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A Simple Empirical Model of Macroeconomic Effects on Agriculture

An Asset Market Approach

John Kitchen

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Abstract

The asset market approach specifies a direct relationship between flexible prices and the growth of the money supply in excess of real money demand. The model described in this report uses the asset market approach in estimating macroeconomic effects on agricultural prices, cash receipts, and land values. Agriculture-specific effects are also included in the model through a use-to-stock ratio variable. Simulations are run to illustrate the effects of alternative monetary and agricultural situations on the agricultural variables.

Keywords: Macroeconomics, money growth, agricultural prices, flexible price dynamics.

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A Simple Empirical Model of Macroeconomic Effects on Agriculture

An Asset Market Approach

John Kitchen

Introduction

This report describes a simple empirical model of macroeconomic effects on agriculture based on the asset market approach for flexible price adjustment. The model concentrates on nominal price and revenue effects in agriculture that result from changes at the macroeconomic level. The specification and coefficient estimates of the model are presented in detail, and results for several alternative simulations are shown. The simplicity of the model facilitates its use for conducting various simulations, and results from the model can be compared with those obtained from more traditional commodity models and frameworks.

The Asset Market Approach

The asset market approach has been used extensively in the international finance literature to examine exchange rate adjustment. Dornbusch (1976) presented a steady state model that examined exchange rate dynamics and described overshooting and undershooting relationships.¹ His use of a steady state model led to subsequent confusion about the definition of overshooting. That is, in the steady state model, exchange rate overshooting was defined relative to the change in the money stock, which defined the change in the equilibrium exchange rate because of the assumptions of fixed income in the steady state and fixed foreign variables. Subsequently, many researchers have mistakenly attempted to define overshooting empirically as being relative to the money stock. Mussa (1982) presented a model that explicitly incorporated dynamic real activity and stressed that exchange rate overshooting could only be defined relative to the equilibrium exchange rate. In the Mussa model a combination of monetary and real activity relationships determined the equilibrium exchange rate. Since real activity affects money demand, a certain part of money growth is required to "fund" changes in real activity to maintain a given equilibrium price level. Increases in real activity produce higher money demand, which for a given expected path of the money supply, produces upward pressure on real interest rates and the exchange value of the dollar, and downward pressure on the price level.

¹See References for complete citation.

More recently, efforts have been made to extend the asset market approach to commodity prices. Frankel and Hardouvelis (1985) presented a theoretical model of commodity price overshooting and they empirically examined the response of commodity prices to money supply announcements. Kitchen and Denbaly (1987) examined the issue of overshooting and the response of implied commodity price dynamics to money supply announcements. Stamoulis and Rausser (1988) presented a Dornbusch-type model for commodity price overshooting, but in their empirical work they mistakenly defined overshooting as relative to the money stock.

An equation that uses the asset market approach to examine commodity price responses to macroeconomic shocks in a dynamic, growth economy can be specified as:

$$\Delta cp_t = \Omega \Delta \left[\sum_{i=0}^{\infty} w_i E_t(m_{t+i} - a_{t+i}) \right] \quad (1)$$

where cp is the natural logarithm of the commodity price, m is the natural logarithm of the money stock, a is the real activity-generated portion of money demand, E_t is the expectation operator based on information available in period t , Δ represents the change in the variable, w_i are discount coefficients that sum to 1, and Ω is a dynamics factor. Since the term in brackets on the right side of equation 1 defines the equilibrium level of cp , through the incorporation of both monetary and real effects, overshooting (undershooting) occurs as Ω is greater than (less than) 1.

To make the underlying relationships a little clearer, consider the equation of exchange:

$$M V = P Q \quad (2)$$

where M is the nominal money stock, V is the velocity of circulation of money, P is the price level, and Q is real output of goods and services. Assuming constant velocity, writing in percentage change form, and rearranging terms yields:

$$\% \Delta M - \% \Delta Q = \% \Delta P \quad (3)$$

Hence, in the long run with constant velocity, changes in the price level are determined by the difference between the rate of growth of money and the rate of growth of real output. In more sophisticated specifications of the asset market approach on which equation 1 is based, the requirement is that velocity is predictable rather than constant, since expectations play the crucial role. The treatment of velocity as constant or predictable in this exposition reveals the monetarist foundation of the asset market approach.

The Model

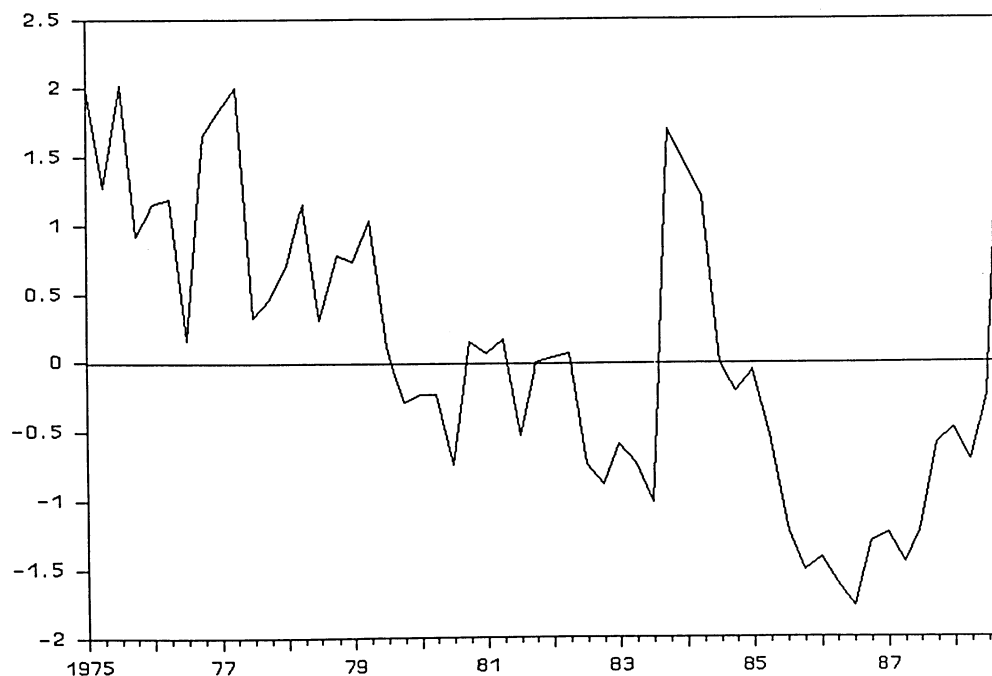
The model described here uses equations for commodity price changes based in part on equation 1. In addition to the velocity assumptions described above, such specifications also implicitly assume constant (or, at least, stable and predictable) income elasticities of money demand. The $\% \Delta M - \% \Delta Q$ variable ($DM1Q$) used in the estimation and described below imposes the further constraint that the income elasticity of money demand is 1.0.

