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Monetary Policy and the Farm/Nonfarm Price Ratio: A Comparison of Effects in Alternative Models

SINCE 1974, FOLLOWING PUBLICATION of Schuh's "The Macroeconomics of Agriculture," much research effort has been devoted to determining whether and how monetary policy affects the farm sector. One of the more active areas of interest has been the question of whether changes in the money stock affect the farm/nonfarm product relative price ratio. The reason for this particular interest, as described by Tweeten (1980), is that declines in the relative price ratio represent a "cost-price squeeze" for farmers; thus, he suggests, if contractionary monetary policy causes farm prices to adjust downward more quickly than farm input prices, farm income will decline as well. Penson and Gardner (1988), surveying the relevant literature, conclude that the agricultural sector has borne the brunt of adjustment costs whenever slower money growth has occurred.

These conclusions received considerable attention in policy discussions during the mid-1980s when real farm incomes, exports and asset values were falling sharply. As those discussions intensified, additional research reported that the quantitative effect of monetary actions on relative farm prices was not only large but persistent, if not permanent.

Among recent studies, Devadoss and Meyers (1987), for example, report that negative money supply shocks . . . "harm farmers because farm product prices decrease relatively more than nonfarm product prices" (p. 842). Many other studies found similar results.[1]

In sum, the notion that contractionary monetary policy affects agricultural prices and income differently than comparable measures in the nonfarm sector has become one of the

[1]Chambers (1984); Starleaf, Meyers and Womack (1985); Falk, Devadoss and Meyers (1986); Taylor and Spriggs (1989); and Tegene (1990) found similar results. Doo Bong Han, Jansen and Penson (1990) reaffirm the significance of this linkage by reporting that the conditional means and variances of agricultural prices are more closely related to the conditional means and variances of M1 than those of industrial prices. Orden (1986a), Lapp (1990), Gardner (1981) and Grennes and Lapp (1986), in contrast, did not find the relative price of farm products to be related to nominal macroeconomic variables.

stylized facts" of agricultural economics.[2] Because neoclassical theory implies that changes in money growth have no real consequences in the long run, however, the large and sometimes permanent effects of monetary actions on agricultural prices reported in the literature seem to present an anomaly. Recent episodes, moreover, seem to run counter to the view that contractionary monetary policy selectively hurts farmers. First, real farm income rose during the late 1980s, a period some analysts would characterize as one of substantial monetary contraction.[3] Second, although the dollar's decline since early 1985 would help expand U.S. farm exports, all other things the same, the exchange rate depreciation has occurred at an odd time: when monetary policy has been contractionary and federal budget deficits have been expanding. Although the conventional wisdom links both factors to lower farm sector prices and income, this result is supposed to be transmitted through a *rising* value of the dollar.[4]

This article reviews the previous literature linking monetary actions to the relative price of farm products and attempts to reconcile the conflicting theoretical and empirical approaches that have been applied to this issue. Because previous studies derive their empirical models from a variety of generally noncomparable theoretical models, this paper highlights cases in which the direction or significance of a particular variable's impact differs across models. By estimating each model with the same data and testing each model's implications directly, we can better assess monetary policy's effects on relative farm prices and the agricultural sector.

A REVIEW OF THE LITERATURE

Table 1 lists the important features of studies that examined the effects of monetary actions on the farm/nonfarm relative price ratio. The most common measure of farm prices used in these studies is the index of prices received by farmers. The relative price issue is typically investigated by dividing this index by another index of either the aggregate price level or the prices of some commodity bundle composed of nonfarm products; in some instances, farm and nonfarm nominal price indexes have been regressed on a monetary measure individually to identify different speeds of adjustment and thereby infer the net impact of changes in money growth on the selected relative price ratio. M1 has been used almost uniformly as the indicator of monetary actions.

Annual, quarterly and monthly data have been used to estimate the empirical relationship between M1 and the relative price measure. Most studies specify this relationship as one between the natural logarithms of the two series, something which, in view of the more recent literature on common trends in data and spurious regression relationships, may have given rise to significant associations where none actually existed.[5]

With the exceptions of Lapp (1990), and Grennes and Lapp (1986), these studies found M1 to have short-run effects on the farm/nonfarm relative price ratio. Unfortunately, in many cases, it is not easy to categorize the significance, magnitude or persistence of these effects. Where tested, the verdict seems about evenly split between those studies that find monetary actions to be neutral in their effect on the long-run relative price ratio and those that find the effects to be permanent. The only general conclusion that emerges from the studies summarized in table 1 is that the wide diversity among sample periods, relative price measures, variable specifications and results makes it difficult to tell whether and by how much monetary actions affect the farm/nonfarm relative price ratio.

A REVIEW OF THE DATA

Figure 1 shows quarterly values for the annualized percentage changes in the indexes of prices received and prices paid by farmers since 1976.[6] These indexes are based on the bundle

[2]Chambers (1985).

[3]Between IV/1986 and IV/1990, for example, the 12-quarter moving average growth rate of M1 declined from 10.3 percent to 3.0 percent. A "trend" growth rate of M1 this low has not been seen in nearly three decades.

[4]See, for example, Belongia and Stone (1985).

[5]See, for example, Granger and Newbold (1974), Plosser and Schwert (1978) and Dickey and Fuller (1979, 1981).

[6]Use of monthly data or producer price indexes for farm and industrial (nonfarm) commodities does not affect the qualitative conclusions of this section. The plot starts in 1976 to avoid the price volatility associated both with OPEC and U.S. farm policies in the 1973-74 period. Moreover, the empirical work to follow begins after the system of flexible exchange rates was adopted and most of the one-time adjustments to new exchange rate levels—especially trade flows—are presumed to have taken place.

