Effects of international shocks and domestic macroeconomic policies upon Brazilian agriculture

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(Accepted 12 December 1991)

ABSTRACT

Barros, G. S.A. C., 1992. Effect of international shocks and domestic macroeconomic policies upon Brazilian agriculture. *Agric. Econ.*, 7: 317–329.

An identified vector-autoregressive model is used to analyze the transmission of external commodity shocks to the Brazilian economy. The effects of the interaction between domestic macroeconomic (monetary and exchange rate) policies and external shocks to agricultural commodity (raw material and food) prices and crude oil price upon domestic (agriculture/industry) terms of trade are estimated.

INTRODUCTION

The international prices of agricultural commodities have been submitted to substantial shocks during the last 20 years. To a significant extent these shocks may be related to some major macroeconomic events. On the one hand, the emergence of a well integrated international capital market in the mid-1960's and the breakdown of the Bretton Woods fixed exchange rate system in the beginning of the 70's brought about important changes in the pattern of interdependence in terms of macroeconomic policies among the major developed countries (Dornbush and Frenkel, 1979). On the other hand, as macroeconomic policymakers in these countries were unable to develop new mechanisms of cooperation to handle the instability associated with this changed environment, we have observed substantial variability in international financial variables such as exchange rates and interest rates and, therefore, in commodity prices as well (Schuh, 1989). In addition, as

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an aggravating problem, the interest rate increase followed by the U.S. dollar exchange rate appreciation in the early 80's resulted in the resurgence of protective legislation, particularly to agriculture (Krugman and Obstfeld, 1988, p. 564) in the U.S.A. and other developed countries.

So far the impact of these shocks upon agricultural relative prices in developing economies has not been analyzed so as to have its empirical relevance properly assessed. In this paper we use an identifiable vector-autoregressive model to analyze the process of transmission of external commodity price shocks to the Brazilian economy. Specifically we examine how Brazilian monetary and exchange rate policies have interacted with external shocks to prices of agricultural commodities and crude oil during the past two decades. The consequences of that interaction upon the Brazilian agricultural and industrial prices – or domestic terms of trade – will be the focus of our analysis.

So this paper extends previous work which analyzed the association between money supply and relative prices in a closed economy framework, such as Bessler's (1984) and Brandão's (1985) papers about relative prices in Brazil. The Brazilian case should be very illustrative of what has taken place in many other developing countries which have chosen to peg their currencies to one major currency, or to a basket of currencies, after the breakdown of the Bretton Woods system. We argue that, during the last two decades, the Brazilian agricultural relative prices depended strongly on the behavior of external prices and on exchange rate policy.

EMPIRICAL APPROACH

In this paper we try to identify the interactions among Brazilian domestic macroeconomic policy and the shocks to prices of international agricultural commodities and crude oil as well as the effects of those interactions upon agricultural-industry relative prices or domestic terms of trade.

This objective is empirically pursued within the multivariate time series model known as Vector Autoregression (VAR), for which we report the impulse response and forecast errors' variance decomposition. Fackler (1988) and Myers, Piggot and Tomek (1990) compare the VAR techniques with the alternative of applying Simultaneous Equations Models as far as the problem of estimating sources of fluctuations in the economy is concerned. The disadvantages of the latter are related to (a) the need to impose identifying restrictions, some or most of which may not be valid; and (b) the decomposition of unconditional, rather than conditional, variances. As a result of the second point, predictable and unpredictable random fluctuations are treated identically and no satisfactory economic interpretation for the covariances among variables is possible. VAR tech-

niques were designed to overcome these disadvantages and have been recommended for allowing substantial flexibility and generality in specifying correlations between the variables in the system, particularly when some uncertainty regarding the true economic structure exists.

