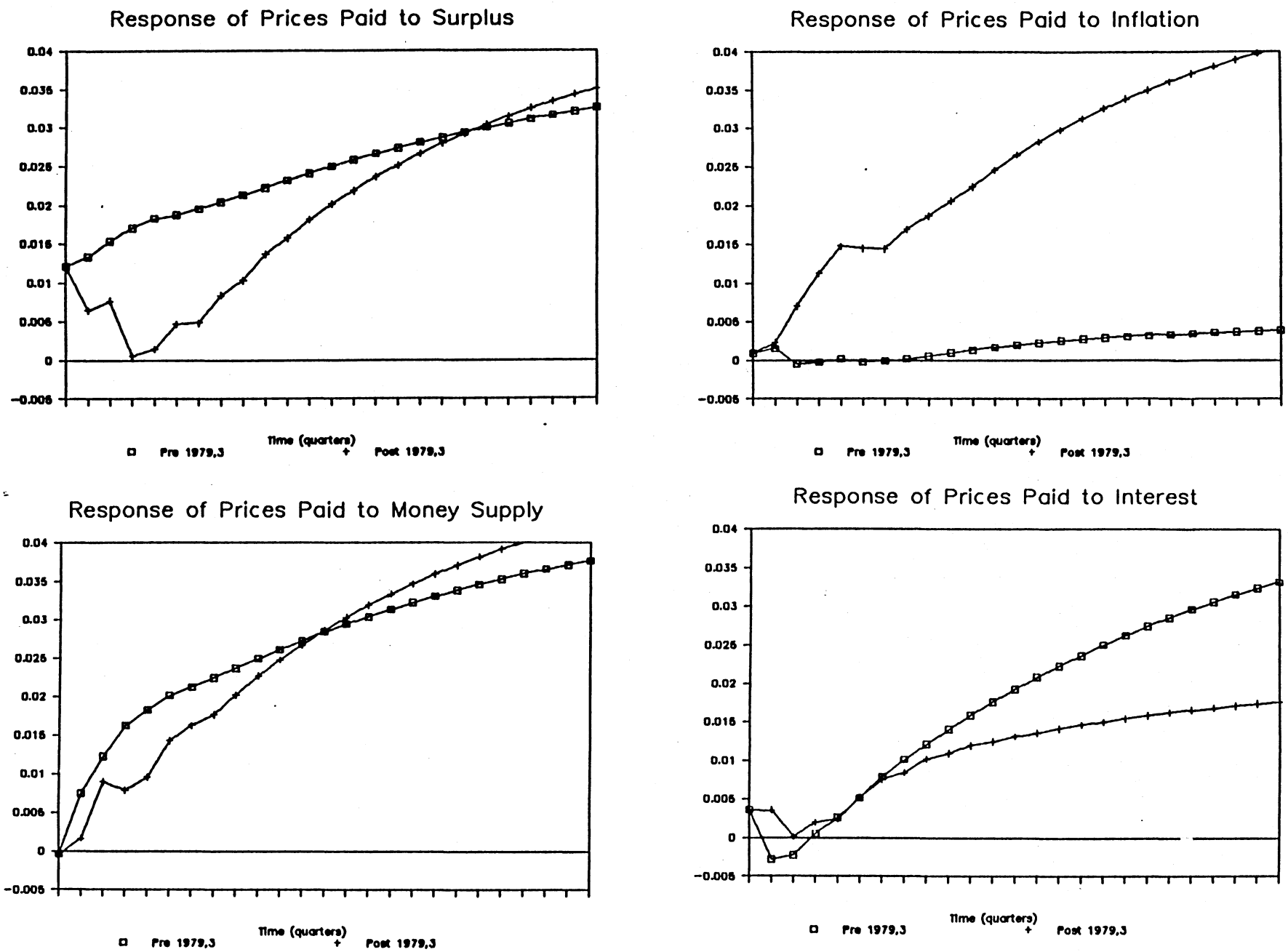
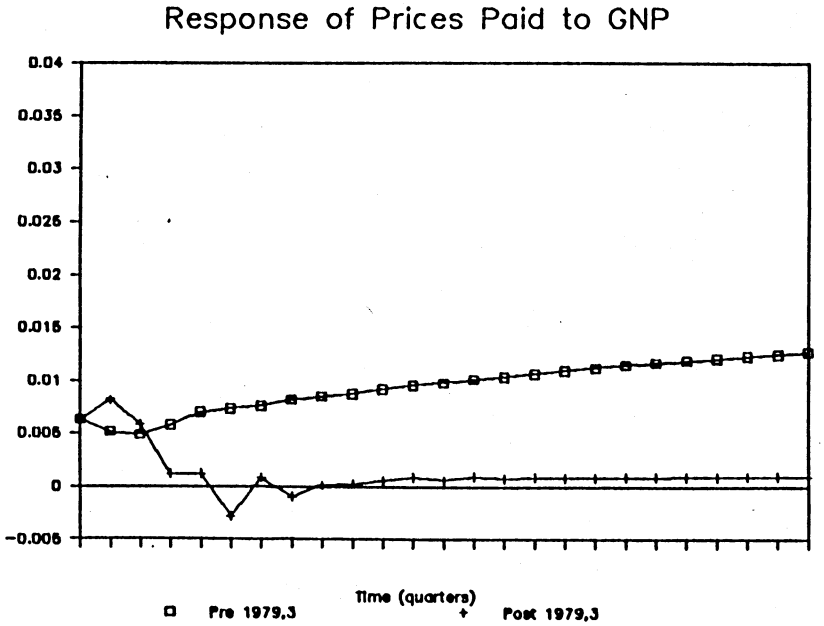


