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OVERSHOOTING AGRICULTURAL PRICES: EVIDENCE FROM BRAZIL

by

Heloisa Burnquist and Steven C. Kyle

Department of Agricultural Economics
New York State College of Agriculture and Life Sciences
A Statutory College of the State University
Cornell University, Ithaca, New York, 14853-7801

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Heloisa Burnquist and Steven Kyle*

*Assistant Professor of Agricultural Economics at the University of São Paulo, Piracicaba, SP and Assistant Professor of Agricultural Economics, Cornell University, Ithaca, NY. Thanks to Professor Timothy Mount for many helpful conversations.

ABSTRACT

This paper uses the case of Brazil to demonstrate that findings of overshooting in agricultural prices in response to monetary shocks depend on the type of time series formulation selected and on the inclusion or exclusion of the exchange rate in the model. Alternative choices in terms of the degree of recursiveness or simultaneity of the models made relatively little difference to the results.

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I. Introduction

Much recent work has focused on the effects of monetary policy on the agricultural sector, and particularly on the question of the overshooting of agricultural prices in response to a monetary shock. The empirical question of whether relative prices do in fact overshoot their long run equilibrium has been intertwined with an ongoing debate over the proper methodological approach to be used in evaluating the question. In general, the debate has involved those who rely on structural econometric models and those who eschew what they regard as ad hoc prior restrictions required in building structural models in favor of reduced form models emphasizing the time series characteristics of a relatively small number of related variables.

This paper analyzes the case of Brazil using several alternative methodologies to demonstrate the sensitivity of the results to the modelling approach used. In particular, it is shown that while it is essential to take into account the long run properties of the relevant time series, it is equally important to consider the structural properties of the economy under analysis when estimating reduced form Vector Auto Regression (VAR) models or Vector Error Correction (VEC) models. Failure to do so can result in spurious findings of overshooting responses. This paper demonstrates that findings of overshooting are influenced both by the type of model estimated and by the inclusion of the exchange rate.

These findings lend support to the idea that the abstractions necessary in any modelling effort must rely both on theory and on the actual structural characteristics of the economy. Several authors have emphasized the basically arbitrary nature of the variance decomposition methods underlying VAR and VEC models due to the need to specify a priori the causal ordering of the variables included to obtain an identified model capable of estimation. Orden & Fackler (1989) have emphasized the arbitrariness of the assumptions underlying particular orderings, and the need to consider a wide range of possible assumptions in terms of the degree of recursiveness in any particular model. Particular orderings and selections of variables have implications for the form which the relevant supply and demand functions can take. For example, Orden and Fackler show that assuming money is exogenous (ordered first) in a three variable system is tantamount to assuming either a perfectly inelastic money supply or a perfectly elastic money demand (with respect to the interest rate).

While the question can be addressed in small models by testing all possible orderings of variables, it leaves open the question of which variables to include in the first place. In evaluating the question of the response of relative agricultural prices to monetary shocks, it has been common for time series analysts to consider only three variables: money supply, agricultural prices, and non-agricultural prices. See for example, Robertson & Orden 1990, and Bessler 1983. This relative parsimony is to some extent a result of data constraints and also of the difficulty in interpreting large scale VAR or VEC models. In the case of Brazil, there is strong evidence from structural models that the exchange rate is an important omitted variable in such specifications. This empirical evidence has firm theoretical foundations; there is ample support for the importance of an independent effect for the exchange rate in a model including money and relative prices.

The next section reviews the literature on overshooting and monetary impacts on agricultural prices, together with studies focusing on Brazil. This is followed by an evaluation of empirical results for the Brazilian case, using various time series models. These results are then reconsidered on the basis of an expanded model allowing for exchange rate effects. Last, the results are summarized and conclusions presented.

II. Overshooting Agricultural Prices: Theory and Evidence

Overshooting was first emphasized as an important phenomenon by Dornbusch (1976) in the context of exchange rates. The basic phenomenon illustrates what is known in physics as the "Le Chatelier" principle: if a system is composed of two or more parts which adjust to shocks at different speeds, then the effects of a shock are initially more pronounced on the more flexible part of the system even if in the long run all parts are affected proportionately. This may (but will not necessarily) result in an overshooting of the long run equilibrium for the more flexible part of the system. In an economy with a fast-adjusting flex-price agricultural sector and a slow-adjusting "fix-price" non-agricultural sector, a positive monetary shock, for example, can result in agricultural prices rising above their long run equilibrium in the short run.

So, an economy in which money is neutral in the long run may still exhibit non-neutralities over shorter periods. Methodologies to evaluate the existence of such phenomena must therefore allow for non-neutralities in the short run while imposing monetary neutrality in the long run. It is precisely this problem which VEC models are designed to address. If money is indeed neutral in the long run, then we should find cointegration between series of money, agricultural prices, and non-agricultural prices. We can use this cointegration, if it exists, to impose restrictions on reduced form models allowing consistent and efficient estimation of parameters.

As noted by Burnquist (1992) and Robertson & Orden (1990), a

VAR model in levels provides consistent estimates but is less efficient than a VEC model which includes the error correction terms which represent the relative flexibility of the adjustment mechanisms in each price series. A VAR model in differenced data is mispecified because it omits the information regarding the level of each variables which allows the imposition of long run neutrality shown by a finding of cointegration.

While previous analysts have emphasized the error inherent in ignoring the information content of the levels of the variables of interest, many have neglected potential problems arising from the method of selecting variables to be included in the model, often focusing instead on designating exo- or endogeneity for whichever variables were chosen. Just as ignoring the information in levels can produce spurious results, so too can omitting important causal variables.

Theory admits of a multitude of potentially important candidates for inclusion; ultimately the decision, if it is to be based on anything other than simple speculation, must rest on the structure of the economy being considered and the resulting characteristics of the data it generates. Examination of the structure of the mechanism generating the data will not only provide a factual basis for choosing which variables to include, but will often provide a basis for choosing when and where to use recursive vs. structural orderings for variables in reduced form models.

Accordingly, there are two potential problems with an evaluation of the existence of overshooting agricultural prices in Brazil (or elsewhere). First, the model should be based on the structural characteristics of the case at hand. Failure to include important variables may result in a spurious determination of causality or it amy be that a causal variable is relatively unimportant even if it is significant. This is of particular importance for those analysts interested in providing relevant advice to policy makers. It makes little sense to get excited about a significant result for one causal variable if in fact most of the variation in the object of interest is the result of something entirely different.