However, instead of applying the conventional recursive VAR approach, we follow suggestions made by Sims (1986), Fackler (1988) and Orden and Fackler (1989) in order to circumvent several shortcomings attributed to the technique. Cooley and LeRoy (1985) argue that exogeneity testing, innovation accounting, impulse response analysis, and policy appraisal are based on incorrect analyses because they are carried out under very restrictive identifying assumptions, namely that the system of variables is recursive, the ordering of recursiveness being unknown. In addition, the procedure to test exogeneity of the policy variables does not correspond to the conventional concept of predeterminedness. The latter is the relevant concept for policy analysis and has to be established by assumption and not by empirical testing. Accordingly, identifying restrictions for the multivariate system should be sought in the relevant economic theories (Leamer, 1985; Sims, 1986). In general a set of simple restrictions on contemporaneous interactions can lead to the formulation of theoretical functions or policy rules so that the disturbances of the system can be given meaningful interpretation.

To estimate the general model:

$$A(0) Y(t) = \sum A(s) Y(t - s) + B_0 v(t) \tag{1}$$

where $Y(t)$ is a vector of random variables, we used the Bernanke procedure of the RATS [1] program where we make $B_0 = I$ and assume $v(t)$ to be a vector of orthogonal shocks with zero means and serially uncorrelated. In order to identify our VAR model, we follow Orden and Fackler (1989) and concentrate all the identifying restrictions on the matrix of contemporaneous interactions $A(0)$, which we assume to have only 1's in the diagonal. The remaining coefficients are specified according to the hypotheses indicated below. Fackler (1988) presents a detailed discussion of the steps involved in the likelihood maximization process for a more general framework.

In order to define the $A(0)$ matrix we make empirical hypotheses based on two-sector models of the Brazilian economy of the types developed by Sayad (1979), Modiano (1985) and Barbosa (1987). The following assump-

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[1] The Bernanke procedure in Doan Associates, Regression Analysis for Time Series, Version 3.0, maximizes the likelihood function of reduced-form residuals to estimate the $A(0)$ matrix.

tions are usually made in these models: (a) wage rate is indexed to price level indexes, (b) exchange rate is fixed according to purchasing power parity principles, (c) agriculture is a competitive sector producing both tradable and nontradable goods, (d) industry behaves as an oligopoly with prices being fixed by rules of markup over costs (which includes imported inputs, agricultural raw materials and labor inputs), (e) money demand is related to income and prices according to a simple version of the quantity theory of money.

Our empirical model includes a set of eight variables, four of which represent international factors. These factors are the indexes of crude oil price, agricultural food price, agricultural raw material price and the U.S. wholesale price. The domestic variables are the indexes of the wholesale agricultural price, wholesale industrial price, the Brazilan exchange rate (domestic currency value of the U.S. dollar) and the Brazilian money supply.

The four international variables enter the model in a natural recursive fashion, beginning with the oil price (OP), followed by the agricultural raw materials price (WPRM), the agricultural food price (WPF) and the U.S. wholesale price (WPUS).

TABLE 1

Coefficient estimates of the $A(0)$ matrix for the Brazilian two-sector model

Dep. Var.	OP	WPRM	WPF	WPUS	ERBR	PINB	M1BR	PAB
OP	1	0	0	0	0	0	0	0
WPRM	−0.224 (NA)	1	0	0	0	0	0	0
WPF	−0.034 (0.035)	−0.282 (0.102)	1	0	0	0	0	0
WPUS	−1.001 (0.004)	−0.024 (0.012)	−0.120 (0.009)	1	0	0	0	0
ERBR	0	0	0	0.143 (0.699)	1	−0.683 (NA)	0	0.089 (0.155)
PINB	−0.509 (0.025)	−0.085 (0.089)	−0.143 (0.074)	1.010 (0.573)	0.151 (NA)	1	0	−0.013 (0.013)
M1BR	−0.133 (0.062)	0.044 (0.187)	0.373 (0.150)	−0.934 (1.778)	0.034 (0.121)	0.569 (0.206)	1	0
PAB	−0.002 (0.042)	−0.079 (0.128)	−0.294 (0.103)	0.796 (0.780)	−0.178 (0.175)	−0.317 (NA)	0.052 (0.052)	1

Figures in parentheses are estimated standard errors.