Figure 1. Step Response Functions For Real Prices Paid by Farmers.



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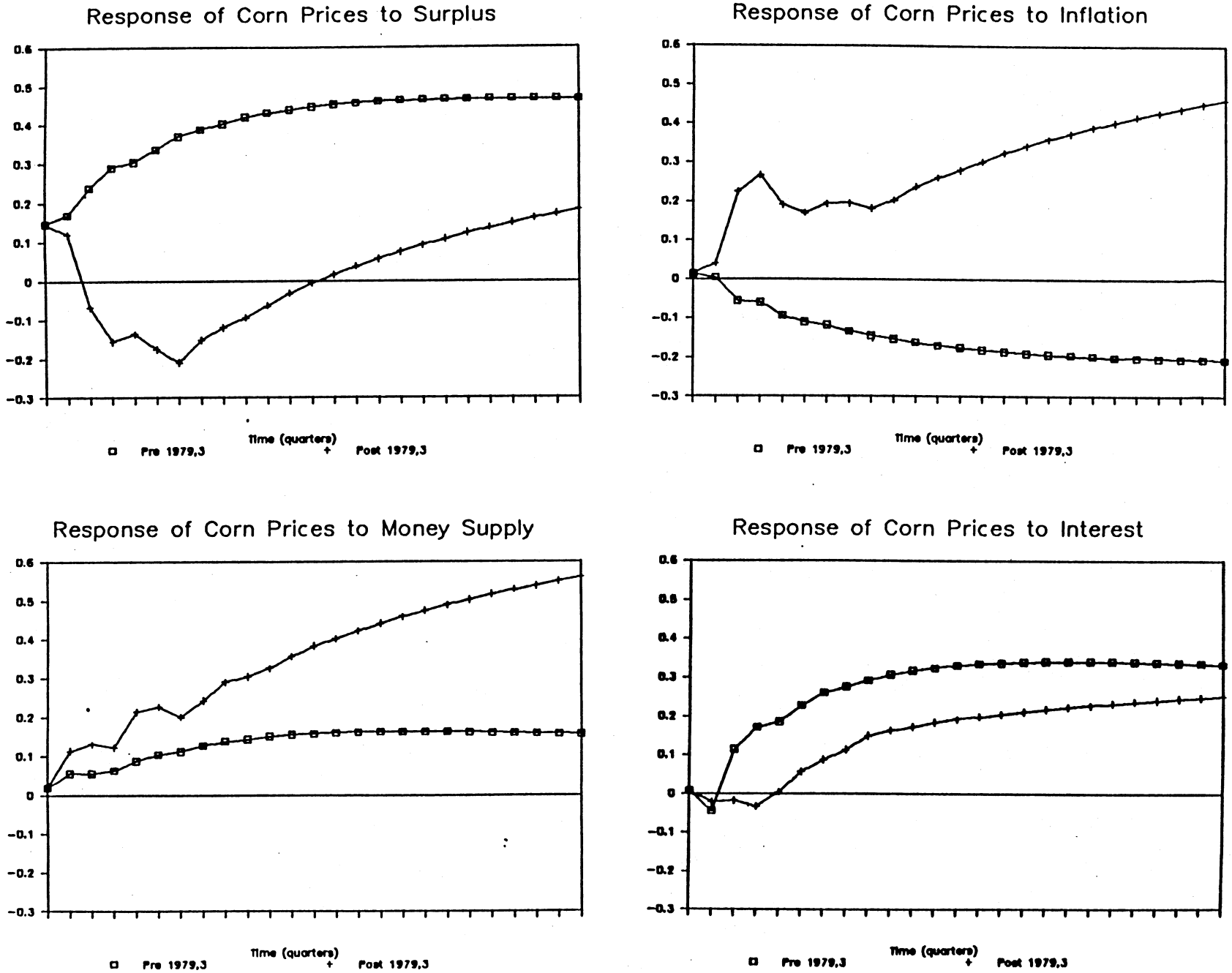
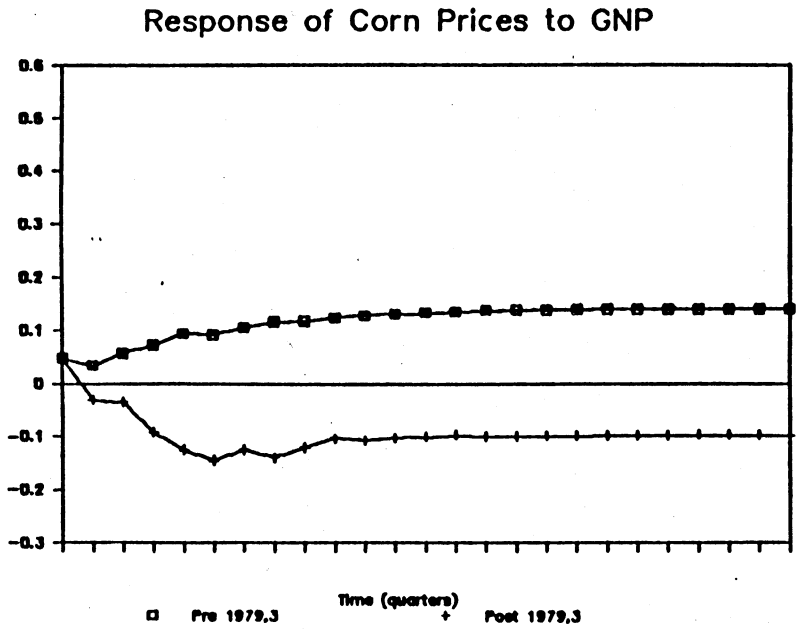


Figure 2. Step Response Functions For Real Corn Prices.