Second, it is important to evaluate the robustness of the results with respect to alternative methodologies; VAR's in differences or levels vs. VEC's. Here it is important to note that even though a VAR in differences may be mispecified, it is entirely possible that this makes no practical difference. That is, one may still obtain the same parameter estimates if the mispecification bias is small. This implies that each of the models should be evaluated not only on their ability to explain the variance in the system (i.e. reduce the mean squared error), but also on whether the estimates obtained are materially different.

Previous analyses of overshooting agricultural prices have for the most part confined themselves to examining three variable systems with money and two prices via various methods. In the Brazilian case, Bessler estimates a three variable VAR in levels for Brazil while Robertson & Orden estimate a three variable VEC for New Zealand. It is clear that more complex formulations are possible since there are clearly more potentially independent sources of variation in the financial/monetary sector than simply money supply and the two relevant prices. Indeed, even the most convinced monetarist would admit that, in an open economy, foreign monetary shocks as well as domestic ones can be important, motivating examination of the exchange rate as an important variable to be considered.

It is this fact, plus numerous empirical studies (See e.g. Taylor et. al. (1980) and the citations therein, or Krueger, Schiff & Valdes (1991)) attesting to the independent importance of exchange rates in small open economies that leads us to consider the exchange rate as an important omitted variable in the commonly used three variable model. Burnquist (92) constructed structural models of the Brazilian economy and was in accord with previous authors in finding the exchange rate to be far more important in determining agricultural sector prices than is money supply.

The theoretical foundations of these empirical studies include economic structure allowing differential effects of exchange rates on different sectors of the economy. A simple traded/non-traded goods formulation will generate this result analytically, while differing sectoral import requirements on the input side can do so as well. See, for example, Bruno (76) for an exposition of the standard Australian model including a monetary sector and making the distinction between traded and non-traded goods. Kyle (92) extends this analysis to include differing imported input requirements.

In terms of Orden & Fackler's analysis of implicit assumptions resulting from exclusion of important variables, omitting the exchange rate is tantamount to assuming that agricultural prices in this model are perfectly inelastic with respect to the exchange rate or that agricultural output is perfectly elastic. Neither assumption is warranted on the basis of the facts presented in numerous empirical analyses of the Brazilian economy such as those cited above.

The next section examines exchange rates and monetary policy in Brazil over the period of interest in order to gain some insight into the structure of the relevant portions of the economy. The following section compares results obtained from a structural model with those from three and four variable VEC models (with and without the exchange rate) to evaluate the impact these different approaches have on the results obtained. The VEC results are also compared with VAR models in levels and in first differences to evaluate the effects of differing assumptions regarding the time series properties of the variables included.

III. Exchange Rates and Monetary Policy in Brazil

During the 1970's and early 1980's, Brazil maintained a "crawling peg" system under which the exchange rate was fixed in nominal terms and devalued on frequent but unannounced basis. The frequency of devaluations during this period was from three to fourteen days; after 1984 this was increased to virtually a daily basis. The objective of this system was to maintain the real value of the cruzeiro, and thereby stabilize export receipts and speculation.

However, the rate of devaluation did not in fact keep pace with the difference between domestic and international deflation, with the result that the cruzeiro became increasingly overvalued after the mid-1970's. Domestic pressure resulted from two factors: devaluations were seen as adding further to inflationary pressures and the local currency cost of servicing the mounting foreign debt of Brazilian firms and state entities mounted with each decrease in the value of the currency. See Zini (1988) and Baer (1983).

In terms of modeling the exchange rate, the evolution of government policy justifies treating it as an exogenous factor. Though the stated intent linked this policy with inflation, the evolution of the nominal exchange rate did not in fact behave in this manner over the period of interest in this study.

The money supply in Brazil increased steadily throughout the period under examination. After 1973 the government budget deficit was perennially in deficit, fueled in large part by large government payrolls and subsidy programs, particularly that for agriculture. Given the limitations of domestic tax capacity, and the constraints on borrowing all that was required to balance the budget, frequent recourse to money emission resulted. See Pereira & Nakano (1987).

The 1981-82 period marked a sharp change in government policy as money supply growth was restricted to below the rate of inflation. The resulting high interest rates led to an explosion in external debt, and was not ultimately successful in restraining inflation. After the onset of the international debt crisis in 1983, recourse to foreign borrowing was effectively cut off and the government was forced to fund itself through a combination of internal debt and money emission. The resulting inflationary spiral was eventually brought to a temporary end in 1986 with the advent of the Cruzado Plan, which combined a new currency with a price freeze.

The upward ratcheting of Brazil's rate of inflation over the period is among the more extreme on record, its progression was the result of numerous government policy initiatives combined with chronic overspending. Unlinked as this spending was to actual economic conditions, there is reason to regard money supply growth as an exogenous factor in the models developed below, just as there is a basis for considering the various controlled exchange rate regimes as exogenous also. Consequently, various formulations were tested to determine whether the results were sensitive to alternative assumptions regarding the exo- endogeneity of these variables.

IV. Data

The agricultural price indexes used for the present study were disaggregated in two groups: domestic food crops and exportable crops including soybeans, orange, cotton and sugar.

There are two major reasons for disaggregating the price indexes into domestic food and export crops. First, the products chosen to compose the food price index were considered appropriate to evaluate the overshooting phenomenon, since the functioning of their markets is considered to be close to competitive conditions in the Brazilian economic context. Second, the exportable products were included to evaluate the effects of a change in export revenue upon the monetary base and henceforth, upon the money supply.

The agricultural food price index is a weighted average of nominal prices at the wholesale level (given in cruzeiros/kg). The weights are the volume of production in each year. Until the 1970's, the price data used to compose the index are those received by agricultural producers in São Paulo, as published by the Instituto de Economia Agricola do E.S.P. Average prices for the whole country were compiled beginning in 1966 by the Fundação Getulio Vargas, but are only used for the period after 1970 in the present study. The observation that the tendency of average food prices for Brazil are compatible with those of São Paulo State allowed the composition of a price series which is a combination of these two different sources.

