Monetary shocks, persistence and temporal effects in agricultural and non-agricultural prices in an impulse response analysis framework. The case of Bolivia and Japan

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1. Introduction

Monetary shocks are quite common in developing countries. Either if they are positive (an acceleration of the money supply, most probably when the government has to finance budget deficits) or negative (macroeconomic adjustments). As Frankel (1996) indicated, when money neutrality does not hold, relative prices will change, meaning that money has a real effect. Dornbush (1976), Stamoulis and Rausser (1988) and others established that if there are differences in the speed of adjustment of prices to money shocks (or any shock), the more flexible sector will bear the burden of the adjustment process. In this paper we will analyze the relative flexibility of agricultural and non-agricultural prices. This analysis will use contemporaneous time series theory, based on the impulse response function. By using data of Japan and Bolivia, the relative flexibility of prices and their responses to monetary shocks can be analyzed by comparing the relative development of the country as well.

2. Theoretical background

With a model that includes flexible and sluggish prices, for both the agricultural and non-agricultural sectors is possible to show that after a monetary shock prices in the flexible sectors will react faster and that will carry most of the costs of the adjustment process. Saghaian, Reed and Marchant (2002) based on Frankel (1986) and Stamoulis and Rausser (1988), extended Dornbush (1976) model of overshooting to include agricultural prices.

$$x_t = A_1 x_{t-1} + A_2 x_{t-2} + \ldots + A_n x_{t-n} + \varepsilon_t \qquad \text{Eq. (1)}$$

Time series theory provides the tools for the econometrical analysis of the overshooting hypothesis. If the series are stationary, then we can specify a VAR system, where the endogenous variables are the agricultural and non agricultural prices (with flexible and non-flexible sectors in each group). The coefficients of the system will indicate if monetary shocks are transitory or permanent and the speed of adjustment of the variables. The VAR analysis can be described with the help of Eq. (1) as in Enders (1995).

$$x_t = \phi_0 \varepsilon_t + \phi_1 \varepsilon_{t-1} + \phi_2 \varepsilon_{t-2} + \ldots \qquad \text{Eq. (2)}$$

$$\phi_i = \sum \phi_{i-j} A_J \qquad \text{Eq. (3)}$$

Where in Eq. (1) $\boldsymbol{x_t}$ is a vector (1xK) of endogenous variables, $\boldsymbol{A_i}$ (KxK) is a matrix of coefficients and $\boldsymbol{\varepsilon_t}$ is a white noise error. The impulse response functions are constructed based on Eq. (1) assuming that at $\boldsymbol{t}$ = 0, only the current shock is observed, everything else constant. In this paper, the impulse response functions will have the form of Eq. (2) (Lütkepohl and Breitung, 1996).Where $\boldsymbol{\phi_0}=I_K$ is the (KxK) identity matrix and the $\boldsymbol{\phi_i}$ can be computed recursively using Eq. (3).

Table 1. ADF test on levels and first differences

	Japan			Bolivia		
	Lag	Value	Prob.*	Lag	Value	Prob.*
Levels						
P_{AN}	5	-3.711	5.00%	3	-2.564	
P_{AT}	5	-2.933		3	-0.64	
P_{IN}	2	-5.914		5	-2.137	
P_{SE}	2	-1.262		4	-3.795	5.00%
M1	2	-0.021		3	-0.977	
First difference						
P_{AN}	5	-4.396	1.00%	3	-8.596	1.00%
P_{AT}	5	-5.391	1.00%	3	-4.204	1.00%
P_{IN}	2	-5.914	1.00%	5	-4.154	1.00%
P_{SE}	2	-4.431	1.00%	4	-4.174	1.00%
M1	2	-4.431	1.00%	3	-4.748	1.00%

*Probabilities calculated using the critical values reported in Mackinnon (1992).

3. Results and discussion

The data for this paper was analyzed at the quarterly level and it runs from 1985:1 to 2001:4, however in the case of Bolivia, after adjusting edge points the system data is restricted from 1989:1 to 2001:4. The first step in the procedure is to determine if the endogenous variables of the system are stationary or not[1]. To do so, the Augmented Dickey-Fuller (ADF) test was performed, and results are showed in Table 1 for Bolivia and Japan. The test failed to reject the null hypothesis of non-stationarity on the levels; therefore a first difference test was run on the data. The first difference indicates that the variables are stationary for Japan and Bolivia at the 1% confidence level, although at different lags. Not only the significance of the ADF test was used to determine this, but also the Akaike Info-Criterion and the Swartz Criterion (Lütkepohl and Breitung, 1996). Following Cuddington and Liang (2000) also the t-values of the lag coefficients were observed to determine the relative stationarity of the variables. The alternative Phillip-Perron test confirmed the previous conclusion. The variables are stationary if they are differenced once. Once the relative stationarity of the variables has been determined, the VAR(n) is specified with the appropriated lengths. For the present analysis, both for Bolivia and Japan two lags were used, $\boldsymbol{n} = 2$.