The model consists of quarterly equations for agricultural prices and cash receipts and an annual equation for land values. The model specification includes both macroeconomic and agriculture-specific effects on nominal agricultural variables. Reverse linkages from agriculture to the macroeconomy are specified only for the effect of agricultural prices on the price level.

Consistent with a strict asset market approach, macroeconomic effects are transmitted to agricultural prices received through a variable that simultaneously accounts for growth in the money supply and real activity. The variable used, DM1Q, was calculated as the difference between the percentage change in the money supply (DM1) and the percentage change in gross national product (DGNP).

Agriculture-specific effects enter into the model through a use-to-stock ratio variable (USESTR). The use-to-stock ratio (quarterly use relative to end-of-marketing year stocks) was constructed as an average of the use-to-stock ratios for corn, soybeans, and wheat. The normalized value of the average ratio was used in the estimation. Hence, a value of zero for USESTR represents an average or "normal" use-to-stock situation. Periods of relative shortages are characterized by positive values of USESTR, while USESTR takes on negative values in periods of relative abundance. Figure 1 shows the historical series of USESTR for 1975-88. Over 1975-83, USESTR trended down, reflecting continued production in excess of use. The spike in 1983 reflects

Figure 1
Normalized use-to-stock ratio (USESTR)



that year's drought, after which USESTR resumed its downward trend. The spike at the end of the series reveals the initial effects of the 1988 drought.

Table 1 presents the equations of the model. The model was estimated in percentage change form, which reduces problems associated with nonstationary data. The sample was chosen so that only data from the flexible exchange rate period after March 1973 was included. Ordinary least squares estimation was used, except for equations 1M and 2M which were estimated as a system of seemingly unrelated regressions. The prices received by farmers equations 1M and 2M include a constant, quarterly dummy variables, the USESTR variable, the macroeconomic DM1Q variable, and exchange rate terms as explanatory variables.

In equation 1M for the percentage change in prices received for crops, USESTR enters as an expectation of the subsequent period value. In the estimation, an instrumental variable approach was used to determine a proxy for the expectation. USESTR(+1) was regressed on a constant and Durbin's rank variable of USESTR(+1). The series of fitted values from that estimated equation were used to proxy the E_t USESTR(+1) series.

Two different exchange rate measures are used in the model. The prices received for crops equation includes the lagged percentage change in the Federal Reserve trade-weighted exchange rate, while the prices received for livestock equation includes the lagged percentage change in the Japanese yen-U.S. dollar exchange rate. Both variables measure the change in the value of the dollar. The exchange rate coefficients are negative and significant, showing that crop and livestock prices fall as the exchange value of the dollar rises.

Equations 3M, 4M, and 5M are identities. Equation 3M specifies the index level for prices received by farmers to be a linear combination of the index levels for prices received on crops and livestock. The weights used represent the approximate relative importance of the components over the sample period. Equation 4M specifies the percentage change in prices paid by farmers on production items, interest, taxes, and wages to be a linear combination of the percentage change in the producer price index, the percentage change in prices received on crops, and the percentage change in prices received on livestock. The weights used in equation 4M were obtained from the relative importance weights used to construct the prices paid index.²

Equation 5M defines the percentage change in the producer price index to be a linear combination of the underlying macroeconomic inflation rate and the percentage change in prices received by farmers. The macroeconomic scenarios are run first, without accounting for any agricultural shocks or abnormalities. That is, the percentage change in the producer price index from the macroeconomic scenarios (DPPIM) represents the underlying rate of inflation in the economy. That information is then used in conjunction with results from the agricultural scenarios to determine the "actual" quarterly inflation rate (DPPI). The weight of .072 on the percentage change in prices received by farmers was derived using the percentage of the producer price index that was composed of processed foods (24 percent) multiplied by the

²See Agricultural Prices July 1988 for the relative importance measures.

Table 1--Equations of the Model

Quarterly equations: Estimation period: 1975.3 - 1988.3

$$(1M) \text{ DPRC} = - 6.39 + 2.92 Q1 + 7.39 Q2 + 1.26 Q3 + 3.71 E_t \text{USESTR}(+1)$$

$$(2.16) \quad (1.83) \quad (1.91) \quad (1.77) \quad (0.82)$$

$$+ (\text{PDLSUM}) 3.33 \text{ DM1Q} - 0.36 \text{ DREX}(-1)$$

$$(1.25) \quad (0.16)$$

$$R^2 = .36 \quad DW = 1.82$$

$$(2M) \text{ DPRL} = - 3.40 + 3.45 Q1 + 1.18 Q2 + 2.53 Q3 + 2.18 \text{ USESTR}$$

$$(1.71) \quad (1.64) \quad (1.64) \quad (1.64) \quad (0.77)$$

$$+ (\text{PDLSUM}) 1.63 \text{ DM1Q} - 0.39 \text{ DREXJ}(-1)$$

$$(0.89) \quad (0.11)$$

$$R^2 = .29 \quad DW = 2.24$$

$$(3M) \text{ PR} = .49 \text{ PRC} + .51 \text{ PRL}$$

$$(4M) \text{ DPP} = .723 \text{ DPPIM} + .142 \text{ DPRC} + .135 \text{ DPRL}$$

$$(5M) \text{ DPPI} = .928 \text{ DPPIM} + .072 \text{ DPR}$$

$$(6M) \text{ DCRCA} = 2.14 + 0.637 \text{ DPRC} + 0.404 \text{ DCRCA}(-1)$$

$$(1.50) \quad (0.262) \quad (0.128)$$

$$R^2 = .31 \quad h = -0.81$$

$$(7M) \text{ DCRLA} = 1.14 + 0.878 \text{ DPRL} + 0.651 \text{ DCRLA}(-1)$$

$$(0.85) \quad (0.149) \quad (0.076)$$

$$R^2 = .72 \quad h = -0.83$$

Annual Equation: Estimation period: 1975 - 1988

$$(8M) \text{ DLANDPA} = 11.08 + 0.262 \text{ DCRCA} - 0.91 \text{ REALR}(-1) - 0.92 \text{ REALR}(-2)$$

$$(1.63) \quad (0.118) \quad (0.41) \quad (0.39)$$

$$R^2 = .88 \quad DW = 2.41$$

Notes: Standard errors in parentheses.