The wholesale food price index was calculated on a quarterly basis using the individual data series available for São Paulo State. The weight used to calculate the index was the annual value of production of each crop.

The prices for the industrial sector correspond to the wholesale price index for the Brazilian manufacturing industry compiled by the Fundacao Getulio Vargas and published in Conjuntura Economica

The source of the data for the monetary system is the Estatísticas Históricas do Brasil-Séries Econômicas, Demograficas e Sociais/1550-1988 - IBGE. The series for M1 was used for this study, and includes money in circulation plus cash deposits in commercial banks and the Banco do Brasil.

Information on the exchange rate was taken from various issues of the Boletim do Banco do Brasil. The rate vis a vis the US dollar was used. This series is identical to that published in Conjuntura Economica.

V. Results

This section first presents the results of a structural model of the Brazilian economy designed to examine the behavior of food prices. Then, it presents a three variable model including money, industrial prices and agricultural prices. A third section presents results of a four variable model including the exchange rate.

A Structural Model of Food Prices

The importance of considering a broad range of explanatory variables in the Brazilian case is demonstrated in Burnquist's analysis where the exchange rate and level of production accounted for more than 70% of the total variation in food prices. This finding, based on the forecast error variance decomposition for a quarterly general macro model including nine variables in the agricultural system, is robust to various reformulations of the structural relationships. The agricultural block of the model reported in Burnquist (1992) is reproduced here in Tables 1 and 2. (Details on the full model are available from the authors on request or can be found in Burnquist 1992) As shown in Figure 1 the model tracks food prices extremely well, while the variance decomposition shown in Table 1 demonstrates that the exchange rate appears to be far more important than the money supply in explaining the variance.

Figure 2 presents impulse response functions showing the response of food prices to shocks in money and the exchange rate. It is apparent that there is quite pronounced overshooting in response to the exchange rate while there is little evidence of the phenomenon in response to monetary shocks.

Three Variable VAR and VEC Models

A first step in constructing a model of money supply, agricultural prices, and industrial prices is an examination of the statistical properties of the variables to determine whether they are stationary and if there are any cointegrating relationships between them. All three series were shown to have a unit root based on an Augmented Dickey-Fuller test of the series over the 1970-1985 period. Table 3 presents the results of tests of cointegrating regressions between the three variables. It can be seen that the results support the hypothesis that there are long run cointegrating relationships between money and each of the price variables.

Based on these results, a three variable VEC model was estimated, including four lags of each variable. The choice of four lags makes this study comparable to previous work (e.g. Robertson & Orden 1990) and is confirmed as appropriate by portmanteau Q tests on the residuals of the integrating regressions. Table 4 shows the contemporary coefficient estimates for the model, demonstrating that the recursive ordering adopted is comparable to previous studies such as Bessler's.

Table 5 shows the forecast error variance decomposition of the estimated VEC model where it can be seen that food prices are dependent mainly on own-sources of variation, while this is even more pronounced in the case of money supply. Industrial prices depend both on own sources of variation as well as food prices. It is striking that money does not account for a significant portion of the variance in either of the two price series.

Figure 3a shows impulse responses in terms of percent changes for each of the two price series in response to a one standard deviation shock in money supply. Overshooting of agricultural prices is evident, but is not large at approximately 1% of the initial price level. Figures 3b and 3c show impulse responses for models estimated in levels without error correction terms (3b) and in differences (3c) for purposes of comparison. It can be seen in Figure 3b that omission of the error correction term generates more pronounced overshooting, while the model estimated in differences (which is expected to yield biased results due to omission of information on levels) generates results in which overshooting is barely apparent.

A Four Variable Model Including the Exchange Rate

Based on the numerous considerations cited above, the three variable model was expanded to include the exchange rate. The exchange rate was found to have a unit root and the cointegration tests reported in Table 6 show that it is cointegrated with both industrial and agricultural prices. In the first model, the exchange rate is assumed to be an exogenous variable, an assumption in keeping with prior analyses (See Barros and Burnquist) and with the history of exchange rate policy in Brazil, where the rate has in fact been set exogenously by the monetary authorities throughout the period under consideration. (This assumption will be relaxed below.) Also in accord with these analyses, food prices are assumed to affect industrial prices but not vice versa. These relationships are shown in Table 7 where contemporaneous coefficient estimates for the model are presented.

Table 8, showing the forecast error decomposition for the model, demonstrates that exchange rates play a far more important role than does money in determining variations in food prices. After 24 months the exchange rate accounts for about 58% of this variation while money accounts for a little more than 3%. In addition, there does seem to be a relatively important role for the exchange rate in affecting money. This is an important result when considering the effect of omitting the exchange rate from a model intended to evaluate the impacts of money supply, since the extent of bias in estimating the coefficient for an included variable depends on its correlation with the omitted variable.

The impulse response functions obtained from this model are presented in Figure 4. Panel (a) compares the response of food prices to shocks in the money supply and the exchange rate respectively. No overshooting in response to monetary shocks is apparent while the plot for exchange rate shocks does in fact show signs of overshooting. In addition, the size of the exchange rate effect is far larger in absolute terms than is that from money. This result is to be expected given the relative unimportance of money in the forecast error decomposition presented above.

Panel (b) shows the same results based on a model in levels with no error correction term. Here the results are even clearer; if there is overshooting in agricultural prices, it is a result of exchange rates, not money. Panel (c), presenting the results from a model estimated in first differences only, again confirms that exchange rates can be an important source of overshooting.

However, here the results for money can be interpreted as showing some signs of overshooting, though not nearly as pronounced as that for exchange rates.

In order to test whether the results were an artifact of the exogenous treatment of the exchange rate, the model was re-estimated allowing for a contemporaneous relation between the exchange rate and the money supply. Tables 9 and 10 present the results of this reformulation, where it can be seen from the FEVD that the results in Table 8 are not changed in terms of which variables are responsible for the largest proportion of the variance in each case. Alternative assignments of exo- and endogeneity of the variables - implying a different set of contemporaneous relations - generated substantially similar results. Figures 5a, 5b and 5c show that a slight overshooting in response to shocks in money is evident when using a VAR in differences or levels but not in the VEC model. In contrast, overshooting in response to exchange rate shocks is evident in both VAR's but not for VEC models. In all cases, the exchange rate effect is larger than that for money. Once again, finding overshooting depends on the model chosen.