The four domestic variables are arranged in the following way. The exchange rate (ERBR) equation assumes a contemporaneous relationship between this rate and the Brazilian agricultural prices (PAB) and industrial prices (PINB) on the one hand, and the U.S. wholesale price on the other. The idea is that the Brazilian currency is depreciated directly with the evolution of domestic prices and inversely to the U.S. prices. Next comes the industrial price equation that relates this price to all variables in the model, except the money supply (M1BR). This latter variable is not included because of our assumption that industrial prices are determined by a markup over cost strategy, not being affected instantaneously by the money supply. The money supply itself is the dependent variable in the seventh equation in which the explanatory variables are all the variables in the model except the agricultural price. The last equation relates the agricultural price to all the other variables in the model.

The oil price variable refers to the Arabian light oil price as published by the Getúlio Vargas Foundation, which publishes the data for the domestic economy as well. The international prices of agricultural commodities are published by the Food and Agriculture Organization of the United Nations.

MAIN RESULTS

We present the results of a 12-lag vector autoregression analysis relating the behavior of Brazilian sectoral prices to domestic and international macroeconomic factors from 1973 to 1987. The number of lags was chosen based on previously related macroeconomic studies (Carneiro Netto and Fraga Neto, 1984; Brandão, 1985; Orden, 1986). A six-lag vector autoregression was rejected by a likelihood ratio test at the 1% level.

The estimates for the $A(0)$ matrix for the Brazilian model are presented in Table 1. The results are satisfactory both in terms of expected signs and significance of the coefficients. The coefficients can be easily interpreted after making the appropriate change of signs of the off-diagonal elements of $A(0)$. They represent the immediate partial effects of shocks to the variables at the top of the columns on the variables at the beginning of each row. For instance, an increase of 10% in the oil price (OP) tends to increase immediately the agricultural raw material price by about 2.2% and the U.S. wholesale price by 10%. The impact on the Brazilian industrial price would be an increase of about 5.1%; the impact on agricultural price would be very small (0.02%). The Brazilian money supply would increase by about 1.3%.

We now report the results related to the decomposition of the variance of the forecast errors for all variables (Table 2). The block of international

TABLE 2

Decomposition of k months ahead forecast-error variance, Brazilian macroeconomic variables (percentages)

Variance of	k	Shocks to							
		OP	WPRM	WPF	WPUS	ERBR	PINB	M1BR	PAB
ERBR	1	4.7	0.1	0.0	0.3	80.0	12.7	0.0	2.1
	6	4.8	1.5	3.1	6.5	51.0	21.8	9.3	1.9
	12	5.4	5.9	2.0	5.8	53.1	14.1	9.4	4.2
	24	14.1	5.3	1.9	6.5	41.3	13.8	7.5	9.3
PINB	1	25.8	1.2	0.1	1.1	7.0	64.3	0.0	0.6
	6	47.0	15.6	0.7	2.3	3.6	29.3	0.2	1.1
	12	41.3	17.2	0.7	2.7	10.0	24.8	0.6	2.7
	24	40.5	11.7	0.9	7.1	17.4	15.2	2.6	4.6
M1BR	1	13.5	2.3	2.7	0.7	0.2	4.5	75.8	0.0
	6	18.1	4.7	4.9	11.2	3.5	3.5	46.4	7.8
	12	16.9	5.6	4.9	9.9	3.0	14.7	37.0	7.9
	24	25.5	9.4	2.3	11.5	3.2	13.0	25.2	9.9
PAB	1	4.4	4.6	3.1	0.9	0.9	3.3	1.6	81.2
	6	19.1	10.0	12.4	0.8	3.4	20.0	1.8	32.6
	12	18.2	7.8	7.1	2.3	30.4	12.7	1.9	22.4
	24	30.2	5.9	5.6	5.0	26.6	10.1	2.1	14.5

variables has, as expected, most of the variance of forecast errors (at least 80% for the oil and agricultural raw material and U.S. wholesale prices and 65% for food price) explained by shocks in variables within that same block. The block of Brazilian variables has the variance of forecast errors explained by a wider set of variables, including both international and domestic factors.

