Monetary Impacts and Overshooting of Agricultural Prices in a Transition Economy: The Case of Slovenia

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Abstract

The paper focus on the time adjustment paths of the exchange rate and agricultural producer and industrial prices in response to unanticipated monetary shocks following model developed by Saghaian et al. (2002). Results indicate that agricultural prices adjust faster than industrial prices to innovations in the money supply, affecting relative prices in the short run, but strict long-run money neutrality does not hold. The impulse response analysis shows that an exogenous shock to the money supply has a significant and volatile effect on the three price variables. The extent of overshooting in agricultural prices is twice as large as for exchange rates or industrial prices. This indicates that in the case of monetary shocks the sectors associated with flexible changes bear the burden of adjustment vis-à-vis the sectors with sticky changes.The exchange rate pass-through on agricultural producer prices revealed by the forecast error variance analysis indicates the relatively greater importance of the exchange rate than the money supply in explaining the expected variation of the agricultural producer price. This is consistent with floating exchange rate policy, while agricultural trade policy for sensitive products has been more restricted until Slovenia joined the European Union.

Keywords: agricultural prices, exchange rates, monetary shocks, overshooting, transition economy

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1. Introduction

There is a continuously growing literature on the agricultural transformation in Central and Eastern European countries. The research has focused on various aspects of transition, including land reform, farm restructuring, price and trade liberalisation. However, until now macroeconomic aspects of agricultural transition were neglected. The agricultural economics literature has emphasised the importance of macroeconomics and financial factors in the determination of agricultural prices already in the second half of eighties (e.g. Chambers, 1984; Orden, 1986a,b; Orden and Fackler, 1989). Recently there has been renewed interest in the analysis of impact of monetary variables for agricultural prices (Saghaian et al., 2002; Ivanova et al., 2003; Cho et al., 2004; Peng et al., 2004) employing cointegration and Vector Error Correction (VEC) framework. Previous empirical research based on mainly U.S. agriculture suggests that any changes in macroeconomic variables should have an impact on agricultural prices, farm incomes and agricultural exports. Therefore, as it has been shown in the case of Bulgaria and Hungary (Ivanova et al., 2003; Bakucs and Fertő, 2005) it is reasonable to assume that due to less stable macroeconomic environment in a transition country these effects are more profound. In this study we focus on the overshooting hypothesis claiming that monetary changes can have real short-run effects on the prices of agricultural commodities. This indicates that money supply is not neutral and monetary impacts can change relative prices in the short run. The paper examines the short-run overshooting of agricultural prices in Slovenia using cointegration and VEC framework. The empirical results have also implications for long-run money neutrality. This issue is important in transition countries, because price variability is much less for industrial prices then for agricultural prices during the transition period especially comparing similar price movements in developed countries. Overshooting of agricultural prices can at least partially explain the observed agricultural-price variability. These monetary impacts and financial factors have policy implications as well. The short- and long-run impacts of monetary policy have been very important for the Slovenian agricultural sector. This has been in spite of a fact that the Slovenian level of agricultural subsidies has been among the highest in the world. The introduced direct subsidization schemes such as direct area and headage payments might have some income stabilization effects, but farm incomes are much more influenced by market prices. If money is neutral in the long run, commodity price overshooting can still have significant effects on short-run farm income and the financial viability of farms.

The paper is organised as follows. Section 2 discusses theoretical background and related empirical evidence. The time series methodology employed is described in section 3. The data and the results of empirical models are presented in the section 4. Finally, the conclusions and implications of the results on the Slovenian agriculture are drawn in the last section.

2. Theoretical considerations and empirical evidence

Since Schuh's (1974) pioneering work interest has continued in the possible impacts of monetary policy on agricultural markets. This issue is important because policies to stabilise agricultural markets should consider the sources of volatility within the agri-food sector. The main issue is that whether levels of agricultural and non-agricultural prices respond proportionally to changes in the level of money supply in the long run, and whether money is neutral in short run. Various explanations are available for relative price movements. It is usually assumed that agriculture is a competitive sector in which its prices are more flexible than in non-agricultural (fix price) sectors. Consequently, expansionary monetary policy favours agriculture, because farm prices can be expected to increase faster than non-agricultural prices, while restrictive monetary policy shifts prices against agriculture. We will test whether this holds for Slovenia where the National Bank argues that has conducted monetary policy more in line with a restrictive one since the currency has been introduced. Bordo (1980) argues that agricultural commodities tend to be more highly standardised and therefore exhibit lower transaction costs than manufactured goods. Consequently, agriculture is characterised to have rather short term contracts, which lead a faster response to a monetary shock.

Other streams of research address the broader macroeconomic environment. Arising from Dornbusch's (1976) overshooting models of exchange rate determination, these studies establish the linkages among exchange rates, money, interest rates and commodity prices. Frankel (1986) applied Dornbusch's model in which exchanges rates, money supply, interest rate and aggregate demand determine commodity prices assuming closed economy. He emphasised the distinction between "fix-price" sectors (manufacturers and services sector), where prices adjust slowly and "flex-price" sector (agriculture), where prices adjust instantaneously in response to a change in the money supply. In Frankel's model, a decrease in nominal money supply is also a decline in real money supply. This leads to an increase in interest rate, which in turn depresses real commodity prices. The latter then overshoot (downward) their new equilibrium value in order to generate expectation of a future appreciation sufficient to offset higher interest rate. In the long run, all real effects vanish. Lai et al. (1996) employed Frankel's framework and phase diagram to investigate how money shocks influence commodity prices. They found that with unanticipated monetary shocks, commodity prices overshoot, but, if manufactured prices respond instantly, commodity prices undershoot. Saghaian et al. (2002) extended Dornbusch's model with agricultural sector and allowing for international trade of agricultural commodities. Agricultural prices and exchange rate are assumed flexible, while industrial prices are assumed to be sticky. Employing small open country assumption, they showed that when monetary shocks occur, the prices in flexible sectors (agriculture and services) overshoot their long-run equilibrium values.