VI. Summary and Conclusions

The results presented in this study confirm that the exchange rate is a potentially important omitted variable in many VAR and

VEC studies of the relation between money and relative agricultural prices. The Brazilian case illustrates two potential costs resulting from this omission: First, three variable models excluding the exchange rate can result in spurious findings of overshooting agricultural prices in response to monetary shocks. Second, the exchange rate is a more important determinant of variations in food prices, in terms of size of response, than is monetary policy in open economies such as Brazil's. Even if prices did overshoot in response to monetary shocks (a result this study does not confirm) this movement is swamped by variations resulting from other variables. Consequently, overshooting is not a phenomenon which is of great importance in terms of public policy.

Indeed, if overshooting agricultural prices are of interest, this study shows that the exchange rate is a far more likely source of the phenomenon than is money supply. This is not a surprising finding in a small open economy, where the scope for independent monetary policy is far more limited than is exchange rate policy. Where overshooting is apparent, it has a duration of between one and two years, limiting the scope for policies of intervention. The forecast error decomposition was shown to be a very useful tool in gaining some insight into the relative importance of the variables included in the model.

Finally, it is apparent from the results presented here that in the Brazilian case (and possible others) it is at least, if not more, important to select the appropriate variables for analysis than it is to worry about methodological concerns such as whether or not to include error correction terms or to estimate the model in levels or in differences. This is a result of the structure of the economy at issue; no matter how the data are manipulated, the exchange rate remains a more important determinant of food prices than is the money supply, and overshooting, if it exists, is relatively unimportant in the case of monetary shocks, and even in the case of exchange rates, a phenomenon of relatively short duration.

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Table 1. Decomposition of Variance of k-months Ahead Forecast Errors (percentage) - Structural Model.

k	FP	TFP	EXPR	M1	ER	Y	PP	LC	TEI	IEP
FP										
3	0.70	85.04	0.04	0.08	12.00	0.00	1.99	0.13	0.00	0.00
6	0.42	60.74	1.00	0.05	23.21	0.03	8.68	0.72	1.53	3.59
12	1.56	20.37	0.32	2.14	64.05	0.89	3.17	1.63	0.45	5.40
24	1.32	9.27	6.64	3.62	59.00	4.87	1.37	2.92	1.65	9.32
TFP										
3	58.77	0.09	3.49	7.00	3.88	0.25	15.70	10.56	0.18	0.05
6	48.84	0.72	3.02	8.80	5.11	6.01	13.84	12.92	0.62	0.10
12	28.80	0.60	2.41	18.12	10.87	5.71	10.67	11.91	8.96	1.96
24	25.19	3.99	4.26	10.38	19.81	4.29	12.46	8.45	7.66	3.49
EXPR										
3	0.00	0.00	84.24	0.00	8.46	0.00	5.94	0.00	0.00	1.35
6	0.79	1.36	52.10	10.77	5.36	2.72	19.37	0.97	0.42	6.12
12	1.97	1.11	42.59	19.41	4.50	2.41	18.99	3.12	0.93	4.94
24	4.30	5.20	20.58	20.51	6.42	3.16	8.52	16.23	11.74	3.32
M1										
3	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.51	0.17	0.00	64.84	6.27	4.29	0.28	21.05	1.06	1.51
12	5.55	0.37	3.20	43.04	4.37	7.90	1.14	20.35	12.72	1.34
24	1.14	9.84	8.47	23.21	4.26	7.23	1.89	10.22	24.27	6.45
ER										
3	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00
6	0.02	0.22	0.03	0.32	91.95	0.93	0.87	1.22	1.82	2.61
12	0.24	0.49	0.72	6.51	76.05	2.58	1.41	0.55	1.53	9.90
24	0.25	6.81	1.72	9.65	54.53	1.91	0.77	5.83	9.06	9.45
Y										
3	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00
6	5.64	0.15	1.35	3.41	0.22	65.60	7.95	8.04	7.22	0.40
12	3.81	8.08	27.28	1.67	1.15	20.81	5.38	6.88	21.98	2.95
24	1.15	16.77	22.45	22.36	1.03	6.68	2.32	1.74	18.89	6.60
PP										
3	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
6	3.06	9.25	3.06	0.09	2.23	1.03	64.65	0.71	8.03	7.87
12	5.26	12.56	1.99	20.17	1.79	2.53	25.58	2.94	19.43	7.74
24	14.37	6.95	2.16	12.09	4.26	1.49	12.16	15.92	21.13	7.62
LC										
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00
6	0.27	5.58	0.27	12.52	4.97	0.30	3.67	69.27	1.80	1.34
12	4.08	4.67	9.93	11.84	6.84	0.41	2.08	39.04	17.72	3.38
24	1.71	10.32	1.09	27.15	9.47	1.09	2.70	16.80	14.30	5.33
TEI										
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00
6	0.00	6.50	3.81	0.02	5.84	6.74	0.03	9.10	67.93	0.03
12	1.06	12.50	10.75	0.83	8.53	8.08	0.33	6.87	50.24	0.80
24	0.91	19.20	10.59	18.83	6.99	5.94	0.30	2.00	33.00	2.24
IEP										
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
6	3.62	0.24	1.09	21.57	0.30	5.01	0.37	8.82	0.65	58.32
12	4.96	2.60	10.97	15.93	3.19	2.93	5.23	23.42	5.78	24.97
24	3.17	7.72	12.96	15.20	3.46	3.39	3.96	32.88	4.49	12.76

Variable Definitions

TFP	Total Production of Agricultural Food Products such as Rice, Beans, Corn and Potatoes
EXPR	Total Production of Agricultural Exportables such as Soybeans, Cotton, Orange and Sugar
FP	Price Index of Agricultural Food Products Composed as a Weighted Average of Wholesale Prices Weighted by the Value of Production
IEP	Price of Exportable Commodities in the International Market
TEI	Total Employment in the Manufacturing Industry-Brazil
PP	Oil Price on the International Market
M1	Money Aggregate Representing Money Supplied Held by the Public and as Cash Deposits in Commercial Banks
LC	Nominal Value of Market Interest Rates
HPM	Monetary Base
P	General Price Index = $FP^{ba}\ IP^{bn}\ EXPU^{bex}$
NDPA	Net Domestic Private Assets = NDGA + CDB
ER	Exchange Rate
Y	National Income