DW is the Durbin-Watson statistic.

h is the Durbin h statistic (distributed normal (0,1) under null).

R² is the coefficient of determination

Continued--

Table 1--Equations of the model--Continued

Definition of variables:

PR	index level of prices received by farmers
PRC	index level of prices received by farmers, crops
PRL	index level of prices received by farmers, livestock
DPRC	percentage change in prices received by farmers, crops
DPRL	percentage change in prices received by farmers, livestock
DPP	percentage change in prices paid by farmers, production items
DCRCA	four-quarter (annual) percentage change in cash receipts, crops
DCRLA	four-quarter (annual) percentage change in cash receipts, livestock
DLANDPA	annual percentage change in land value
Q1,Q2,Q3	quarterly dummies
USESTR	normalized use-to-stock ratio
DM1Q	percentage change in M1 (DM1) minus percentage change in real GNP (DGNP)
DREX	percentage change in the Fed trade-weighted dollar index
DREXJ	percentage change in the yen-dollar exchange rate
DPPI	percentage change in producer price index
DPPIM	percentage change in producer price index from macroeconomic model
REALR	real rate of interest: prime rate minus annual DPPIM
E_t	represents the expectation formed in period t

PDLSUM signifies that a polynomial distributed lag was used for DM1Q, and the coefficient shown is the sum of the PDL coefficients. For the DPRC equation, the specification used 9 lags with a first-degree polynomial and the far endpoint constrained to zero. For the DPRL equation, the specification used 5 lags with a first-degree polynomial and the far end tied to zero.

farm-to-retail price spread for the market food basket (approximately 30 percent).³

Equations 6M and 7M specify the four-quarter percentage changes in cash receipts to be functions of the lagged dependent variable, and the quarterly percentage change in prices received. Finally, the annual equation specifies the percentage change in land values as a function of the annual percentage change in cash receipts for crops and two lagged values of the real prime interest rate. The real prime interest rate was calculated as the prime interest rate minus the annual percentage change in the producer price index from the macroeconomic scenarios.

The use of polynomial distributed lags for DM1Q in the prices received equations 1M and 2M deserves further consideration. First, the validity of using the constrained variable DM1Q was tested against the hypothesis that the percentage change in M1 and the percentage change in GNP should enter as separate variables. For purposes of parsimony, a maximum lag of 9 quarters was used in the estimations. Hence, the sample period ranged from the third quarter of 1975 to the third quarter of 1988.⁴ The calculated values of the F-statistic for testing the use of the constrained DM1Q were 1.56 for the prices received for crops equation 1M, and 1.59 for the prices received for livestock equation 2M. The validity of the use of the constrained DM1Q cannot be rejected since the critical value of the F-statistic is 2.20 for the .05 level of significance and (10,27) degrees of freedom. Hence, imposing the constraint allows for more efficient estimation.

Second, Akaike's Final Prediction Error (FPE) technique was used to determine the optimal length and form of the polynomial distributed lag.⁵ The search was conducted for the following characteristics of the lag structure: zero through nine lags for DM1Q; first-, second-, and third-degree polynomials; and, with and without the far end of the polynomial tied to zero. For the prices received for crops equation 1M, the minimum FPE was observed for a first-degree polynomial with nine lags and the far end tied to zero. For the prices received for livestock equation 2M, the minimum FPE was observed for a first-degree polynomial with five lags and the far end tied to zero.

The coefficients from the PDL estimation for DM1Q are shown in figure 2 and table 2 presents the values of the coefficients. The value of the coefficient for the contemporary asset market shock is less than 1, though not significantly for the percentage change in prices received for crops (DPRC). This result does not provide support for "impact" overshooting over a quarterly time horizon, but it does not rule out the possibility that impact overshooting could occur and be observed for periodicities of shorter intervals, such as monthly or weekly. Note, however, from the sum of the polynomial distributed lag coefficients that sustained increases in monetary growth relative to real activity would generate coefficients larger than 1.

³See Producer Price Indexes and Agricultural Outlook for information on these weights. The linear combination of percentage changes is only an approximation for the percentage change in the total index since the producer price index is arithmetically weighted.

⁴The estimation and simulations were performed for data available in February 1989.

⁵See Hsiao (1981) for details about the FPE approach.