Table 1
A Summary of Results from Studies of the Monetary Policy-Relative Farm Price Question

Author(s)	Relative price measure	Monetary policy indicator	Sample period	Data frequency	Specification of variables	Long-run neutrality of money
"Important" Monetary Effects						
Chambers (1984)	CPI-food / CPI-nonfood	M1	1976.05-1982.05	Monthly	Logs	Not tested
Starleaf, et al. (1985)	Prices received, Prices paid	Inflation rate	1930-83; 1930-53; 1954-70; 1971-83	Annual	Percentage changes	Not tested
Devadoss and Meyers (1987)	Prices received / Index of Industrial Prooduct Prices	M1	1960.01-1985.12	Monthly	Logs	Non-neutral
Taylor and Spriggs (1989)	Index of Canadian Farm Product Prices	M1 (Canada)	1959.1-1984.4	Quarterly	Δ Logs	M1 had largest effect of *domestic* variables, but all foreign variables had larger effects.
Tegene (1990)	PPI farm output, PPI nonfarm output	M1	1934-87	Annual	Logs	In the short run, a change in M1 affects farm prices more quickly than manufacturing prices.
Han, et al. (1990)	Index of Farm Prices	M1	1960.1-1985.4	Quarterly	ΔLogs	Conditional mean and variance of farm prices are more sensitive to changes in M1 than are the conditional mean and variance of industrial prices.
"Small" Monetary Effects						
Grennes and Lapp (1986)	Prices received / CPI	M1	1951-81	Annual	Logs; Δ logs	Neutral
Lapp (1990)	Prices received / PPI or CPI	M1	1951-85	Quarterly	Δ Logs	Neutral
Importance of Monetary Effects is Subject to Interpretation						
Orden (1986)	Prices received / GNP deflator	M1; Interest rates	1960.1-1984.3	Quarterly	Logs	Monetary effects are small if represented by M1, but larger if represented by interest rates.
Orden and Fackler (1989)	Prices received / GNP deflator	M1; Interest rates	1975.1-1988.1	Quarterly	Logs	Small, but significant, effect over four quarter period; long-run neutrality.
Robertson and Orden (1990)	New Zealand farm output prices, Manufacturing prices	New Zealand M1	1963.1-1987.1	Quarterly	Logs	Clear short-run effect over four quarters; long-run neutrality holds.

of farm products that farmers produce and sell and commodities that farmers purchase as production inputs, respectively.[7] Quarterly values for the growth rate of M1 also are shown in this figure. Data for the individual series are summarized in table 2. As the figure and table show, farm product prices have been more volatile than farm input prices. A test of the equality of variances, for example, produces an F-statistic of 7.62 against a 5 percent critical value of 1.53.

Figure 2 shows changes in the ratio of the indexes plotted against changes in M1 growth. In

[7]The prices received measure is a weighted index of about 112 farm product prices; the prices paid measure is a weighted index of about 450 farm input prices. For more detail, see Handbook #365, U.S. Department of Agriculture (1970).

Figure 1
Growth of M1, Prices Paid by Farmers, and Prices Received by Farmers

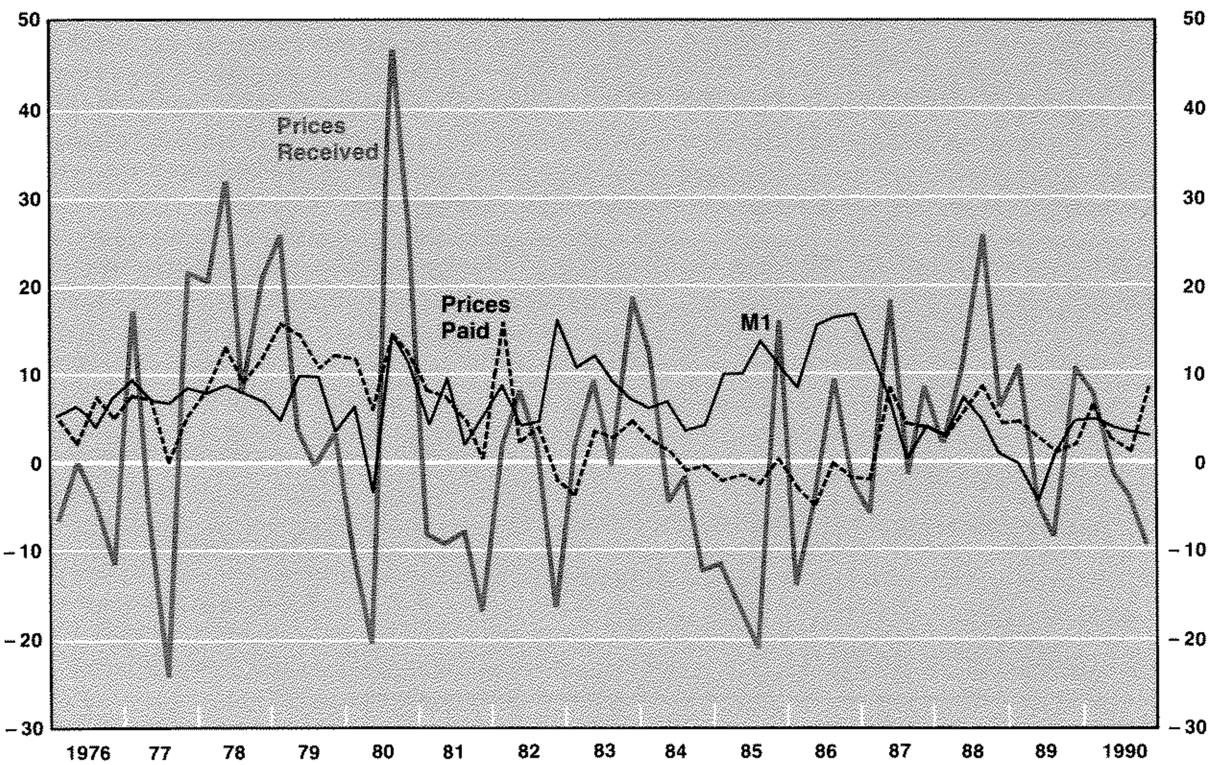
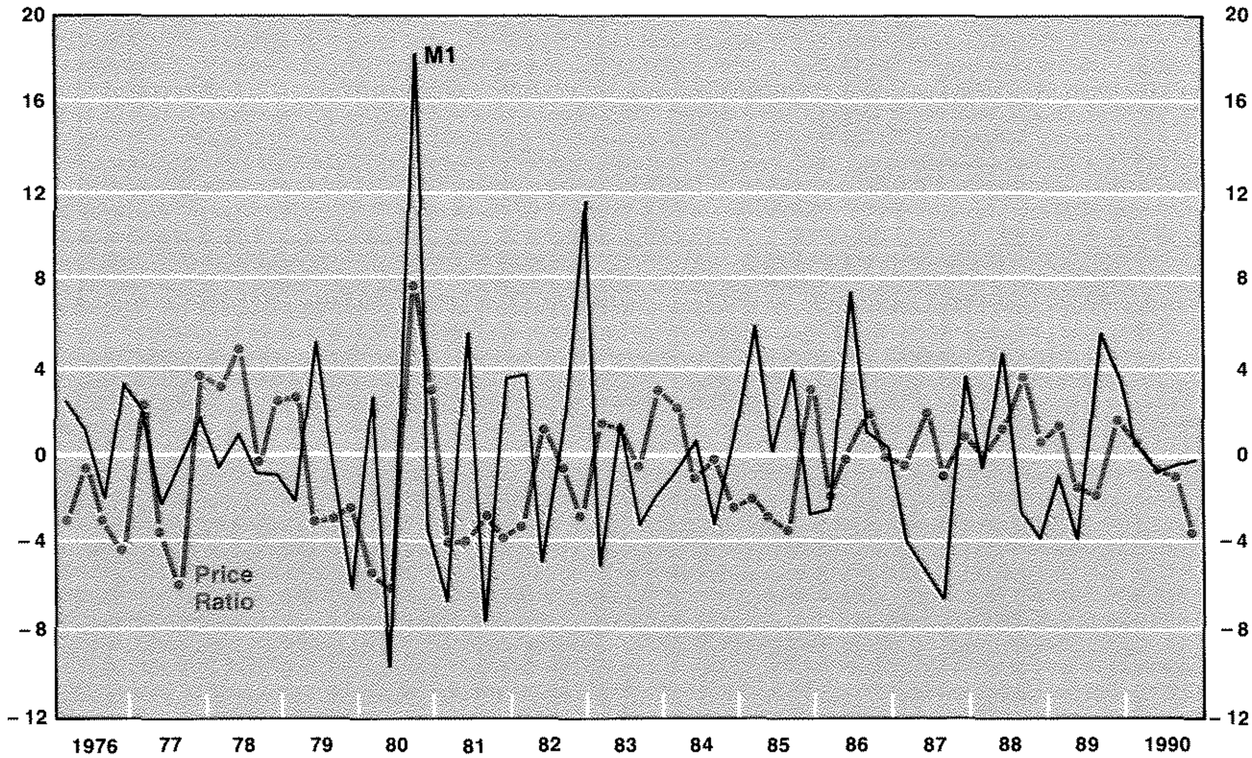