Table 2. Contemporaneous Relations for the Agricultural System - Structural Model*

Dependent Variables	Explanatory Variables									
	FP	TFP	EXPR	M1	ER	Y	PP	LC	TEI	IEP
FP	1	1	1	1	1	1	1	1	1	1
TFP	1	1	0	0	1	0	1	0	0	0
EXPR	0	0	1	0	1	0	1	0	0	1
M1	0	0	0	1	0	0	0	0	0	0
ER	0	0	0	0	1	0	0	0	0	0
Y	0	0	0	0	0	1	0	0	0	0
PP	0	0	0	0	0	0	1	0	0	0
LC	0	0	0	0	0	0	0	1	0	0
TEI	0	0	0	0	0	0	0	0	1	0
IEP	0	0	0	0	0	0	0	0	0	1

* Variables defined as in Table 1.

Table 3. Tests of Cointegration for Bi-variate Equations.

t=62 (1970:2-1985:4)	Dependent Variable					
	LIP		LFP		LM1	
Regressor	LFP	LM1	LIP	LM1	LFP	LIP
	0.91	1.08	1.07	1.17	0.84	0.92
R^2	0.99	0.98	0.99	0.99	0.99	0.98
Cointegration tests						
Unrestricted Model						
ADF (lag = 4)	-2.70*	-2.91*	-2.70*	-3.11**	-3.11**	-2.84**
Restricted Model (coeff = 1)						
ADF (lag = 4)	-3.03**	-1.73	-3.40**	-1.88	-2.04	-2.06

* reject null hypothesis at 0.10 level
** reject null hypothesis at 0.05 level
*** reject null hypothesis at 0.01 level

Table 4. Contemporaneous Relationship Coefficient Estimates for Three Variable Model (standard error in parentheses).

Dependent Variables	LM1	LFP	LIP
LM1	1.00	0.00	0.00
LFP	0.06 (0.08)	1.00	0.00
LIP	0.05 (0.08)	0.24 (0.04)	1.00

Table 5. Decomposition of k-months Ahead Forecast-Error Variance (percentage) Three Variable Model.

k	M1	FP	IP
M1			
3	100.00	0.00	0.00
6	97.32	2.11	0.56
12	94.42	3.77	1.80
24	90.03	7.47	2.49
FP			
3	0.20	99.79	0.00
6	0.26	99.39	0.34
12	1.22	89.17	9.60
24	1.92	84.37	13.70
IP			
3	1.02	24.70	74.27
6	0.79	39.08	60.12
12	1.12	36.25	62.62
24	1.42	37.05	61.52

Table 6. Tests of Cointegration with Exchange Rate.

t=62 (1970:2-1985:4)	Dependent Variable				
	LIP			LFP	
	LFP	LM1	LER	LM1	LER
Regressor	0.37	0.23	0.42	0.53	0.64
R^2	0.99	0.98	0.99	0.99	0.99
Cointegration tests ADF (lag = 4)		-3.18**		-6.19***	

* reject null hypothesis at 0.10 level
** reject null hypothesis at 0.05 level
*** reject null hypothesis at 0.01 level

Table 7. Contemporaneous Relationship Coefficient Estimates for Four Variable Model (standard errors in parentheses).

Dependent Variables	LM1	LFP	LIP	LER
LM1	1.00	0.00	0.00	0.00
LFP	0.07 (0.09)	1.00	0.00	0.62 (0.15)
LIP	0.18 (0.03)	-0.19 (0.05)	1.00	0.06 (0.07)
LER	0.00	0.00	0.00	1.00

Table 8. Decomposition of k-months Ahead Forecast-Error Variance (percentage) - Four Variable Model, Exchange Rate Exogenous.

k		M1	FP	IP	ER
	M1				
3		100.00	0.00	0.00	0.00
6		86.41	0.50	11.30	1.77
12		72.56	0.66	13.31	13.46
24		65.20	2.76	12.76	19.27
	FP				
3		0.72	77.10	0.00	22.17
6		1.52	63.32	0.76	34.39
12		1.48	43.16	2.20	53.14
24		3.30	34.96	5.94	57.84
	IP				
3		23.86	12.77	55.14	8.23
6		20.00	12.82	41.83	25.34
12		12.77	8.23	24.29	54.70
24		9.68	8.40	18.13	63.78
	ER				
3		0.00	0.00	0.00	100.00
6		3.33	3.83	2.09	90.74
12		3.44	5.27	3.64	87.65
24		4.97	5.80	6.59	82.64

Table 9. Contemporaneous Relationship Coefficient Estimates (standard errors in parentheses).

	LM1	LFP	LIP	LER
LM1	1.00	0.00	-0.93 (0.15)	0.39 (0.39)
LFP	0.03 (0.02)	1.00	0.00	-0.59 (0.20)
LIP	-0.11 (0.05)	-0.19 (0.09)	1.00	-0.03 (0.04)
LER	0.00	0.00	0.00	1.00

Table 10. Decomposition of K-months ahead forecast-error variance (percentage) re-estimated model.

		LM1	LFP	LIP	LER
	LM1				
3		85.65	2.28	8.79	3.29
6		84.81	1.64	10.69	2.84
12		71.88	2.13	12.35	13.63
24		63.36	6.10	11.30	19.23
	LFP				
3		0.14	78.90	0.01	20.93
6		0.64	65.70	0.78	32.87
12		0.99	44.57	2.01	52.42
24		1.44	37.65	5.02	55.89
	LIP				
3		6.57	18.46	70.95	4.02
6		6.44	19.61	52.11	21.83
12		4.40	13.24	27.27	55.08
24		3.16	12.22	18.43	66.19
	LER				
3		0.00	0.00	0.00	100.00
6		1.33	4.98	3.00	90.69
12		1.35	7.06	3.57	88.02
24		1.74	8.30	5.76	84.19

Figure 1. Wholesale Food Price - Actual Versus Standard.