Figure 2
PDL Coefficients for DM1Q

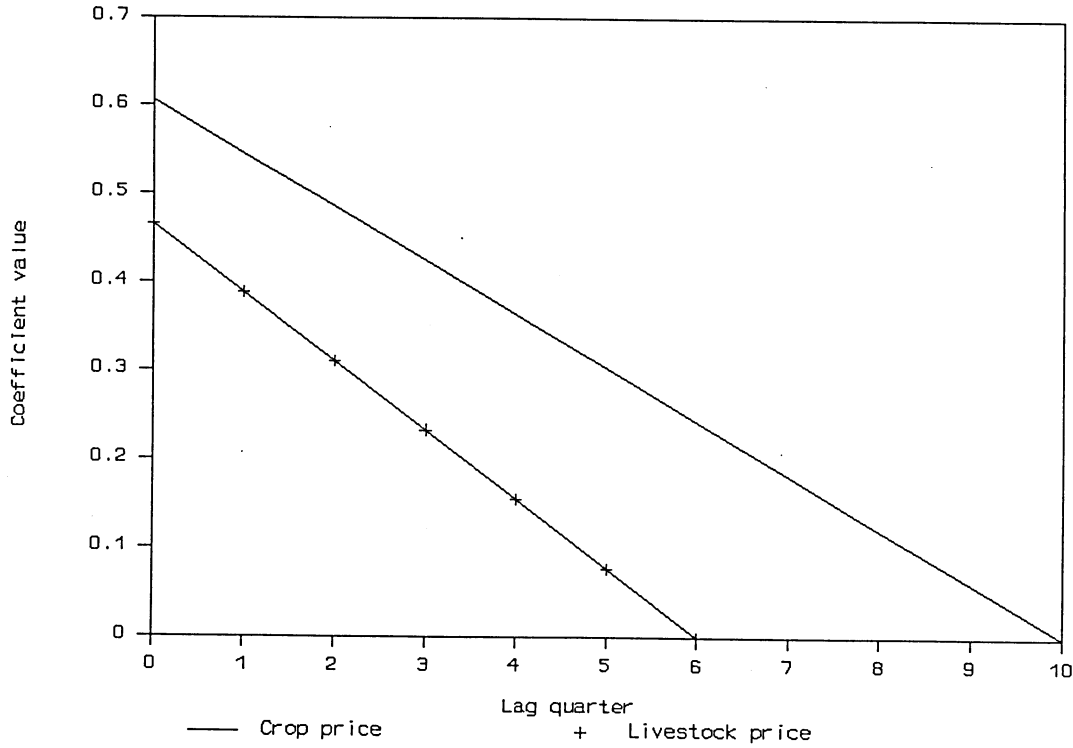


Table 2--Coefficients for nominal money effects on agricultural prices

lag									
0	1	2	3	4	5	6	7	8	9

DPRC equation:

0.606	0.545	0.424	0.364	0.323	0.303	0.242	0.182	0.121	0.061
(.227)	(.204)	(.181)	(.159)	(.136)	(.113)	(.091)	(.068)	(.045)	(.023)

DPRL equation:

.466	.388	.310	.233	.155	.078	0	0	0	0
(.256)	(.213)	(.171)	(.128)	(.085)	(.043)				

Such results are consistent with the general interpretation of overshooting. Models examining the issue of overshooting generally examine the response of flexible prices to an expected sustained change in the rate of growth (or level in the Dornbusch frameworks) of the money stock, not to one-time transitory monetary shocks.⁶

Base and Alternative Scenarios

Several macroeconomic scenarios and an alternative agricultural scenario for 1989-90 were examined to illustrate the operation of the model. Table 3 shows the assumed values of the exogenous variables under the various scenarios.

The base scenario assumes steady 5-percent annual M1 growth over 1989-90. Real GNP increases 3-4 percent throughout 1989 and then settles at just below 3 percent growth in 1990. In 1989, the dollar initially appreciates, then falls by about 5 percent over the rest of the year, and remains stable in 1990. The producer price index (PPI) increases at about a 4 percent annual rate during 1989, but then rises by about 3.6 percent during 1990.

An alternative scenario (LM--low money) examines the effect of lower money growth, specifically, M1 growth at about 3 percent annually. Real GNP growth is lower in the LM scenario than in the base scenario, being cut nearly in half by the end of the 2-year period. The dollar initially appreciates in response to the tighter monetary policy of the LM scenario during 1989, but then depreciates slightly throughout 1990 as real activity slows. The producer price index increases at a lower rate under scenario LM than under the base scenario, slowing to a 3-3.2 percent annual rate of increase by the end of 1990.

A second alternative scenario (HM--high money) examines the effect of higher money growth, M1 growth at about 9 percent annually. Real GNP growth increases relative to the base case, while the value of the dollar initially depreciates strongly, then depreciates at a lower and steady rate, with a total depreciation over the 2 years of about 15 percent. The producer price index initially increases at a rate slightly above that of the base scenario, but by the end of the second year, PPI inflation under the HM scenario exceeds the base PPI inflation by more than 2 percent annually.

The final alternative scenario (LS--low stocks) examines the effect of a shock from the agricultural sector: a shock to USESTR similar in magnitude to that which occurred from the drought of 1988. In scenario LS, 1989 is treated as another drought year. Increased production in 1990 is assumed to return USESTR to normal levels.

Table 4 shows the results from the model under the base and alternative scenarios. Figures 3 and 4 show the historical series for the levels of

⁶The use of lagged values of DM1Q (and the polynomial distributed lag coefficients) can also be justified through a rational expectations approach. For variables that have a permanent component that follows a random walk and a transitory component that is serially uncorrelated, Muth (1960) showed that expectations of the level of the variable will be based on exponentially weighted averages of past observed levels, and the change in expectations will be determined by an adaptive expectations mechanism.

Table 3--Base and alternative scenarios, exogenous variables

Quarter	DMI	DGNP	DMIQ	DREX	DPPIM	USESTR
Base scenario:						
1989.1	1.25	0.80	0.45	0.50	1.10	2.95
1989.2	1.25	.85	.40	-1.25	1.00	2.15
1989.3	1.25	.80	.45	-1.50	.95	.61
1989.4	1.25	.85	.40	-1.75	.90	-.26
1990.1	1.25	.70	.50	0	.90	0
1990.2	1.25	.70	.55	0	.90	0
1990.3	1.25	.70	.55	0	.90	0
1990.4	1.25	.70	.55	0	.90	0
Alternative scenario LM:						
1989.1	.75	.80	-.05	2.00	1.00	2.95
1989.2	.75	.725	.025	2.50	.95	2.15
1989.3	.75	.70	.05	1.00	.90	.61
1989.4	.75	.70	.05	.30	.875	-.26
1990.1	.75	.55	.20	-.30	.85	0
1990.2	.75	.45	.30	-.70	.825	0
1990.3	.75	.40	.35	-.10	.80	0
1990.4	.75	.375	.38	-.11	.75	0
Alternative scenario HM:						
1989.1	2.25	.80	1.45	-3.00	1.10	2.95
1989.2	2.25	.85	1.40	-2.25	1.00	2.15
1989.3	2.25	.925	1.325	-1.75	1.05	.61
1989.4	2.25	1.00	1.25	-1.55	1.10	-.26
1990.1	2.25	1.10	1.15	-1.50	1.20	0
1990.2	2.25	1.20	1.05	-1.50	1.30	0
1990.3	2.25	1.00	1.25	-1.50	1.40	0
1990.4	2.25	.90	1.35	-1.50	1.50	0
Alternative scenario LS:						
1989.1	1.50	.80	.70	.50	1.10	2.95
1989.2	1.50	.85	.65	-1.25	1.00	2.15
1989.3	1.50	.80	.70	-1.50	.95	2.00
1989.4	1.50	.85	.65	-1.75	.90	2.00
1990.1	1.50	.70	.80	0	.90	2.00
1990.2	1.50	.70	.80	0	.90	2.00
1990.3	1.50	.70	.80	0	.90	0
1990.4	1.50	.70	.80	0	.90	0