Table 2
Descriptive Statistics for Farm and Nonfarm Prices, I/1976-IV/1990 (annualized first differences of logarithms, quarterly data)

	Mean	Standard deviation	Minimum	Maximum
Prices received by farmers	2.22%	14.30%	−24.75%	46.74%
Prices paid by farmers	4.74	5.18	−4.96	15.92
Prices received/prices paid	−2.52	12.38	−26.35	32.18
M1	7.03	4.49	−4.09	16.85

Figure 2
First Difference of the Ratio of Prices Received to Prices Paid and the Change in M1 Growth



very simple terms, these series represent the logic in much of the literature that links monetary policy to the relative price of farm products. For example, accelerations in money growth are thought to be associated with increases in the farm/nonfarm product price ratio. Over this sample period, however, the simple correlation coefficient for these series, 0.13, is not significantly different from zero at the 5 percent significance level.

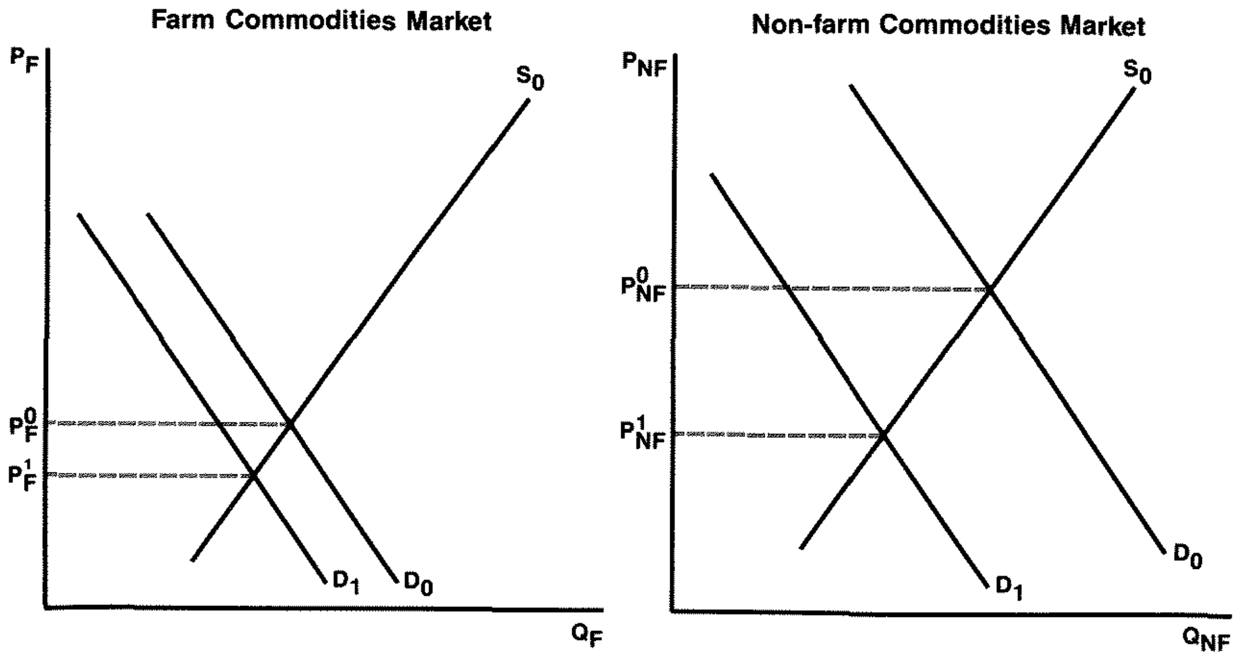
Finally, it is interesting to abstract from the short-run volatility in these series and examine the data for longer-run trends. Since 1976, the average growth rate of prices received by farmers has been about one-half that of farm input prices; as a consequence, the relative farm price ratio has fallen at an annual rate of more than 2.5 percent. Conversely, M1 has grown over the sample period at an annual average rate of 7.03 percent. From a long-run perspective, the downward trend in the relative price ratio is consistent with what Tweeten has called a "cost-price squeeze" for farmers. The origin of this squeeze, however, does not seem to be related to the relatively expansionary long-run course of monetary policy.[8]

MONEY GROWTH AND RELATIVE PRICES: ALTERNATIVE THEORETICAL RESULTS

The research attempting to link monetary actions to relative farm price changes has not questioned *whether* changes in money growth

[8]See Meltzer (1990) for a thorough review of U.S. monetary policy since the mid-1960s, with special emphasis on its tendency to produce increasing rates of money growth.