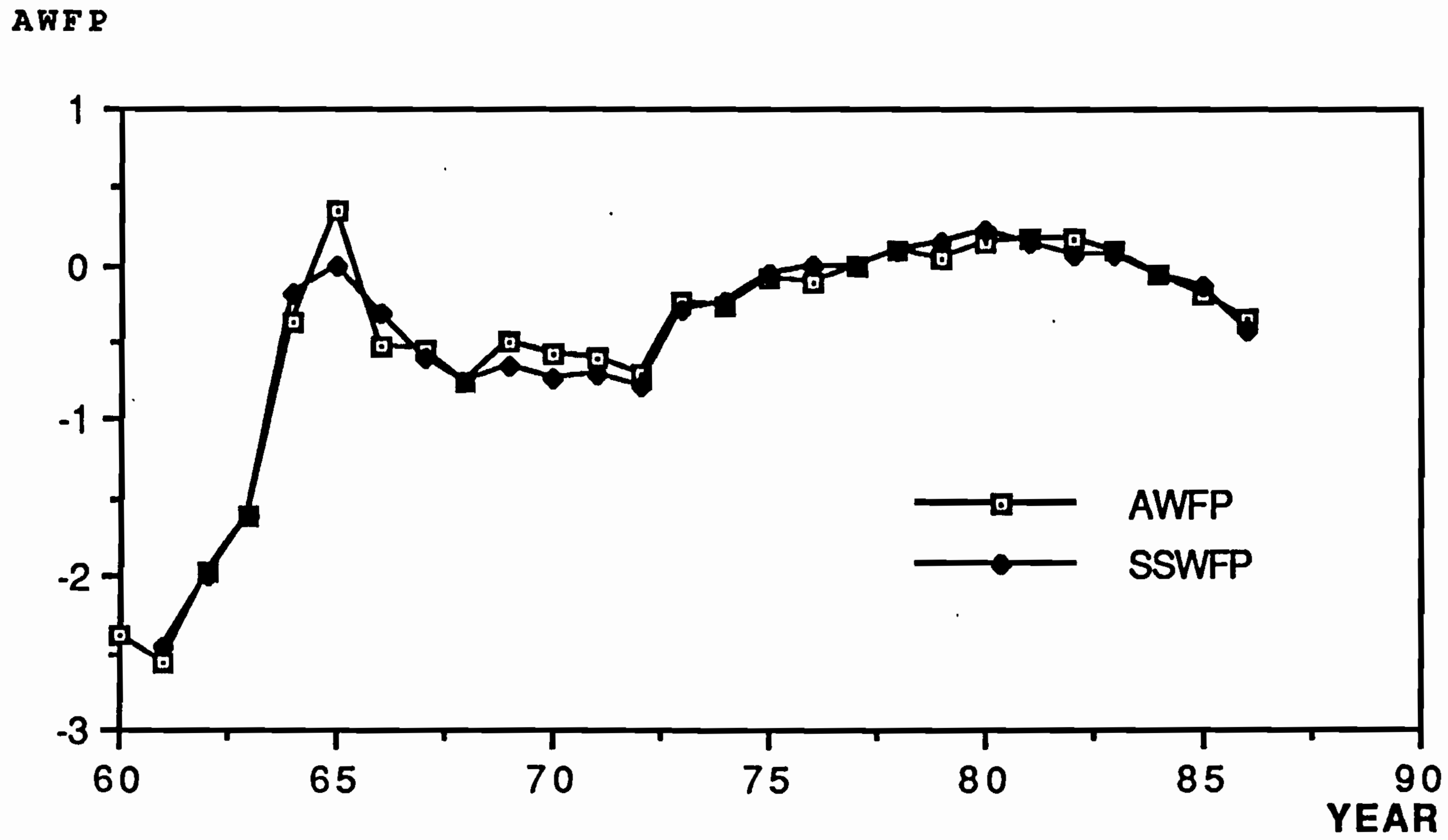


Figure 2. Response of Food Prices to Money and Exchange Rate Shocks - Structural Model.

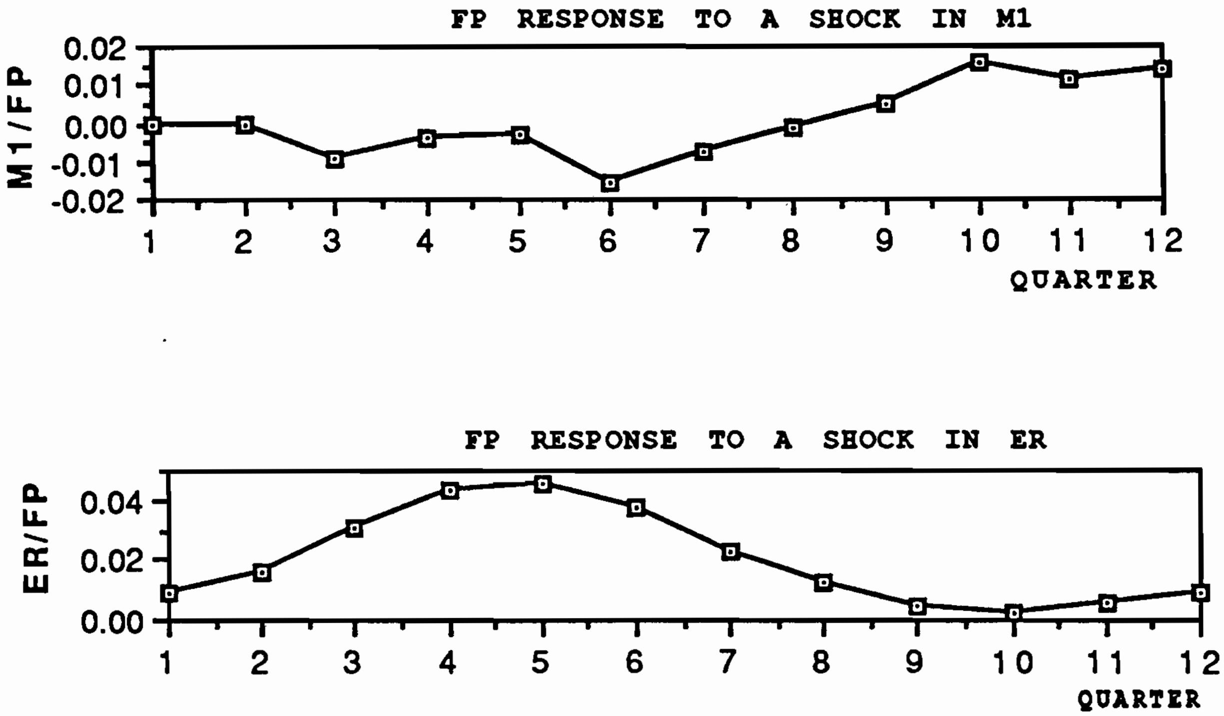


Figure 3. Response of Food Prices and Industrial Prices to Money Supply Shocks - 3 Variable Model.