Table 4--Quarterly model results, endogenous variables

Quarter	DPRC	DPRL	DCRCA	DCRLA	DPP	DPPI
Base scenario:						
1989.1	4.14	5.42	10.16	9.04	2.12	1.46
1989.2	3.93	2.82	8.76	9.50	1.66	1.17
1989.3	-4.73	1.54	2.68	8.68	.22	.78
1989.4	-4.79	-2.79	.18	4.34	-.41	.57
1990.1	-1.53	1.42	1.24	5.21	.62	.84
1990.2	2.45	-1.43	4.21	3.28	.81	.85
1990.3	-3.59	-0.04	1.56	3.24	.14	.72
1990.4	-4.79	-2.54	-.28	1.02	-.37	.58
Alternative scenario LM:						
1989.1	3.84	5.19	9.97	8.84	1.97	1.34
1989.2	2.89	1.86	8.02	8.52	1.35	1.05
1989.3	-6.77	-.41	1.08	6.33	-.37	.60
1989.4	-6.51	-4.32	-1.56	1.47	-.87	.43
1990.1	-3.21	.03	-.53	2.12	.16	.69
1990.2	1.59	-1.86	2.94	.88	.57	.74
1990.3	-4.30	-.24	-.60	1.51	-.06	.60
1990.4	-5.67	-2.90	-1.22	-.43	-.65	.40
Alternative scenario HM:						
1989.1	4.75	5.89	10.55	9.45	2.26	1.50
1989.2	6.34	5.04	10.45	11.71	2.30	1.33
1989.3	-2.81	3.04	4.58	11.44	.77	1.00
1989.4	-2.79	-1.41	2.22	7.35	.21	.87
1990.1	.50	2.69	3.36	8.28	1.30	1.24
1990.2	5.07	.32	6.73	6.81	1.70	1.38
1990.3	-.93	1.57	4.27	6.95	1.09	1.33
1990.4	-1.98	-.91	2.61	4.87	.68	1.29
Alternative scenario LS:						
1989.1	4.29	5.54	10.26	9.14	2.08	1.47
1989.2	9.37	3.03	12.26	9.75	2.46	1.36
1989.3	4.06	4.86	9.69	11.75	1.99	1.20
1989.4	3.15	2.48	8.07	10.97	1.58	1.04
1990.1	6.49	6.16	9.54	13.69	2.62	1.29
1990.2	3.13	3.33	8.00	12.98	1.83	1.07
1990.3	-2.85	.37	3.56	9.91	.66	.75
1990.4	-4.00	-2.13	1.04	5.72	.23	.62

Figure 3
Prices received by farmers, crops

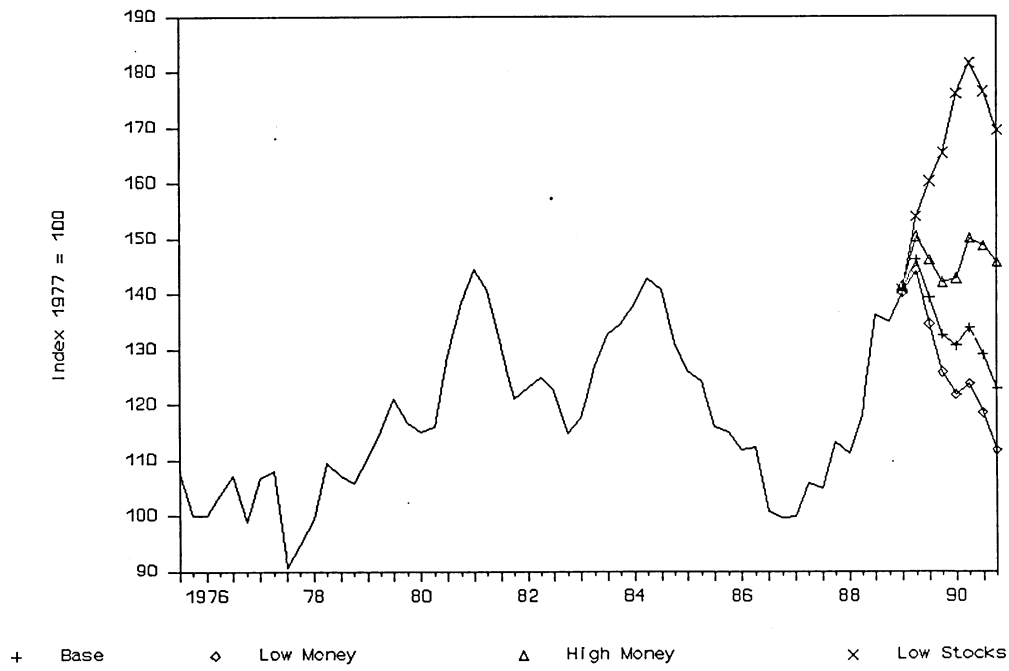
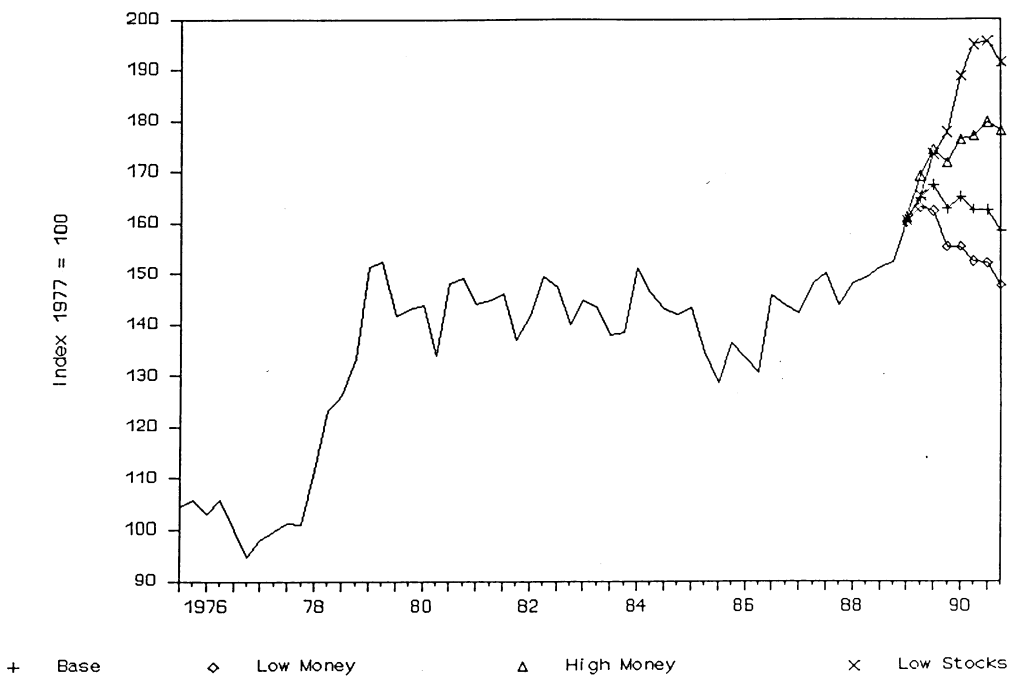