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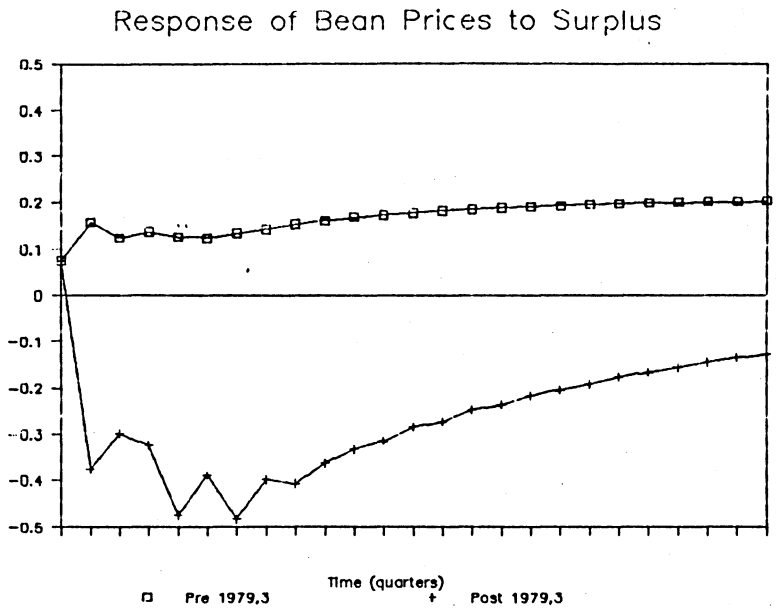
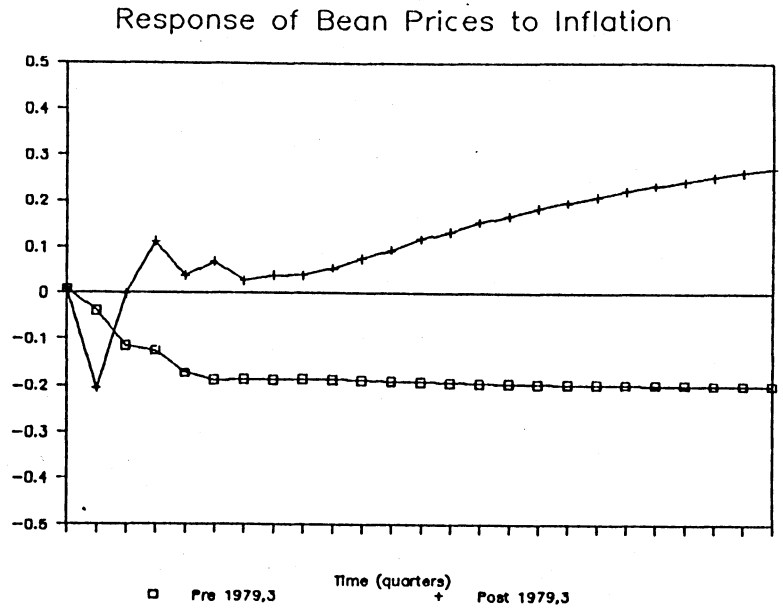
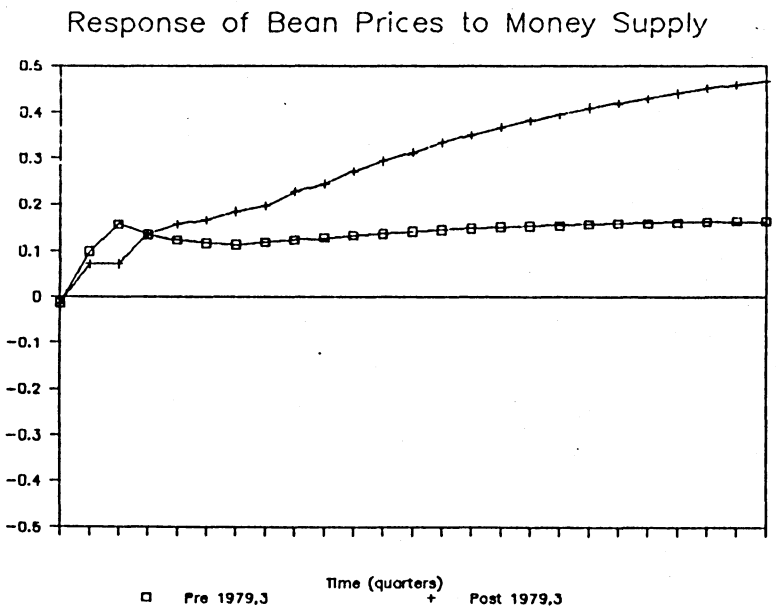