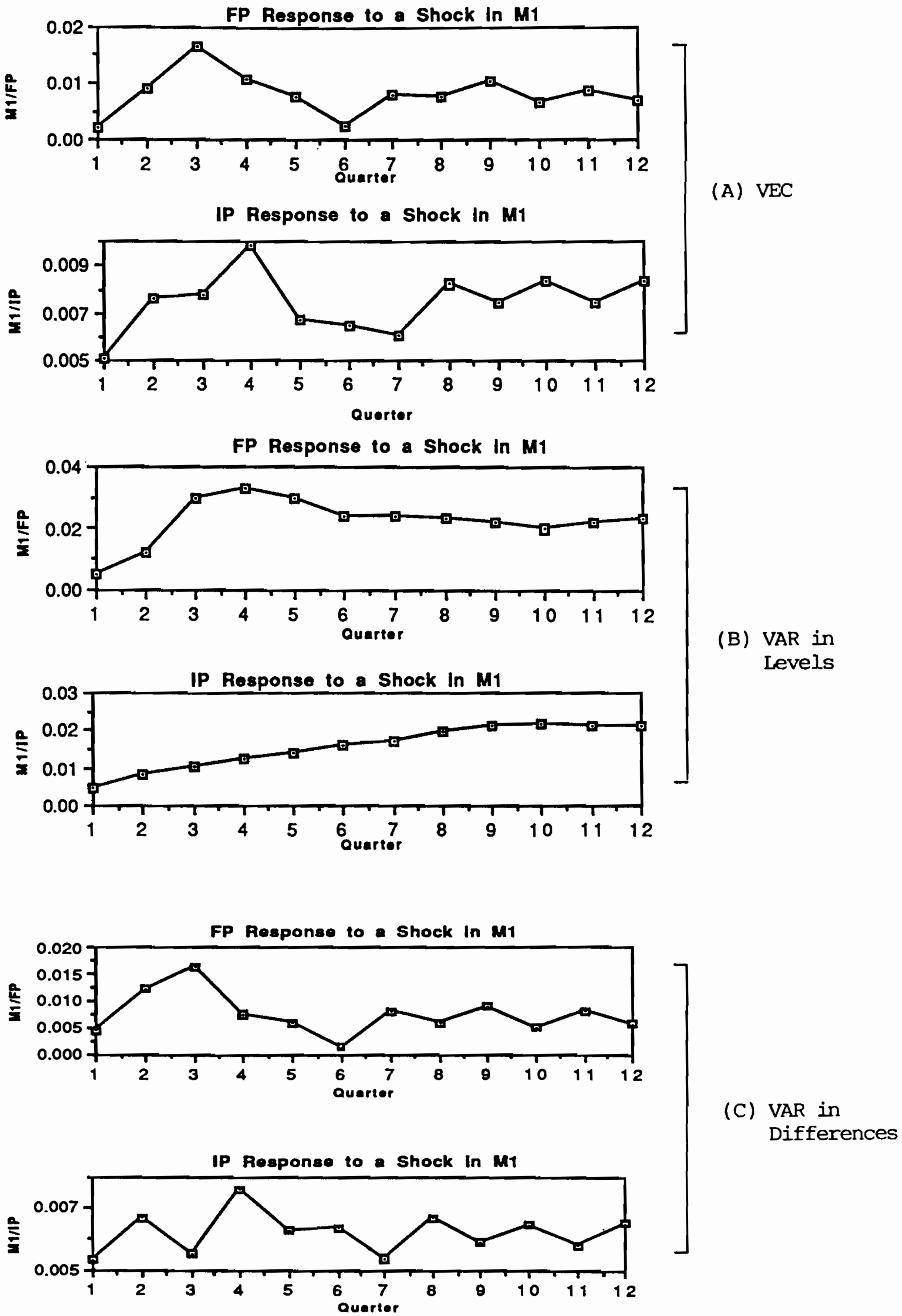


Figure 4. Response to Shocks in Money Supply and Exchange Rates - 4 Variable Model.