Figure 3
Graphical Representation of a Barro-type Model
MODEL I.



Model Assumptions and Predicted Result:An unanticipated decrease in money growth causes the demands for both farm and nonfarm commodities to fall. Because the income elasticity of farm commodity demand is assumed to be lower than that for nonfarm products, the decrease in farm product demand is smaller. Assuming identical supply elasticities in the two markets, $\Delta P_F < \Delta P_{NF}$ and (P_F/P_{NF}) rises.

affect the farm/nonfarm price ratio; instead, the direction, size and persistence of this effect have been its primary focus. Because alternative theoretical models produce different empirical specifications and, quite possibly, different results, some attempt must be made to distinguish among these alternatives. For guidance on these issues, the testable implications of three models used to investigate the money-relative price question are developed below.

Model 1: A Change in Money Growth as a Shock to Aggregate Demand

Equilibrium "Barro-type" models assume that anticipated changes in the money stock affect all nominal prices equi-proportionally and therefore leave relative prices unchanged.[9] Relative prices are affected in these models only by an *unexpected* change in the money stock. In model #1, illustrated in figure 3, an unanticipated decline in the money stock produces a negative shock to aggregate demand as people find themselves with a shortage of real money balances and an excess supply of goods. Their collective actions to restore equilibrium by reduced spending shifts aggregate demand to the left. This shift lowers output and income temporarily and the price level permanently.

If supply elasticities in the farm and nonfarm sectors are identical, this demand shift will affect relative prices only if the income elasticities

[9]See, for example, Barro (1976).

of demand for farm and nonfarm products differ. If the income elasticity for farm products is lower than that for nonfarm products, an unexpected decrease in the money stock would *increase* temporarily the relative price of farm products.[10] This interpretation of the model, therefore, predicts a response that is contrary to the story embedded in the "stylized facts" of agricultural economics. Because the direction of relative price change will vary with the particular assumptions about shifts in supply and demand across markets, the "sign" on this effect in a regression equation offers a direct way to test the implications of this one interpretation of the model.

The predictions of this model, however, deny that monetary contractions are a source of long-lasting harm to the farm sector. In this case, as in the other examples that follow, the real income effect is a short-run phenomenon. When people realize that the real demand for individual products has not changed fundamentally but that, instead, the monetary contraction caused a general decline in aggregate demand, the aggregate price level will fall to restore the original equilibrium and relative price ratio. Thus, because the decrease in the money stock is reflected only in a lower aggregate price level in the long run, the neutrality of monetary actions is preserved. In this model, as well as in model #2 that follows, whether the relative price ratio rises or falls and whether it returns to its original value in the long run are the model's testable hypotheses. As shown in table 1, however, the long-run neutrality proposition has not been tested in many previous studies or, when violated, often has not been discussed.[11]

Model 2: Relative Price Changes Caused by Different Elasticities of Supply

A slightly different variant of the equilibrium Barro model, which predicts a relative price change in the opposite direction from the previous discussion, is based on different assumptions about the structure of the farm and nonfarm goods markets. In this model, illustrated in figure 4, the short-run elasticity of supply of farm products is argued to be less than that of nonfarm products because of differences in the production processes.[12] With long lags between planting and breeding decisions and product marketings, the ability to adjust farm output in the short run is assumed to be limited. Other things the same, this characteristic of farm production would cause the farm/nonfarm relative price ratio initially to fall in response to a negative aggregate demand shock. Again, the existence of long-run neutrality is a testable proposition and the length of the adjustment process must be determined empirically. This model's predictions, however, are consistent with the argument that the relative price of farm products will fall under a contractionary monetary policy.

Model 3: Price Stickiness and "Overshooting"

So far, prices in both the farm output and input markets were assumed to be flexible in response to changes in other variables that affect them. Thus, changes in the relative price ratio depended on the relative magnitudes of shifts in supply and demand and the slopes of those curves; they were not influenced by different speeds of adjustment in the two markets. Another approach to this question has relied on some degree of price-stickiness in nonfarm prices to explain changes in the relative price ratio.

By adapting the overshooting model from the exchange rate literature, as illustrated in figure 5, this analysis assumes that prices in the flexible price (farm) sector adjust to a monetary change more quickly than other prices in the fixed price (nonfarm) sector.[13] So, for example, while long-term contracts prevent nonfarm prices from adjusting downward immediately in response to a monetary contraction (as they would in the Barro-type model), the auction market characteristics of the determination of farm prices force them to fall quickly and, consequently, temporarily reduce the farm/nonfarm relative price ratio as well. Thus, again in the short run, a negative monetary change causes a temporary reduction in farm prices relative to nonfarm prices.