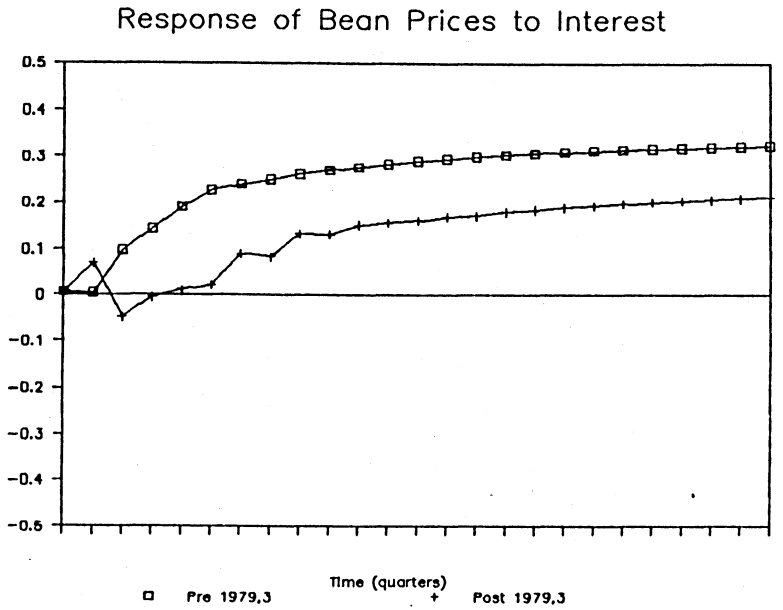
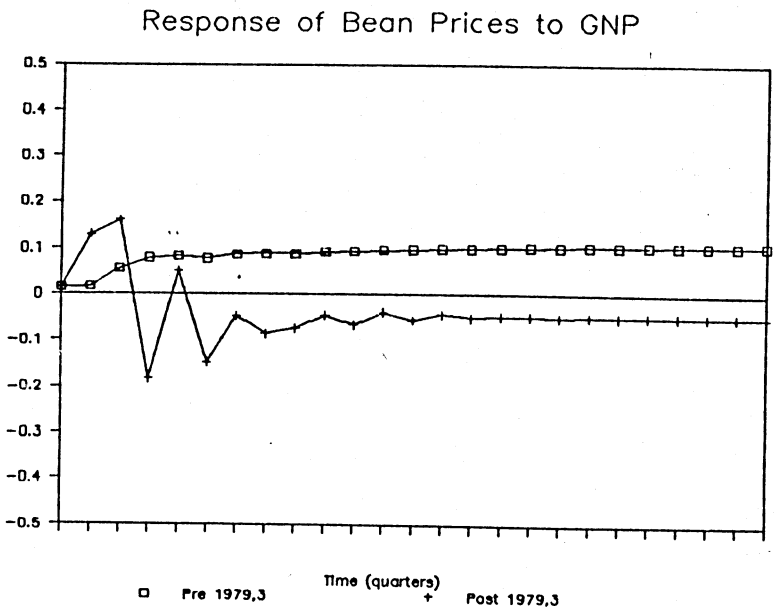


Figure 3. Step Response Functions For Real Soybean Prices.