The forecast variance of each of the Brazilian macroeconomic variables is explained by own-shocks and by shocks to other variables. For the exchange rate (ERBR) we notice the relatively important role played by the industrial price and, to a lesser extent, by the money supply and the oil price. The industrial price forecast-error variance seems to be reasonably explained by the oil price, international agricultural raw material price and the exchange rate. In the case of the money supply we see the relevant effects of the oil price and U.S. price level and the domestic sectoral prices. The forecast-error variance of the domestic agricultural price is explained to a reasonable degree by all variables except money supply and the U.S. wholesale price level.

We now proceed to comment on the results of the impulse analysis associated with the moving average representation of the VAR model
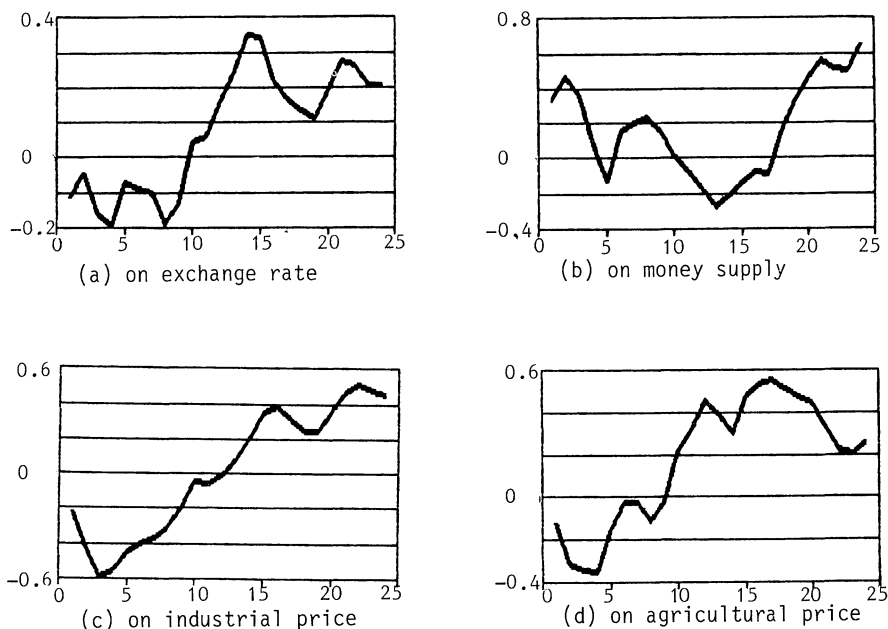
Fig. 1. Impulse elasticities of oil price.

(Figs. 1 to 8). These estimates are presented as elasticities relating a 10% initial unexpected shock to a given variable upon all the remaining variables in the model during 24 months following the shock. To save space, we present these results only for those effects considered significant from the point of view of the decomposition of variances discussed above.

Unexpected shocks in the oil price explain a large portion of the variance of the forecast errors of all domestic variables. An increase in the price of oil tends to reduce (appreciate) the Brazilian exchange rate and
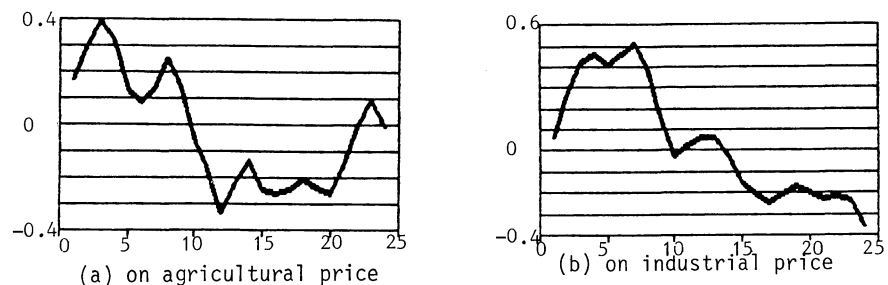
Fig. 2. Impulse elasticities of international raw material price.
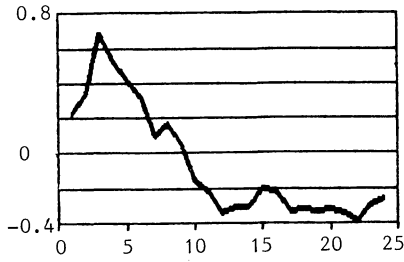
Fig. 3. Impulse elasticities of international agricultural food price.
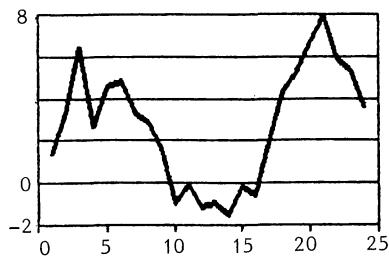
Fig. 4. Impulse elasticities of U.S. wholesale price.