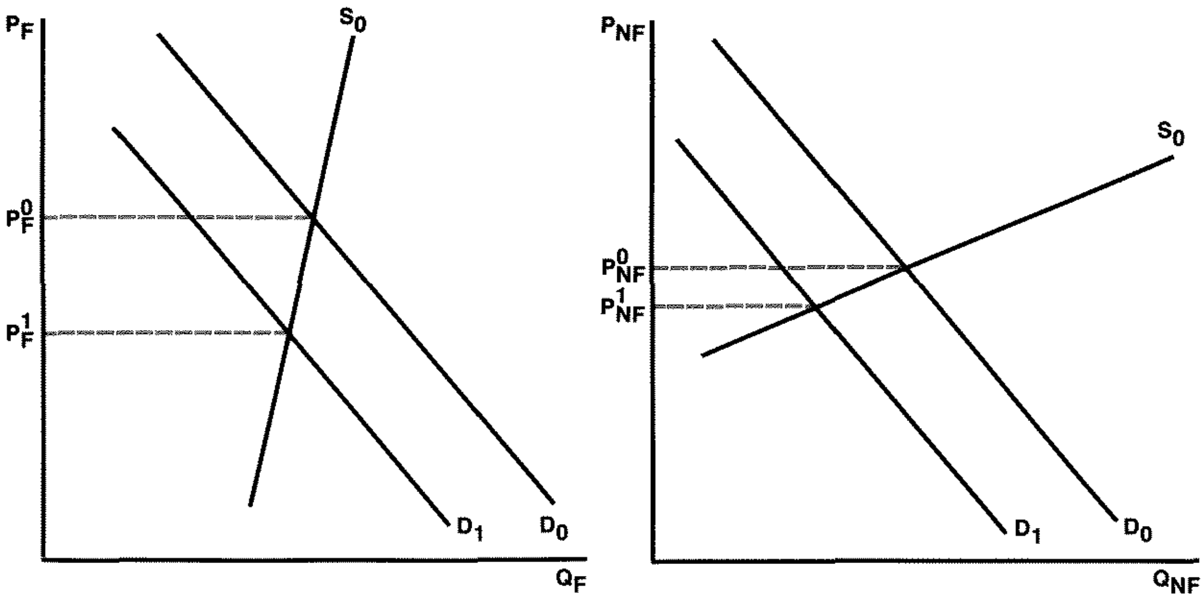
[10]Historically, this assumption has been supported by the data with estimates of the income elasticity for food demand near 0.2 and higher estimates for nonfood items; see King (1979) for a review of this literature.

[11]Exceptions are Bessler (1984) and Robertson and Orden (1990).

[12]See, for example, Starleaf (1982).

[13]See, for example, Frankel (1986) or Rausser (1985).

Figure 4
Graphical Representation of Differing Supply Elasticities Model



As in Model I, an unanticipated decrease in money growth decreases the demands both for farm and nonfarm products; here, however, the decreases are assumed to be equal. Under these conditions, a lower elasticity of supply for farm products will cause $\Delta P_F > \Delta P_{NF}$ and (P_F/P_{NF}) will fall. Note that combining the results of Model I with Model II produces an ambiguous result because differences in the sizes of demand shifts may be large enough to cause an increase, a decrease, or no change in (P_F/P_{NF}).

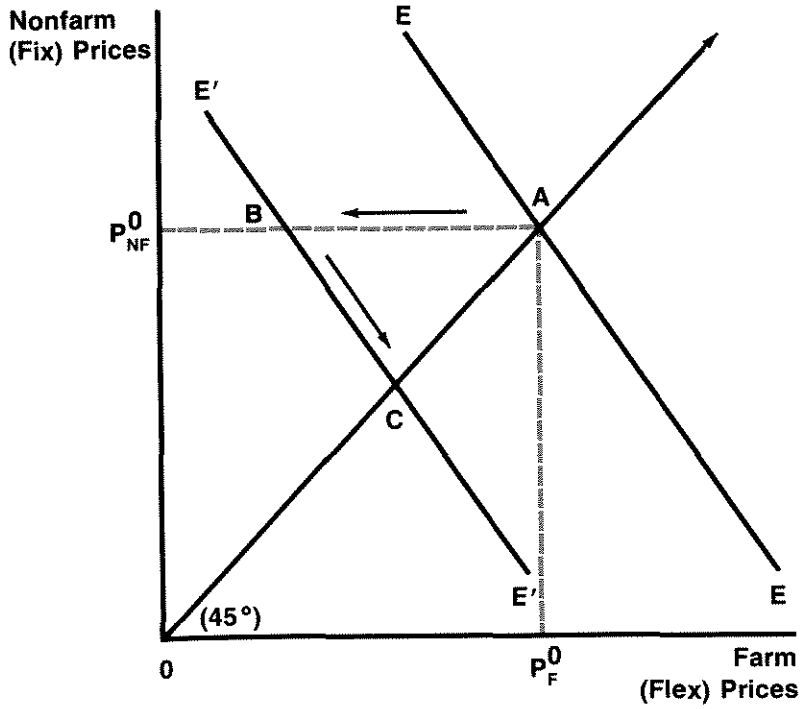
Although this predicted direction of relative price change is the same as in model #2, the mechanics of price stickiness allows the possibility that fully anticipated monetary changes (as well as unexpected changes) can affect the relative price ratio. Thus, testing for the significance of expected monetary changes on the relative price ratio provides a direct way to discriminate between the two models. Unfortunately, the converse is not true: failing to find significant effects from anticipated monetary changes does not necessarily reject an overshooting type of model because its mechanics can be set in motion solely by monetary surprises as in the previous cases.

RECONCILING ALTERNATIVE THEORIES

The foregoing discussion showed that farm prices are significantly more variable than nonfarm prices, and that the farm/nonfarm relative price ratio has declined persistently over time. Unfortunately, the implications of our three models differed considerably in terms of the expected direction of change in the relative price of farm products to nonfarm products as well as the mechanism by which a monetary action influenced this ratio. To resolve this conundrum, each model was estimated using identical data sets to see which one's implications are best supported by the results.

These estimations are intended to provide evidence on three aspects of the possible monetary influences on the farm/nonfarm relative price ratio. The first piece of evidence is the *direction* of relative price change; this will discriminate between model #1 vs. models #2 and #3. The second piece of evidence is the *statistical significance* of the relationship, where the significance of a variable can be viewed as evidence for or against a particular model. The

Figure 5
The Overshooting Model[1]



Schedule EE shows all possible equilibrium relationships between P_F and P_{NF} prior to the change in monetary policy. Slower money growth, which is disinflationary, shifts EE to E′E′ where farm (flex) prices (P_F) decrease but nonfarm (fix) prices (P_{NF}) do not adjust; thus, P_F "overshoots" from point A to point B. As fix-price markets adjust, (P_F/P_{NF}) gradually returns to the long-run equilibrium at point C.