$$\Delta P_i = \sum_{j=1}^{n}\left(\alpha_{ij}\Delta P_{ANTt-j} + \beta_{ij}\Delta P_{ATt-j} + \phi_{ij}\Delta P_{INt-j} + \lambda_{ij}\Delta P_{SEt-j} + \varphi_{ij}\Delta m_{t-1}\right) + \varepsilon_{1t} \qquad \text{Eq. (4)}$$

Table 2. VAR coefficients for Bolivia and Japan

		P_{ANT}	P_{AT}	P_{IN}	P_{SE}	M1
Bolivia	$P_{ANT}(-1)$	0.256	-0.233	0.260	0.286	-0.551
	$P_{ANT}(-2)$	-0.429	0.482	0.118	0.122	-0.556
	$P_{AT}(-1)$	0.006	0.268	-0.027	0.055	0.514
	$P_{AT}(-2)$	-0.008	0.012	-0.059	-0.070	-0.328
	$P_{IN}(-1)$	0.401	0.485	-0.183	-0.070	2.015
	$P_{IN}(-2)$	0.167	-0.443	-0.041	-0.169	0.549
	$P_{SE}(-1)$	0.229	-1.112	0.325	0.033	0.629
	$P_{SE}(-2)$	0.154	0.782	-0.035	0.022	1.014
	M1(-1)	0.083	-0.150	0.044	0.018	-0.235
	M1(-2)	0.000	-0.028	0.007	0.019	0.141
	C	0.002	-0.009	0.012	0.014	-0.046
	R^2	0.361	0.142	0.359	0.440	0.370
Japan	$P_{ANT}(-1)$	-0.228	0.212	0.011	0.011	-0.186
	$P_{ANT}(-2)$	-0.095	-0.168	0.014	-0.005	-0.136
	$P_{AT}(-1)$	-0.202	-0.094	0.012	0.007	-0.006
	$P_{AT}(-2)$	-0.106	0.160	0.021	-0.005	0.065
	$P_{IN}(-1)$	0.985	-1.343	-0.104	0.089	-0.637
	$P_{IN}(-2)$	1.696	2.320	0.597	0.264	0.690
	$P_{SE}(-1)$	-1.265	2.428	0.046	0.289	-3.033
	$P_{SE}(-2)$	0.749	-7.679	-0.041	-0.022	0.128
	M1(-1)	0.458	0.042	-0.052	0.023	-0.586
	M1(-2)	0.560	-0.143	0.061	0.060	-0.458
	C	-0.021	0.022	0.000	0.002	0.041
	R^2	0.441	0.276	0.811	0.489	0.633

Significant at 5% Significant at 10%

Where $\boldsymbol{i}$ = P_{ANT} (agricultural-non tradables prices), P_{AT} (agricultural tradables prices), P_{IN} (industrial prices), P_{SE} (services prices), and $\boldsymbol{m}$ (monetary supply, M1). All variables were introduced in logarithmic form, first difference. Prices and money are deflated by the CPI, base year 1995. Eq. (4) states that endogenous variables react to own-past disturbances, disturbances on the other variables and a white-noise error, which is the shock. For Bolivia, P_{ANT} includes all products but wheat, soybeans and sugar which are the P_{AT} products. P_{IN} and P_{SE} were obtained from the CPI for both countries.

[1] No and Zapata (2001) analyze different outcomes when a VAR is used to analyze impulse response functions. Their results indicate that if the data is non-stationary and is not differentiated then the results are heavily biased.

Coefficients calculated with Eq. (4) are presented in Table 2. The order of the variables is important for the results (Enders, 1995 and Lütkepohl and Breitung, 1996), in this paper it is assumed that the monetary shock affects the other variables, but it is not affected by them. Significance of the coefficients is high although some R^2 values are low, especially for the P_{AT} equation for the Bolivian and Japanese data. In the case of Bolivia, agricultural prices seem to be related with their own lagged values but not with lagged values of the non-agricultural prices, which is not the case for the Japanese results. On the other hand, non-agricultural services prices (P_{SE}) are related with agricultural, traded and non-traded in the case of Bolivia but not related at all in Japan. However, all prices react to changes in the money supply. Japanese prices are affected by the first and second lag of the money supply but in the case of Bolivia, only the first lag seems to be important for the determination of relative prices. Utilizing a similar model Saghaian, Hasan and Reed (2002) found that agricultural prices respond to monetary shocks (although with a cointegrating term in the specification) and that agricultural prices are more sensitive to monetary shocks than industrial prices. If we add the coefficients for M1, only P_{ANT} for Japan seems to be close to unity, indicating that money neutrality does not hold in this model. After a money shock, agricultural prices in Bolivia increase by 0.08% and decrease by 0.15% for non-tradables and tradables respectively. Money is inflationary, but for agricultural tradables, is deflationary. This can explained if we consider that monetary supply shocks can be traced to exchange rate depreciations. Exporters on the agricultural sector expect a future depreciation, which leads to an increase in the production. In the short-run, price then, will fall. In the case of Japan, money shocks are inflationary for all prices. For both countries, shocks on the agricultural sector are stronger than those in the non-agricultural sector.