(a) on exchange rate

(b) on agric. price
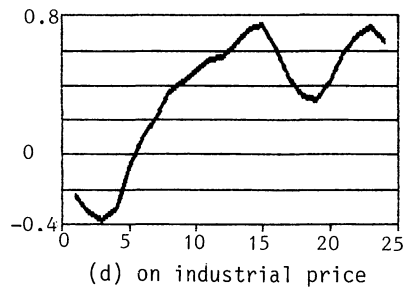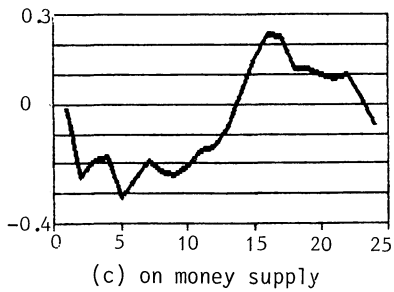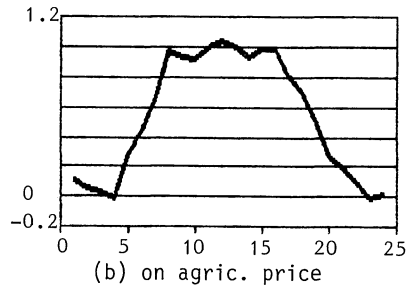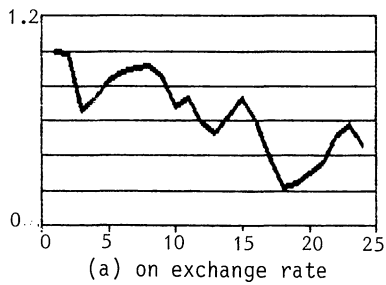
(c) on money supply

(d) on industrial price

Fig. 5. Impulse elasticities of exchange rate.

both of the Brazilian prices during most of the first year following the shock (Fig. 1). These results are apparently associated with the Brazilian exchange rate policy that appreciates the national currency when the U.S. wholesale price increases. As we have seen, the latter is immediately and proportionally affected by the oil price shock. As the initial shock is transmitted to the whole domestic economy, we see that a complete reversion of the effects takes place as the end of the first year approaches. We also see that the Brazilian money supply tends to increase temporarily following the oil price shock. We will have more to say about that below.

Unexpected increases in the world agricultural raw materials price tend to raise both Brazilian sectoral prices (Fig. 2). In the second year following the shock these prices will decrease following an approximately cyclical pattern typical of agricultural price shocks.

Unexpected increases in the world price of food also tend to increase the agricultural price. This trend is also reversed toward the end of the first year (Fig. 3).

Shocks in the U.S. wholesale prices generated very high impulse elasticities related to the domestic money supply, which increases at first, falling after the tenth month and then increasing again from the seventeenth month on (the pattern of the effects upon money supply is similar to that of the oil price) (Fig. 4).

Let us now consider the effects of shocks to the domestic variables.

A devaluation, for instance, of the Brazilian currency tends to be gradually reduced during the following eighteen months. The effect on the industrial price is at first a small reduction, but, after the sixth month, substantial (albeit less than proportional) increases are observed. Agricultural prices also increase, accumulating, after six months, a growth proportional to the exchange rate devaluation. While the effect of the devaluation on agricultural prices practically vanishes by the end of the second year, the industrial price increase tends to exhibit a more persistent pattern (Fig. 5).