Figure 4
Prices received by farmers, livestock



prices received on crops and livestock and the behavior of the price index levels under the base and alternative scenarios for 1989-90.

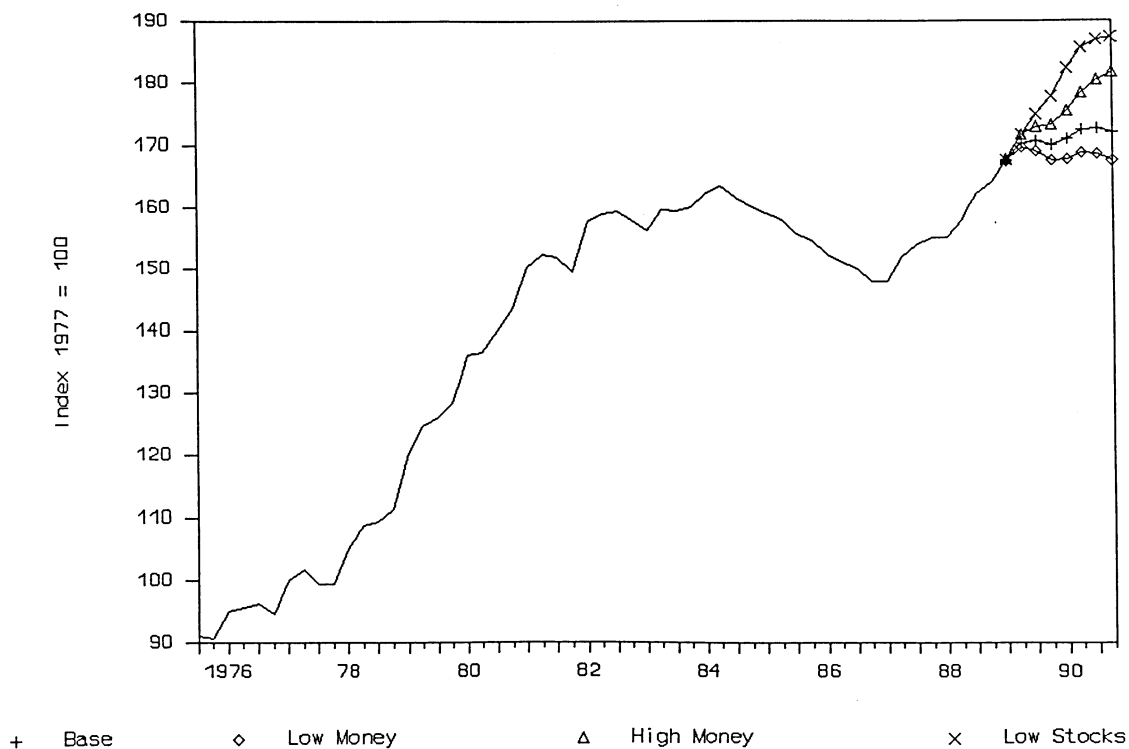
Under the base scenario, crop and livestock prices continue to rise in the early part of 1989 as the effect of low stocks from the 1988 drought persists. Higher production in 1989 pushes USESTR to more normal levels, however, and prices fall in the latter part of 1989 and into 1990.

Results for the base scenario fall between the results for the LM and HM scenarios. With restricted money growth, prices received by farmers are lower, while with high money growth, prices received by farmers are higher. Under the HM scenario, prices received for crops remain at the relatively high levels of 1988, and prices received for livestock rise above the 1988 level.

The results under the various scenarios for the percentage change in prices paid by farmers on production items, interest, taxes and wages are shown in the fifth column of table 4. Figure 5 shows that the prices paid index behaves in a fashion similar to that of the prices received indexes under the various scenarios.

Similar results are observed for the crop and livestock cash receipts variables. Figure 6 shows annual values of alternative forecasts for cash receipts for crops. Quarterly values for the cash receipts for crops are not

Figure 5
Prices paid by farmers



shown because of the highly seasonal behavior of the quarterly series. Figure 7 shows quarterly values of forecasts for cash receipts for livestock.

The LS (low stocks) scenario shows the largest effect on prices received for both the crop and livestock cases. This is somewhat reassuring, as it suggests that agriculture specific factors tend to have the stronger effects in the model and that substantial macroeconomic shocks are required to generate price effects that would be as strong. Cash receipts for crops and livestock for the LS scenario are markedly higher. However, costs to farmers under the low stocks scenarios are also higher as revealed by the increase in prices paid.