[1]Adopted from R. Dornbusch, *Open Economy Macroeconomics*, Fig. 11-8, p. 208.

third piece of evidence is the *magnitude* of the impact that a given monetary change has on the relative price ratio; here, it is recognized that monetary effects may be statistically significant and yet still be quantitatively unimportant.

VAR Estimation

As a first step in the investigation, a vector autoregressive (VAR) model was estimated. A VAR, which can be used to determine the amount of variation in the relative price ratio that one might attribute to monetary shocks, is useful in gauging the strength of the hypothesized relationship. It has the additional advantage of not requiring the specification of any particular functional form among the variables included in the model. The VAR and other equations that follow were estimated with quarterly, seasonally adjusted data over the I/1976-IV/1990 sample interval. Thus, by way of in-

Table 3
Single-Equation Results for the VAR Estimation, I/1976-IV/1990

Dependent variable	Relative prices	M1	Exchange rate	Industrial production	$\bar{R}^2$	DW
	Explanatory Variables					
Relative price	0.206 (1.089)	0.031 (0.064)	−0.233 (1.735)	−0.147 (0.413)	.12	1.98
M1	0.015 (0.257)	0.626 (4.192)	−0.020 (0.488)	−0.257 (2.340)	.28	1.96
Exchange rate	0.451 (1.874)	−0.046 (0.075)	0.499 (2.929)	−0.137 (0.302)	.09	2.04
Industrial production	0.131 (1.690)	0.344 (1.737)	0.003 (0.063)	0.515 (3.541)	.29	2.01

NOTE: t-statistics in parentheses apply to sums of lag coefficients and apply to the null hypothesis that the sum is equal to zero.

troduction to the more specific testing to follow, the VAR can offer some insights to the strength of the money-relative price link.

The VAR model included four variables: the farm/nonfarm price ratio (as measured by the ratio of the indexes of prices received by farmers to the producer price index), M1, the index of industrial production and the real trade-weighted exchange rate. Variables other than M1 were included because observed changes in the relative price ratio may have other origins. For example, technological changes in the nonfarm sector (which would affect industrial prices) or export demand (which could have varying effects across the farm and nonfarm sectors) could affect the relative price ratio in isolation from monetary changes.[14] While these other measures do not exhaust the list of influences on the relative price ratio, they do capture other influences affecting prices in the farm and nonfarm product markets so that the remaining variation can be explained by changes in M1 growth and the past history of the relative price ratio itself. These variables also were chosen because they have been used in previous work and our interest is in stressing comparability with other studies. All variables were specified as first differences of logarithms.[15]

Sums of lagged coefficients and t-statistics for these sums for the single equation estimation are reported in table 3. The results of interest indicate that M1 growth is not related significantly to changes in the relative price of farm products.[16] One possible explanation for this result is that flows from farm inventories, which were historically large over most of the sample

[14]Evaluating the impact of the industrial production measure here also will serve as an additional check on the overshooting model, which includes an output measure as an explanatory variable and predicts a positive relationship with the relative price ratio.

[15]A likelihood ratio test suggested by Sims (1980) was employed to select a single lag length for all variables in each of the four equations in the VAR representation. This test indicated a choice of two quarters.

[16]The estimations reported in tables 3 and 4 also were performed using relative price measures defined as the index of prices received by farmers divided by either the index of input prices paid by farmers or the all-item CPI. The possible effects of exports on relative prices also was investigated by replacing the real exchange rate index with the real quantity of U.S. farm exports. In no case, however, were the qualitative conclusions discussed in the text affected by this change: M1 growth never had a significant effect on the relative price ratio and the effects of trade flows were significant only if significance levels beyond the standard 5 percent level were used.

Table 4
VAR Variance Decomposition: Four-, Eight- and 12-Quarter-Ahead Forecast Error Variances

	Innovations Series			
Dependent variable	Relative prices	M1	Exchange rate	Industrial production
Relative price	81.62	0.72	8.11	9.54
	81.28	0.93	8.15	9.64
	81.28	0.93	8.15	9.65
M1	5.42	79.14	2.81	12.63
	6.87	76.11	2.75	14.27
	6.90	76.04	2.75	14.30
Exchange rate	6.30	7.14	84.78	1.79
	6.47	7.33	84.24	1.96
	6.48	7.33	84.20	1.98
Industrial production	29.59	13.51	2.75	54.16
	28.92	15.10	3.05	52.93
	28.93	15.12	3.05	52.91

NOTE: Row 1 = Four-quarter-ahead forecast error
Row 2 = Eight-quarter-ahead forecast error
Row 3 = 12-quarter-ahead forecast error

period, offset any relative price change caused by an aggregate shock.

Only the real exchange rate, which has a marginally significant and negative coefficient, is statistically associated with the relative price ratio. While this result is consistent with many of the arguments raised by agricultural economists about how restrictive monetary policy could raise the exchange rate, reduce exports and depress farm prices, this line of reasoning is not shown by line 3 of table 3, which indicates no statistically significant relationship between M1 and the real exchange rate. Thus, these reduced-form estimates suggest that monetary changes have little, if any, effect on the relative price ratio.

Variance Decomposition

Further evidence about the effect of monetary shocks on relative prices is found in table 4, which presents the percentage of four-, eight- and 12-quarter-ahead forecast error variances explained by past innovations in the relative price ratio and the other variables in the model.[17]

Monetary shocks explain less than 1 percent of the relative price forecast error variance, while about 81 percent is attributable to past innovations in the relative price series itself. These findings are generally consistent with those reported by Chambers (1984) and Orden (1986b), who found less than 10 percent of the error variance could be attributed to monetary shocks and more than half could be attributed to past behavior of the relative price ratio.[18] Moreover, both the real exchange rate and industrial production explain substantially more of the variation in the relative price ratio than does M1.

As noted earlier, other analysts (most notably Schuh) have argued monetary effects are trans-

[17]Because VAR results are sensitive to the ordering of variables [e.g., Cooley and LeRoy(1985)], the table contains the results from the ordering that gives the largest potential influence for M1.