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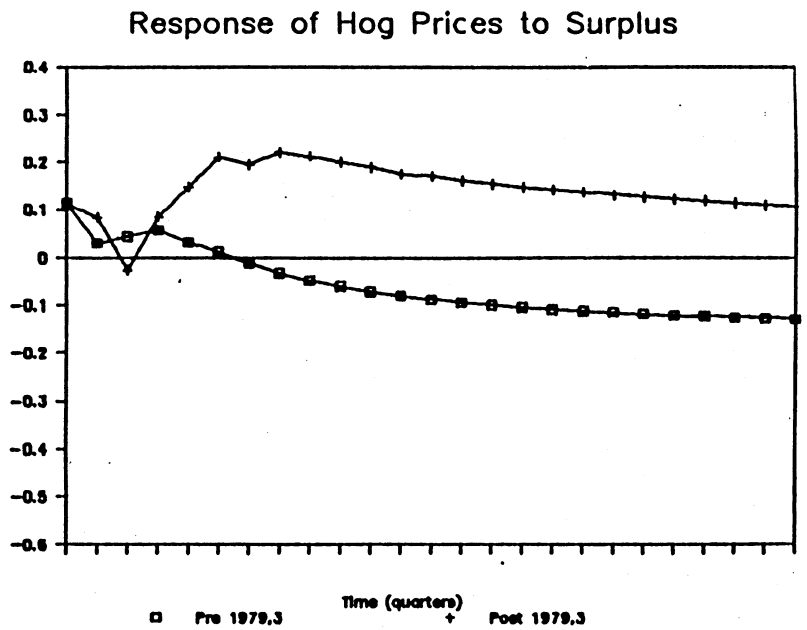