The results for the percentage change in the producer price index (DPPI) show that incorporating agricultural effects produces relatively small impacts in the LM and HM scenarios. The LS scenario shows larger impacts on the producer price index. The model predicts that a relatively severe drought in 1989, generating the USESTR numbers of the LS scenario shown in table 4, would lead to PPI inflation being 1.13 percent higher at an annual rate in 1989 and 0.76 percent higher in 1990, relative to the base scenario.

The data and results for the alternative scenarios for the annual land price equation are shown in table 5. Under the base scenario land prices initially rise in 1989 and then flatten out in 1990. Under the LM scenario, the initial

Table 5--Annual data and land price results for the base and alternative scenarios

Year	DCRC	REALR(-1)	DLANDP	LANDP
Base scenario:				
1989	3.78	5.22	1.93	108.0
1990	.85	6.60	1.75	109.9
Alternative scenario LM:				
1989	2.64	5.22	1.62	107.7
1990	-.24	8.10	-1.01	106.6
Alternative scenario HM:				
1989	5.23	5.22	2.35	108.5
1990	3.23	5.40	2.44	111.1
Alternative Scenario LS:				
1989	8.59	5.22	3.30	109.5
1990	3.93	6.60	1.55	111.2

Note: DCRC was calculated from annual numbers that were derived from the quarterly model estimates. The land value index (1977=100) had a value of 106 for 1988.

Cash receipts, crops

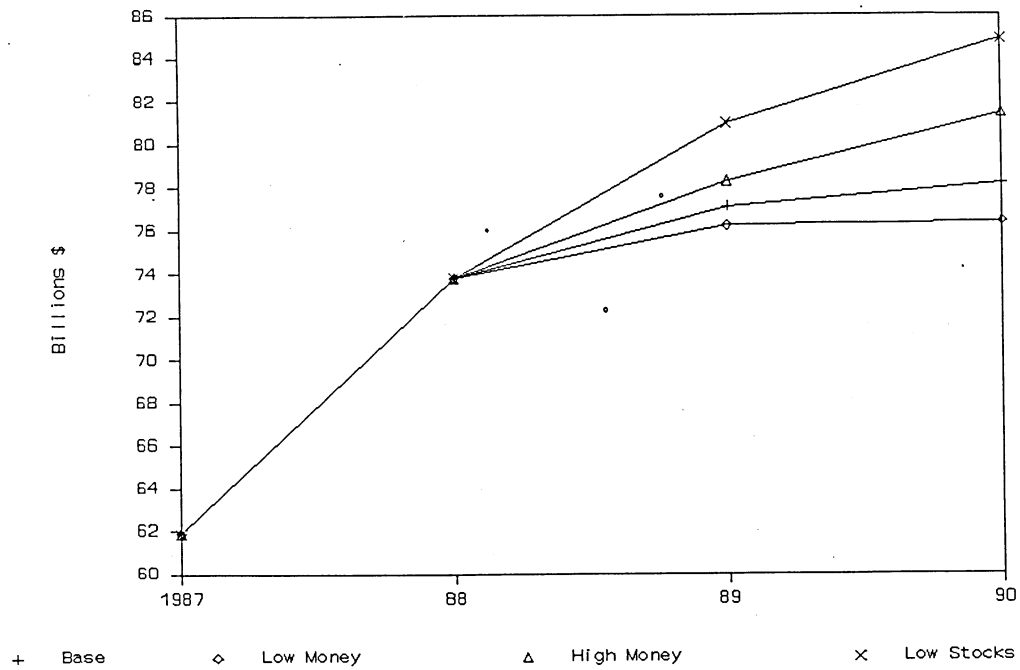
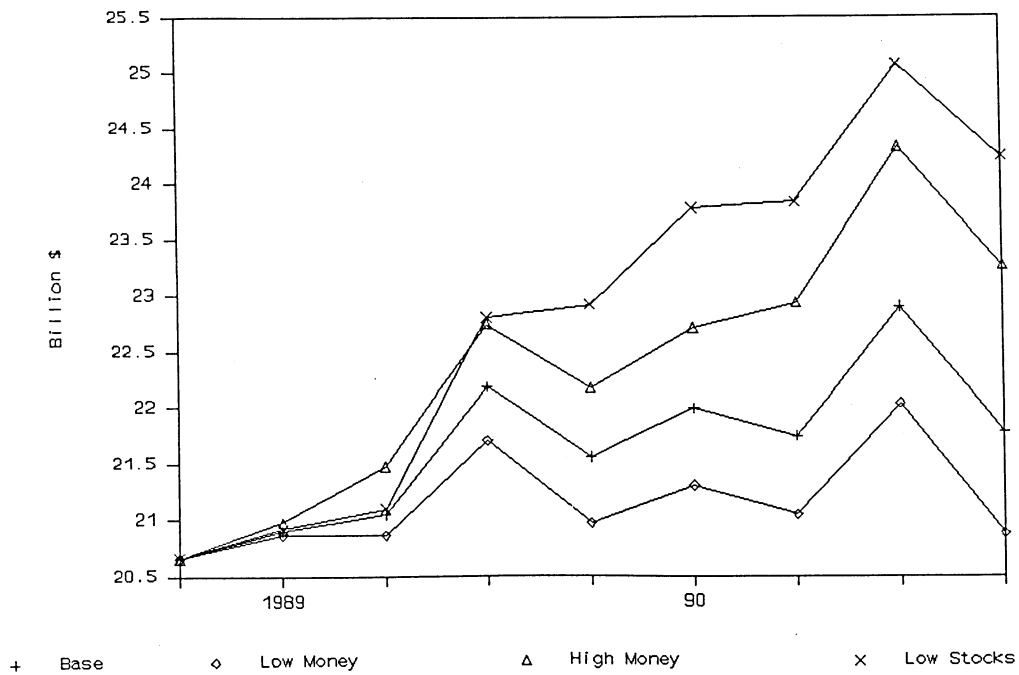


Figure 7
Cash receipts, livestock



price increase is not as large, and land values fall in 1990. Under the HM scenario, land values increase throughout 1989 and 1990. Finally, under the LS scenario, the land price increase in 1989 is the largest of the scenarios examined, while the 1990 level of land prices exceeds that of the base by 1.3 percent.