[18]Devadoss and Meyers (1987), who reported large and quite persistent monetary effects on relative prices, did not report a variance decomposition, so their results are not directly comparable.

mitted to agriculture *through the real exchange rate* and its impact on farm exports. Some insight into this notion is found in table 4, which shows that innovations in the real exchange rate series account for about 8 percent of the variance in relative farm prices. Moreover, monetary shocks apparently explain only about 7 percent of the variance in real exchange rate movements, a result consistent with the small or non-significant effects of monetary shocks on the real exchange rate reported by Batten and Belongia (1986). Thus, all things and potential avenues of influence considered, these results indicate a statistically weak and numerically small relationship between monetary shocks and movements in the farm/nonfarm price ratio. The shaded insert on page 42 discusses possible changes in these relationships if the thrust of monetary policy is measured by different indicators.

Estimates From a Barro-Type Model

While the foregoing results suggest a fairly weak relationship between monetary shocks and relative price changes, the VAR method is not appropriate for testing the relevant structural hypotheses that characterize the models discussed above. In a model that treats a monetary shock as a shock to aggregate demand, assuming a lower income elasticity for farm products would imply that, in the short run, the farm/nonfarm relative price ratio is inversely related to innovations in M1. Moreover, because neoclassical models of this nature recognize that nominal shocks affect real or relative magnitudes only in the short run, the sum of the coefficients for lagged innovations in M1 should not be significantly different from zero. The persistence of any short-run nonneutralities, however, remains to be determined.

The basic predictions of this model can be examined by estimating an equation of the form:

$$(1)\ \Delta\left(\frac{P_F}{P_{NF}}\right) = a + \sum_{i=0}^{p} b_i\, E(\dot{m})_{t-i} + \sum_{j=0}^{q} c_j\, [\dot{m} - E(\dot{m})]_{t-j} + \varepsilon_t,$$

where $E(\dot{m})$ is the expected growth rate of M1, $[\dot{m} - E(\dot{m})]$ is the unexpected component of M1 growth, and a, b_i and c_j are coefficients to be estimated over undetermined lag lengths p and q, respectively. Under the assumptions about market structure discussed earlier, the b_i coefficients should be zero and the c_j coefficients for the initial lags of unexpected changes in money growth should take negative values; the model's general prediction about the long-run neutrality of monetary shocks implies that the sum of c_j coefficients should be zero. Lapp (1990), who recently discussed and reported results from a model of this form, found monetary actions to have small, short-lived effects on the relative price ratio.[19]

Before equation 1 can be estimated, the requisite values for the aggregate demand shock (the unexpected component of M1 growth) must be obtained. An autoregressive model was fit to the first differences of logarithms of M1 and inspection of the autocorrelation functions indicated an AR(6) was an adequate representation of this series. The null hypothesis that the residuals from this representation were white noise could not be rejected. These residuals were employed in equation 1 as the measure of monetary shocks; the fitted values were used to represent anticipated money growth.

A final prediction error (FPE) criterion suggested estimating a model with contemporaneous and three lagged values for the unanticipated component of money growth and excluding the anticipated portion of money growth entirely. Before estimating equation 1 in this form, it first was estimated using contemporaneous and three lagged values for both monetary variables in order to test more directly whether anticipated money growth had any effect on relative prices. As the first row of table 5 indicates, neither component of money growth is related significantly to the farm/nonfarm product ratio. The second row of the table, which reports the results of the model chosen by the FPE criterion, shows that monetary shocks have no permanent effects on the relative price ratio. Moreover, none of the individual lag coefficients (not reported) is significantly different from zero indicating the

[19]Equation 1, in many respects, is the one Devadoss and Meyers (1987), among others, estimated after placing zero restrictions on the b_i coefficients. If, however, their results are explained by a fix-price/flex-price (overshooting) economic structure, fully anticipated changes in the money stock could affect the relative price ratio and there is no justification for the restrictions (see equations 2 and 3 below); rather, the significance of those coefficients is a key hypothesis to be tested. Moreover, by failing to specify a theoretical model, Devadoss and Meyers also miss the chance to rule out a Barro-type model as an explanation for relative price behavior on the basis of "wrong" (positive) signs for the c_j coefficients.

Is M1 The "Right" Measure Of Monetary Actions?

Investigations of how monetary actions affect economic activity have been influenced in the 1980s by financial deregulation and innovation. Most notable among these financial changes was the introduction of interest-bearing checkable deposits, which, many economists believe, has distorted the behavior of M1 since 1981.[1] Other research has argued that another measure of Federal Reserve actions—the federal funds rate—is more closely related to economic activity than money growth; indeed, Orden and Fackler (1989), in a similar study of monetary actions and the relative price of farm products, speculate about whether interest rates are a better gauge of monetary actions than money growth.[2]

To investigate these issues, the analysis reported in tables 3 and 4 was repeated replacing M1 growth with the growth rate of M1A and the first difference of the federal funds rate. M1A, which is M1 less interest-bearing checkable deposits, presumably deletes idle savings-type balances from what is intended to be a transactions-based measure of the money stock. Indeed, Darby, et al. (1989) found M1A to be a better empirical measure of monetary actions in the 1980s than M1. Using the federal funds rate can be defended by arguing that it examines the influence of an interest rate that is directly under the control of the Federal Reserve. The relevant results of these estimations are reported in the table below.[3]

Revised VAR Estimates Using M1A and the Federal Funds Rate As Monetary Indicators: I/1976-IV/1990

Revised Reduced-Form Estimates

Dependent variable	Relative price	Monetary indicator	Exchange rate	Industrial production	$\bar{R}^2$	DW
Relative price	0.215	0.019[1]	−0.237	−0.167	.12	1.97
	(1.124)	(0.036)	(1.488)	(0.471)		
Relative price	0.213	−2.718[2]	−0.210	0.034	.15	1.96
	(1.148)	(1.404)	(1.694)	(0.091)		

Revised Variance Decompositions

Dependent variable	Relative price	Monetary indicator	Exchange rate	Industrial production	Forecast horizon
Relative price	81.70	1.48[1]	7.53	9.29	4 Qtr.
	81.05	2.21	7.47	9.27	8 Qtr.
	81.04	2.21	7.47	9.27	12 Qtr.
Relative price	78.19	8.94[2]	3.60	9.28	4 Qtr.
	77.81	9.09	3.62	9.47	8 Qtr.
	77.81	9.09	3.62	9.47	12 Qtr.