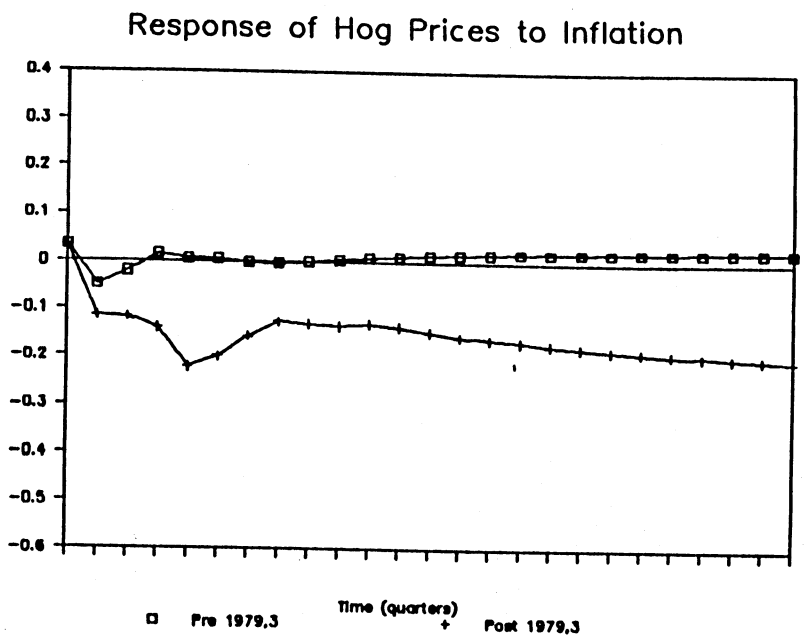

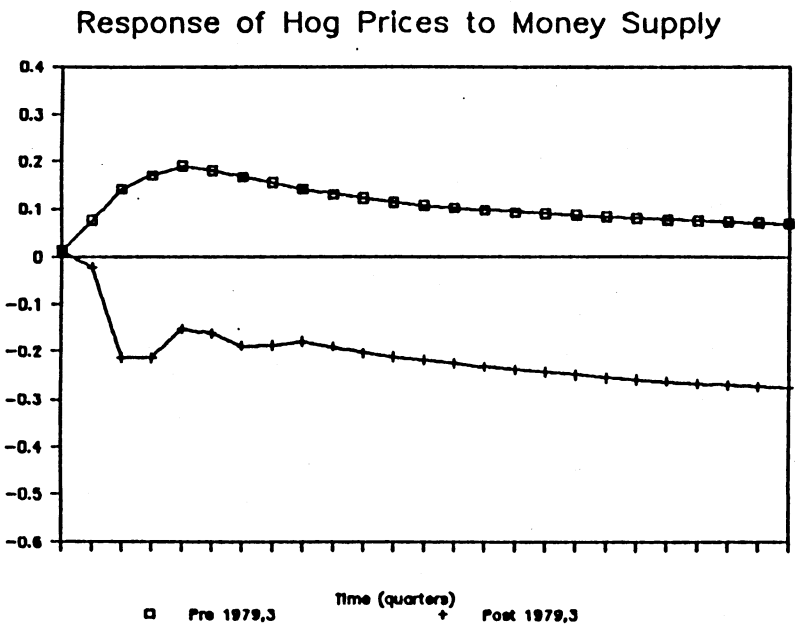

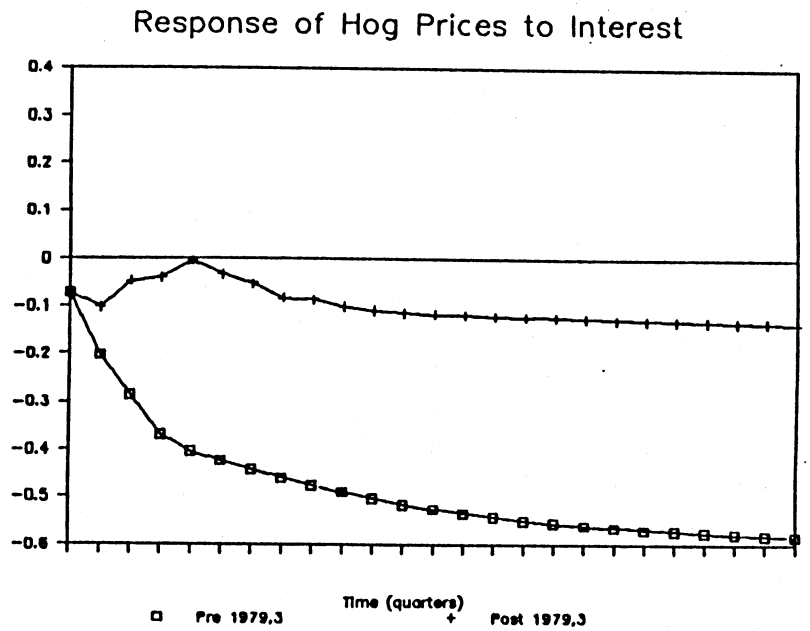