Fiscal Policy Effects

Fiscal policy variables do not enter directly into the model. Hence, it is difficult to make any statements about the effect of fiscal policy on agricultural variables using the model. The asset market approach does not specify any direct relationship between fiscal variables and flexible prices. Rather, fiscal policy variables would affect real activity, and through real activity, affect flexible prices. Thus, to determine the effects of fiscal policy on agricultural prices, revenues, and land values using this model, the effect of fiscal variables on real activity (growth in real GNP), real interest rates, and the exchange value of the dollar would have to be identified first.

For example, for a given expected path of the money supply, deficit spending would produce a higher level of real activity, driving up real interest rates and the value of the dollar, and putting downward pressure on prices. Note that this requires that the agents do not treat current deficit spending as perfectly discounted future tax liabilities, that is, that the "pre-Ricardian equivalence proposition" fails to hold exactly (Feldstein 1982). Given these macroeconomic relationships, the model indicates that a reduction in government deficit spending would lead to higher agricultural prices, cash receipts, and land values. The rise in land values could be particularly strong if the real interest rate fell significantly as a result of reduced government deficit spending. For example, the model predicts that a 300-basis-point (3-percent) fall in the real prime interest rate over a 2 year period would lead to an increase in land values, relative to what they otherwise would have been, of 2.7 percent higher in the first year and 5.5 percent higher in the second year. Such increases would persist if real interest rates could be maintained at the lower levels, for example, in the 3-percent range rather than 6-percent range.

Limitations of the Model

The model presented here has several important limitations. First, it is highly simplified and examines effects on highly aggregated variables. This is an important limitation since commodity specific statements cannot be made based on the model. The primary purpose of the model, however, is to provide general information on the effect of macroeconomic, especially monetary, shocks on agricultural variables. As such, there was a strong desire to maintain simplicity. The approach used in this report can be extended quite easily to examine specific commodity prices or systems of equations for commodity prices and markets.

A second limitation is the absence of quantity variables in the specification. Agricultural output and exports are completely exogenous to the model.⁷ Their price effects are captured only by introducing them from outside the model (for example, through the use-to-stock variable, USESTR) or to the extent that there were similar effects in the historical period over which the model was estimated. There is no feedback from prices to output and no direct information on the effect of exchange rates and prices on agricultural exports.

A third limitation is the absence of agricultural policy variables or effects. Agricultural policy effects could be introduced only through exogenous variables, in particular the use-to-stock ratio. For example, policies aimed at reducing stocks or improving exports could be included in simulations by increasing USESTR over the forecast periods.

A fourth limitation is the shortrun to intermediate-run nature of the model. In addition to the lack of an agricultural output specification and the absence of agricultural policy effects, there is also no endogeneity of monetary policy that could account for possible reactions to inflationary pressures, for example. Such longer term relationships and feedbacks are simply not present in the model. Hence, the model should be used only for short- to intermediate-term analysis.

Conclusions

The model presented in this report provides a straightforward and easily accessible tool for examining the effect of macroeconomic shocks on agricultural prices, cash receipts, and land values. Despite limitations, the model can yield much information at a relatively low cost. With careful manipulation, the model can be used to analyze the effects of a large range of macroeconomic, agricultural, or foreign shocks, although the intended use is to provide general information on the effect of macroeconomic, especially monetary, shocks on agricultural variables. The more aggregate view of the model provides a different way of looking at agricultural price behavior, and allows comparisons with the results from more traditional commodity price models.

⁷See the Appendix for a brief discussion about incorporating a specification for agricultural exports in the model.

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Appendix--Agricultural Exports

The model presented in this report does not incorporate an explicit specification for agricultural exports. Some very preliminary work has been done using a simple specification for agricultural exports:

$$(A1) \text{ DRAGEX} = 1.77 - 0.32 \text{ DRAGEX}(-1) - (\text{PDLSUM}) 1.04 \text{ DREX}$$

$$(0.98) \quad (0.13) \qquad \qquad \qquad (0.41)$$

$$R^2 = .17 \qquad h = -0.10$$

where DRAGEX is the percentage change in real agricultural exports, DREX is the percentage change in the trade weighted value of the dollar, PDLSUM indicates that the coefficient on DREX is the sum of the coefficients in a polynomial distributed lag (PDL), and standard errors are in parentheses. The Final Prediction Error approach described in the text yielded a specification of a first degree polynomial with 7 lags and no endpoint constraints. The values of the PDL coefficients are shown in appendix table 1. The values for the percentage change in agricultural exports for the base and alternative scenarios of the text are shown in appendix table 2. Under the base scenario, real agricultural exports increase by about 7 percent in 1989 and just over 3 percent in 1990. Under the low money scenario, agricultural exports increase 5 percent in 1989 and fall by about 1 percent in 1990. The high money scenario generates an increase of about 8 percent in 1989 and an increase of nearly 7 percent in 1990. Because of the coefficient lag structure, the

Appendix table 1--Coefficients for exchange rate effect on real agricultural exports

-----lag-----	0	1	2	3	4	5	6	7
	-0.052	-0.074	-0.097	-0.119	-0.141	-0.164	-0.186	-0.208
	(.118)	(.091)	(.067)	(.053)	(.054)	(.071)	(.096)	(.123)

Appendix table 2--Real agricultural export response (DRAGEX)

Quarter	Base	Low money	High money
1989.1	4.60	4.52	4.78
1989.2	.18	- .09	.44
1989.3	1.98	1.52	2.33
1989.4	- .02	- .70	.41
1990.1	- .07	- .89	.51
1990.2	- .13	-1.09	.60
1990.3	1.54	.44	2.46
1990.4	1.90	.66	3.02

largest difference in the effects occurs toward the end of the 2 year simulation period. Even larger differences would likely be observed if the simulation period were extended beyond 2 years.

To fully incorporate the effects of agricultural export responses into the model, the use-to-stock ratio (USESTR) would have to account for differences in export use. This step has not been made in this preliminary analysis. Some additional price pressure could result from incorporating agricultural export effects in the USESTR variable. However, since USESTR variation is dominated by production variation, by droughts, for example, the price effects of export changes are likely to be small relative to information already included in the model.