An unexpected increase in the industrial price tends to lead to a proportional devaluation of the Brazilian currency by the third month. After that an oscillatory pattern is observed. The pattern of these effects on the exchange rate is very similar to the one presented by the industrial price itself. These facts, plus the major importance of industrial price shocks in explaining the variance of forecast errors of the exchange rate, suggest that the Brazilian exchange rate policy tends to follow very closely the behavior of the industrial prices. The agricultural price is almost proportionally affected by the industrial price increase by the second month following the initial shock. After the seventh month an oscillatory pattern is observed. The money supply at first decreases, but by the end of
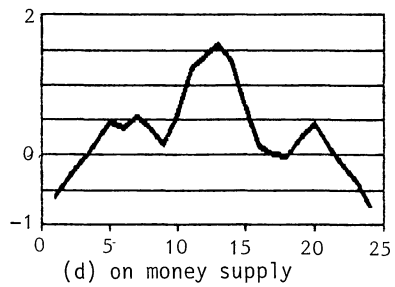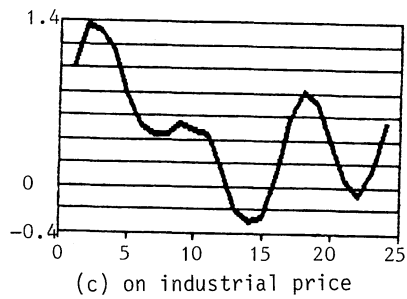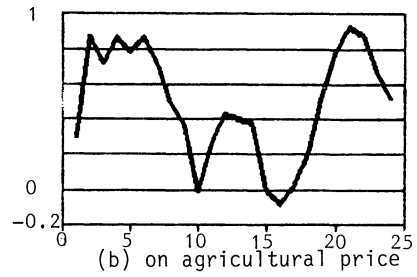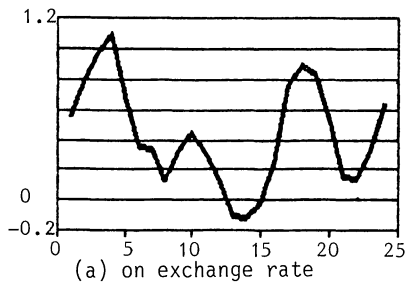
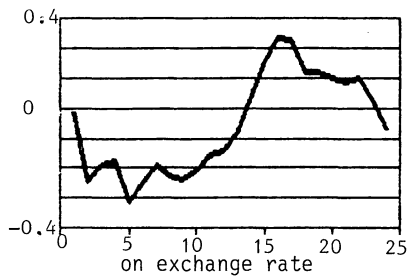Fig. 6. Impulse elasticities of industrial price.

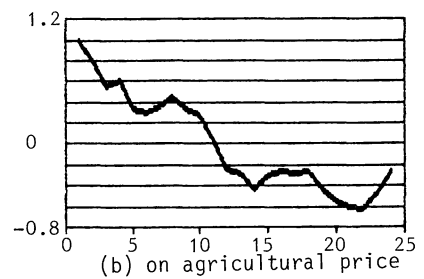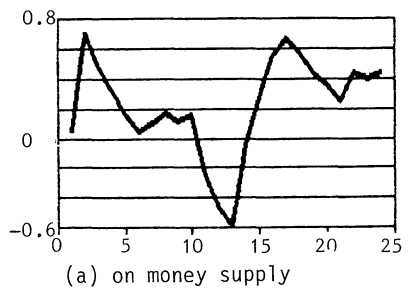Fig. 7. Impulse elasticities of money supply,

Fig. 8. Impulse elasticities of agricultural price.

the year its growth will have exceeded that of the industrial price. This is a temporary effect, however (Fig. 6).