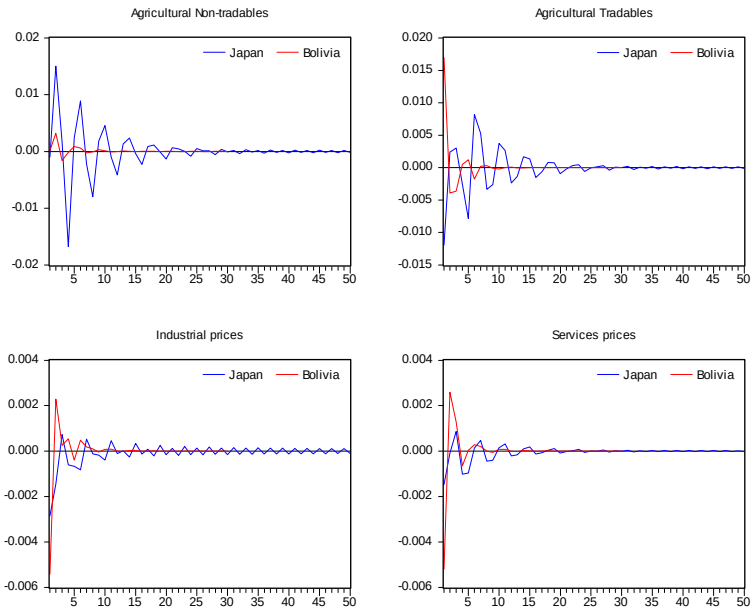

Figure 1. Impulse response representations from a one SD shock

Figure 1 shows the corresponding impulse response functions for agricultural and non-agricultural prices in both countries from a one standard deviation shock in the money supply. Bolivian prices in both sectors return to their long run trend after (in average) the seventh quarter. Industrial prices have similar responses to monetary shocks and they return to equilibrium around the ninth quarter. Prices of agricultural non-tradables seem to be the most flexible prices, monetary shocks are only important the first four quarters, after that they return to the previous state very fast. Agricultural tradables seem to have a more persistent departure from the long run trend than agricultural non-tradables prices.

In the case of Japan, monetary shocks are more persistent than in the Bolivian case. In average, prices return to the original state after thirty quarters (seven years and a half), everything else constant. Agricultural prices have a strong response to monetary shocks, increasing sharply the first two quarters, and then they fall the next two. This increase and decrease continues until the 20^{th} quarter, where it becomes unobservable. Industrial prices are considerably less responsive to monetary shocks, and they return to their previous state, after the 10^{th} quarter. One possible explanation for the persistence of monetary shocks in Japan is that expectations in this country tend to consider the shock as permanent, meanwhile in Bolivia, the shocks is considered temporal. This relative difference in expectations is consistent with the more stable conditions of a developed economy than in a developing country.

The response of P_{ANT} for Japan is stronger than in the case of Bolivia. This is partly because P_{ANT} in Japan accounts only for rice, which is highly regulated. A monetary shock increases prices in both countries, but is stronger in Japan because imports are too expensive. In Bolivia, P_{ANT} includes most agricultural products which have close substitutes in the international market but they are not currently imported basically due to transportation costs. At the same time, P_{AT} is more responsive in Bolivia because agricultural products for international markets are comprised in soybeans (exports) and wheat (imports) making this sector vulnerable to any change in the macroeconomic environment.

The previous discussion is also confirmed with results on Table 2. Coefficients for P_{ANT} and P_{AT} in Bolivia and Japan are bigger than coefficients for P_{IN} and P_{SE}, which shows that agricultural products have a strong reaction to changes in the money supply. However, the speed of adjustment is controversial. In both countries non-agricultural prices return to the original state faster than agricultural products.

4. Concluding remarks

Prices in the agricultural sector have stronger responses to monetary shocks than prices in the non-agricultural sector. These results are confirmed with the VAR specification and the impulse response functions. Prices react for the first two quarters in both countries, although the relative effect is stronger for the P_{ANT} in Japan. As expected, agricultural non-tradables are more responsive in Japan (developed country) and tradables are more responsive in Bolivia (developing country). These results highlight the importance of macroeconomic variables in the agricultural sector and especially the role of money in the determination of prices, and therefore, production.

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