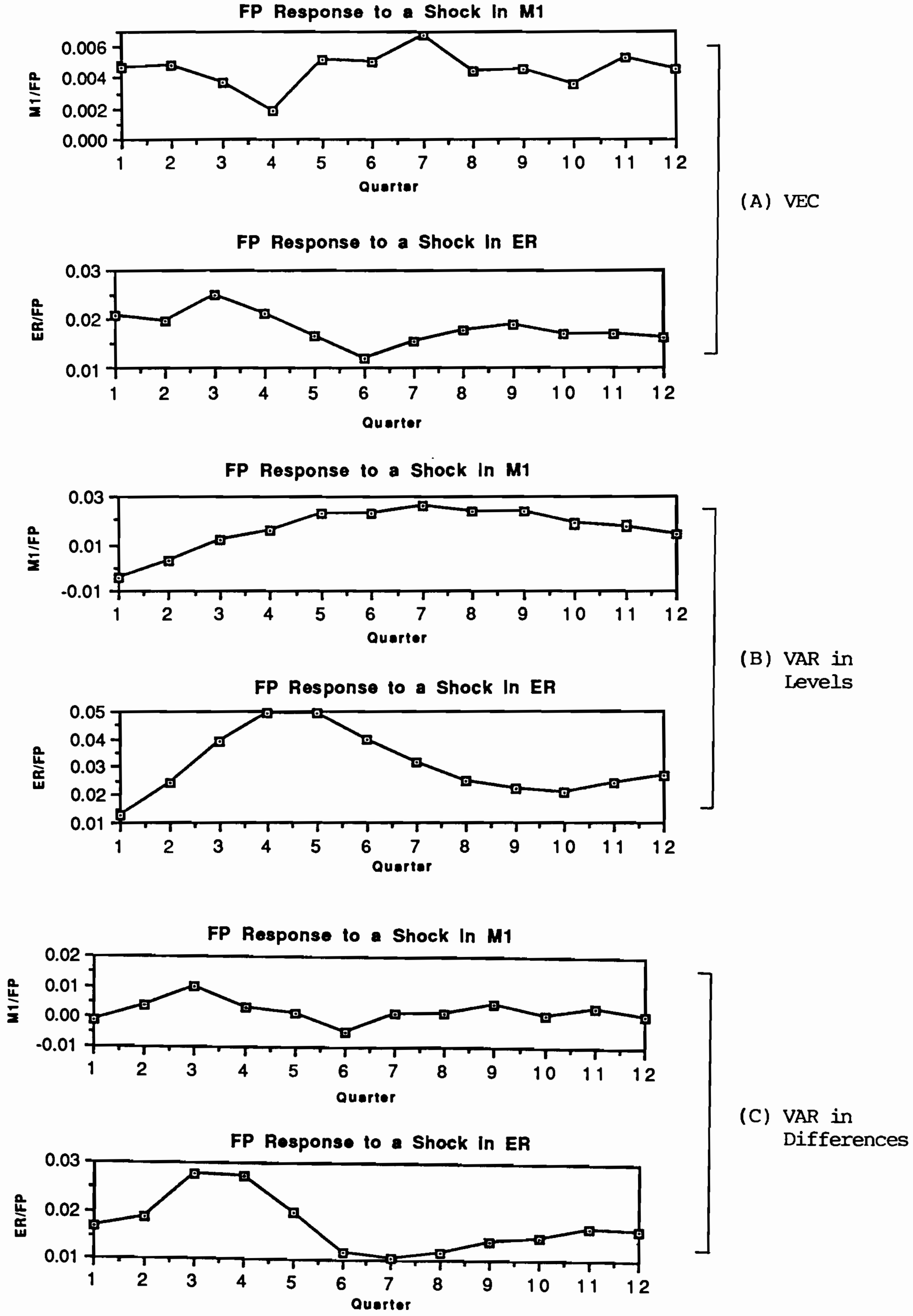
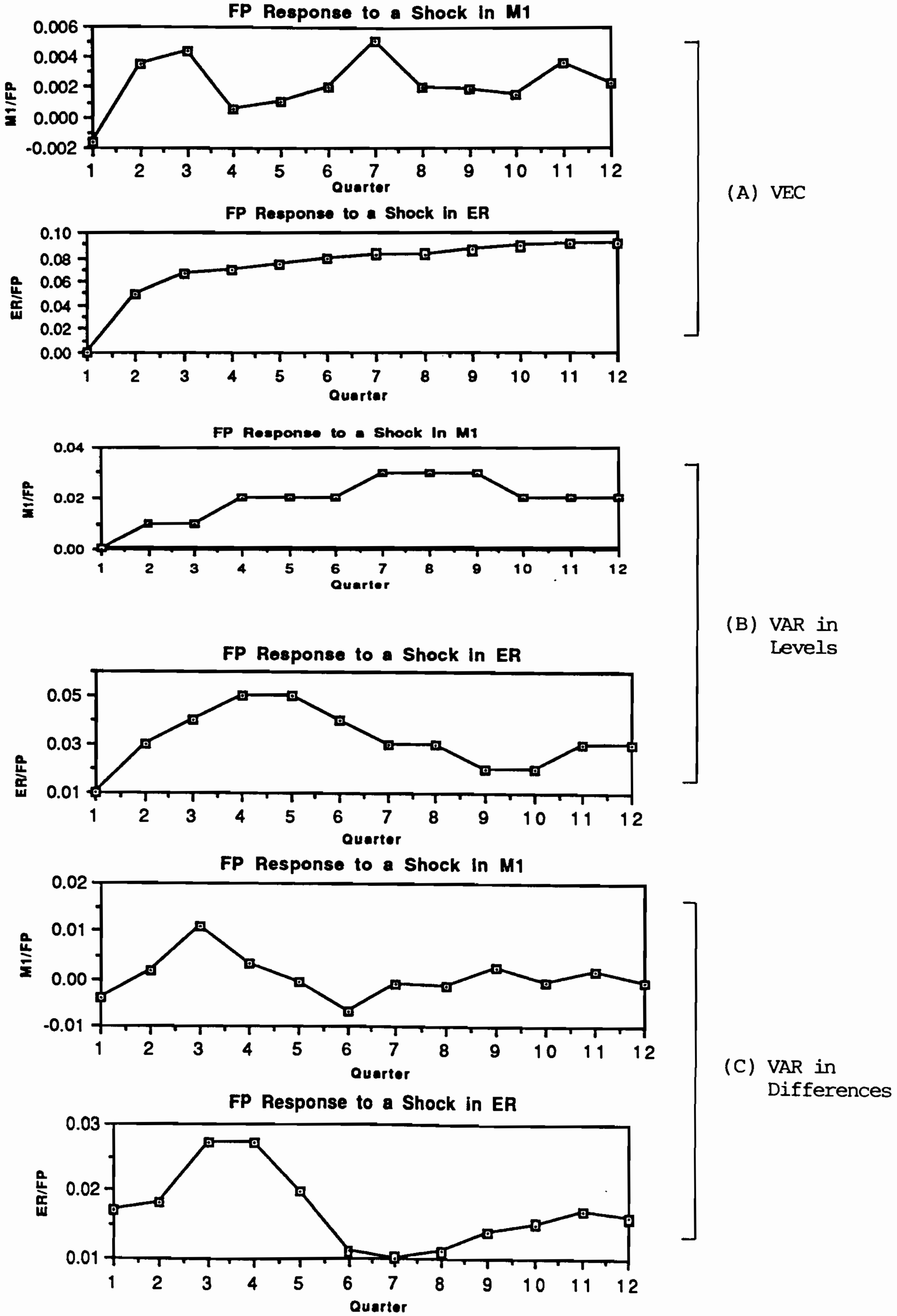


Figure 5. Response of Food Prices and Industrial Prices to Money Supply Shocks - 4 Variable Model Re-estimated.



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