The effects of an unexpected increase in the Brazilian money supply upon the sectoral prices are relatively small and nonsignificant. The effect on the exchange rate is also relatively small, with some appreciation in the first year followed by a slight depreciation in the second year (Fig. 7).

An unexpected increase in the agricultural price tends to gradually disappear during the first year, in part due to the behavior of the exchange rate. The money supply increases temporarily following the agricultural price increase and also reduces temporarily at the 13th month, indicating, during the first year, a clear association with the agricultural crop pattern (Fig. 8).

Now we summarize the pattern of responses of the Brazilian monetary and exchange rate policies to the shocks considered in this analysis.

The exchange rate policy tends to follow very closely the industrial price changes. It is thus possible that Central Bank authorities pay more attention to the industrial price index when adjusting the Brazilian currency to inflation. (Other results, not presented here, also suggest that in fact the exchange rate policy may have been used to at least partially offset agricultural price changes).

Regarding the monetary policy, our results suggest a relatively passive or endogenous role for the money supply. Apparently, the money supply strategy has been to accommodate agricultural and external price shocks. Following a currency devaluation, money supply is temporarily contracted, but later on, possibly due to trade balance effects, a monetary expansion takes place. Only in the case of industrial price changes do we notice a temporary effort to use money supply to counteract inflationary trends.

It is important to emphasize, however, that these comments are based on the initial reactions of the money supply to changes in prices and exchange rate. After a time interval of 3 to 12 months this money supply strategy becomes hardly identifiable.

CONCLUDING REMARKS

A detailed analysis of the impulse elasticities estimated in this paper indicates that two of the variables included in our model clearly affect the domestic terms of trade in Brazil. These are the international price of food and the value of the exchange rate. Increases in the first one tend to increase agricultural prices relative to industrial prices; the positive effect lasts for 6 months and then changes its direction since the international price itself tends to decline after that period of time. Devaluations of the

Brazilian currency tend to increase the agricultural relative price during 18 months after the shock.

Therefore, the exchange rate policy has been mostly relevant for the agricultural sector in Brazil. However, the strategy of following purchasing power parity principles cannot assure a stable current account balance, since during the last two decades the values of the major currencies have oscillated a lot against each other. For the agricultural sector in particular, that strategy resulted in substantial variations in relative prices.

In 1990, the Brazilian exchange rate policy changed to a more flexible system. However, one can hardly speak of a free exchange rate market for two basic reasons: (a) the Central Bank still participates strongly in the market, trying to control the exchange rate, and, (b) Brazil is not integrated in the international capital markets; this integration will take place only when the Brazilian government succeeds in negotiating its external debt with the international financial community. Anyhow, a freer exchange rate market in Brazil can benefit the agricultural sector, since it would probably result in a more devaluated currency. If that change is also accompanied by more trade liberalization as has been proposed, the benefit will be still more significant. Money supply control would also be improved and so would the possibility to effectively fight inflation.

Regarding the monetary policy, in addition to the domestic institutional problems [2] related to money supply control, the unstable behavior of the current account balance meant that monetary policy could not be used as an effective instrument of domestic stabilization. Rather than that, money supply became an endogenous variable affected by an ample set of domestic and international factors.

The major conclusion of this paper is, therefore, that the role of the external sector is certainly relevant in understanding the behavior of not only relative price, but also of the money supply itself in Brazil. As a consequence, previous work relating these two variables within a domestic framework missed some important insights relating to the role of exchange rate policy and international commodity price shocks.

Finally, with regard to the specific results of this paper, it should be mentioned that they show the responses of terms of trade to macroeconomic policy and external shocks within a two-year period. Certainly one cannot talk about long-run effects in this type of analysis. Other estimation

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[2] Up to 1986, the effectiveness of money supply control in Brazil was said to be weak because the Bank of Brazil – the federal government commercial bank – maintained a current account with the Central Bank. Funding through this account was relatively uncontrolled, complicating the monetary management.

methods could possibly be devised to check the long-run behavior of the variables in the model. Apparently, vector error correction models (Engle and Granger, 1987) can be very useful in dealing with this type of question.

ACKNOWLEDGEMENTS

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