Figure 4. Step Response Functions For Real Hog Prices.

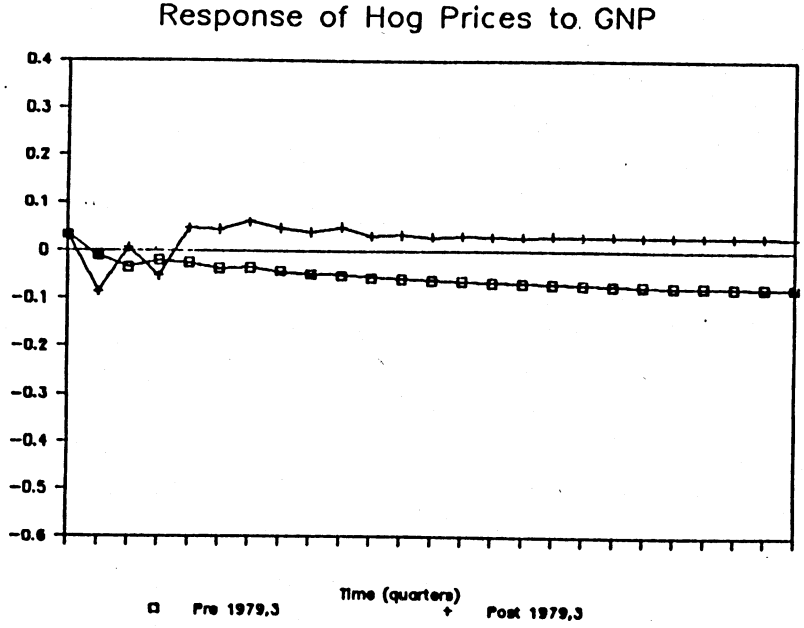

Figure 4 (Continued)