[1]Monetary indicator is △ ln M1A.

[2]Monetary indicator is △ fed funds rate.

[1]See, for example, Belongia and Chalfant (1990) for a review of some of the issues.

[2]See Friedman and Kuttner (1990) for arguments and evidence on the federal funds rate as an indicator of monetary policy.

[3]Complete results are available from the author.

The top portion of the table, which reports the revised reduced-form equations using the growth rate of M1A and changes in the federal funds rate as monetary indicators, shows no qualitative change to the results in table 3: neither indicator of monetary actions is related significantly to movements in the relative price ratio. Similarly, the bottom portion of the table indicates that neither monetary indicator explains more than 10 percent of the forecast error variance and that movements in the relative price ratio continue to be dominated by past shocks to the ratio itself.

absence of short-run effects as well. If monetary actions have any effect on the farm/nonfarm price ratio, the results in table 5 reject the notion that they are transmitted through the mechanism described in figure 3.

The Overshooting Model

The implications of the overshooting model, derived in Frankel (1986), can be stated in a straightforward manner. The testable hypotheses implied by the model shown in equation 2 are that a change in the log level of the money stock (Δm_t) or in the expected growth rate of money ($\Delta \mu_t$) will have larger-than-proportional effects on farm prices. That is, in a regression of the form,

(2) $\Delta P_{Ft} = c_0 + c_1 \Delta m_t + c_2 \Delta \mu_t + \varepsilon_t$,

where ΔP_{Ft} is the change in the log level of the index of prices received by farmers, the expected results are that $c_1 > 1$ and $c_2 > 1$. Thus, "overshooting" occurs because farm prices respond initially by a larger percentage than either the actual level of the money stock or the expected rate of money growth. The standard interpretation of this model, which assumes that nonfarm prices are fixed in the short run, also would imply that contractionary monetary policy would temporarily depress the farm/nonfarm relative price ratio, a result opposite to that from model #1.

Finally, some analysts have tried to account for business cycle effects on farm prices by adding the change in the log level of real output (Δy_t) to equation 2. This gives equation 3:

(3) $\Delta P_{Ft} = c_0 + c_1 \Delta m_t + c_2 \Delta \mu_t + c_3 \Delta y_t + \varepsilon_t$.

Note that equation 3 maintains the two original overshooting hypotheses implied by equation 2 ($c_1 > 1$; $c_2 > 1$).

The hypotheses embodied in equations 2 and 3 were tested over the same periods reported earlier. Real output was measured by industrial production. The change in the expected money growth rate, $\Delta\mu$, was calculated as the first difference of fitted values from the money growth autoregression discussed earlier. The equations first were fit only with contemporaneous values for right-hand-side variables and then, again, allowing for lags. Results of the estimations are reported in table 6.

Table 5
Effects of Monetary Shocks on Relative Prices in a Barro Model

Intercept	Expected $\dot{M}$	Unexpected $\dot{M}$	$\bar{R}^2$	DW
−25.862 (1.604)	3.371 (1.473) 0-3	−2.298 (0.909) 0-3	−.03	1.51
−2.211 (1.237)	—	0.493 (0.535) 0-3	−.01	1.48

NOTE: The third line of numbers in each row of the table indicates lags estimated. The numbers in parentheses are t-statistics for the sum of the lag coefficients.

Table 6
Results from Overshooting Models, I/1976-IV/1990

Intercept	Δm	Δμ	Δy	$\bar{R}^2$	DW
−0.071 (0.20)	0.350 (0.80)	0.381 (0.49)	—	−.01	1.56
−1.662 (0.47)	0.248 (0.59)	0.283 (0.38)	0.793 (2.58)	.08	1.60
5.26 (1.36)	−0.485 (1.01) 0-1	0.120 (0.17) 0	0.685 (1.77) 0-1	.23	1.38

NOTE: The third line of numbers in the bottom row of the table indicates lags estimated. Numbers in parentheses for bottom regression are t-statistics for the sums of the lag coefficients.

Although none of the results for the restricted model shows any effects from either monetary variable, the more general form of the overshooting model indicates a significant contemporaneous relationship between the growth rate of industrial production and index of prices received by farmers; the sum of this effect and the coefficient for the lagged effect, however, is not significantly different from zero.

The crucial question for the overshooting model, however, is whether the coefficients associated with the growth rate of M1 and the change in the expected growth rate of M1 are significantly greater than one. For Δm, its coefficient in each of the three regressions is numerically *less than* one and is significantly less than one in the last regression. This rejects a prediction of the overshooting model. Similarly, the coefficient associated with Δμ, the change in the expected growth rate of money, is numerically less than one in each case and significantly so in the last equation. The implication is a rejection of the overshooting model.

CONCLUSIONS

Because many studies have found monetary shocks to have positive and persistent effects on the farm/nonfarm relative price ratio, the pursuit of a contractionary monetary policy to reduce inflation has been blamed for causing widespread financial distress in agriculture. Although an understanding of this literature is certainly important to the debate about whether farm programs can or should be used to cushion the sector from changes in macroeconomic policies, the evidence on the response of farm prices and income to monetary policy actually has been widely mixed. In part, this diversity has been due to the different theoretical models and empirical techniques that have been employed.

Following a research strategy suggested by King (1979) to distinguish among alternative models and empirical results, a revised set of "stylized facts" emerges on the relationship between monetary actions and the relative price of farm products:

- Farm prices are significantly more variable than nonfarm prices.
- VAR results consistently show that monetary innovations explain less than 10 percent of the forecast error variance of the farm/nonfarm price ratio, whereas past innovations in the relative price ratio itself explain 80 percent or more of the error variance. Thus, while monetary effects may be statistically significant, they are economically unimportant.
- Although the flex-price/fix-price model is widely asserted to represent the economic structure generating the farm/nonfarm price series, its main hypotheses are rejected by the data. The standard interpretation of a Barro-type model also is rejected.

- Tests find the behavior of farm prices to be consistent with the neoclassical prediction of long-run neutrality; the "long run" for adjustments in the farm/nonfarm price ratio to a monetary change is less than one year.

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