Furthermore, they showed that with presence of a sticky sector, in case of monetary shock, the burden of adjustment in the short run is shared by two flexible sectors and having a flexible exchange regime decreases the overshooting of agricultural prices and vice versa. The extent of overshooting in the two flexible sectors depends on the relative weight of fix-price sector.

3. Empirical Procedure

The empirical procedure is based on testing for unit roots, cointegration analysis and Vector Error Correction Model. We test for cointegration using Johansen's multivariate approach (Johansen, 1988). This procedure is a Maximum Likelihood (ML) approach in a multivariate autoregressive framework with enough lags introduced to have a well-behaved disturbance term. It is based on the estimation of the Vector Error Correction Model (VECM) of the form:

$$\Delta \mathbf{Z}_t = \mathbf{\Gamma_1} \Delta Z_{t-1} + \ldots + \mathbf{\Gamma_{k-1}} \Delta Z_{t-k+1} + \mathbf{\Pi} Z_{t-k} + \mathbf{u_t} \quad (1)$$

where $Z_t = [PPI_t, IPI_t, XR_t, M1_t]'$ is a (4 x 1) vector containing the four I(1) variables, $\mathbf{\Gamma_1}$,…. $\mathbf{\Gamma_{k+1}}$ are vectors of the short run parameters, $\mathbf{\Pi}$ is matrix of the long-run parameters, and $\mathbf{u_t}$ is the white noise stochastic term.

$\mathbf{\Pi} = \boldsymbol{\alpha\beta}$\`, where matrix $\boldsymbol{\alpha}$ represents the speed of adjustment to disequilibrium and $\boldsymbol{\beta}$ is a matrix which represents up to (n - 1) cointegrating relationships between the non-stationary variables. There are five (M1-M5) possible models in (1) depending on the intercepts and linear trends.

4. Data and results

Monthly time series data of an agricultural variable, the log of producer price index (PPI), the log of industrial producer price index (IPI), the log of tollar/Euro exchange rate and the log of the money supply (M1) were used. The dataset covers the January 1996 – July 2005 period, consisting of 115 observations. The data are presented on Figure 1. Data sources are the Slovenian Statistical Office, and the Bank of Slovenia.

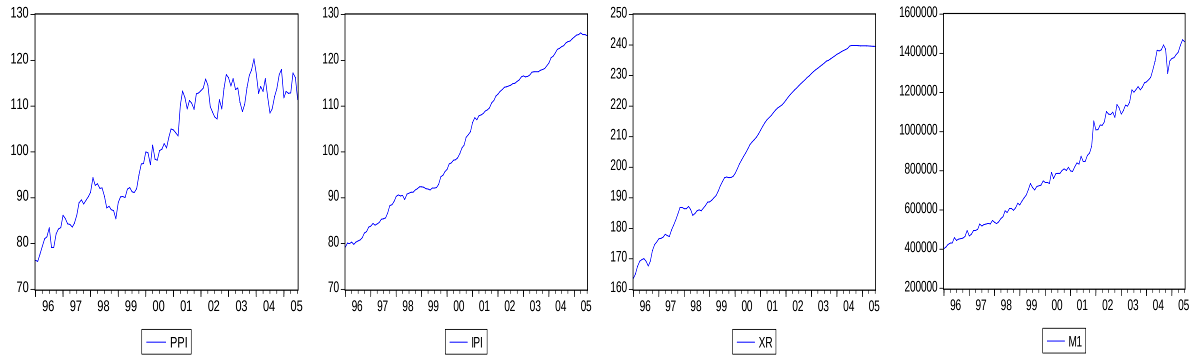

Figure 1. The agricultural producer and industrial producer price indexes, the exchange rate (SIT/Euro) and money supply (mil SIT)

4.1. Stationarity and integration tests

The stationarity and integration test is conducted in two steps. First, the Augmented Dickey-Fuller unit root tests (not shown here) with and without a trend are performed. Test results suggest all series are integrated of order one, I(1). Second, the more up-to-date Elliott, Rothenberg, Stock (1996) DF-GLS unit root test, with and without a linear trend is run. The results are presented in the first part of Table 1. None of the tests statistics is significant, and the variables appear to be non-stationary. To check whether all series are I(1) or integrated of a higher order, the first differences are tested using the DF-GLS unit root tests. The results are presented in the second part of Table 1. With or without a trend, the first difference of the industrial prices seems to be integrated of a higher order than one. The first difference of the exchange rate with a constant does not reject the unit root null either. At this point, two issues need to be mentioned. First, the poor size and power properties of the unit root tests may lead to unbalanced results. Second, it is possible that cointegration exists when there is a mix of variables integrated of different order as the variables integrated of order 2 can first cointegrate down to I(1), then cointegrate with the rest of the variables resulting stationary residuals (Harris and Sollis, 2003, pp.112).

Therefore we test for cointegration between the four variables, and then analyse the stationarity properties of the resulting residuals.

Table 1. DF-GLS unit root tests of the variables

Variables	Specification	Lags	Test statistic
PPI	constant	0	0.245
	constant and trend	0	- 1.798
IPI	constant	10	0.235
	constant and trend	0	- 0.779
XR	constant	1	1.485
	constant and trend	1	- 0.841
M1	constant	6	1.606
	constant and trend	6	- 2.942
First differences			
ΔPPI	constant	2	- 6.34
	constant and trend	0	- 9.104
ΔIPI	constant	9	- 1.252
	constant and trend	9	- 2.148
ΔXR	constant	0	- 1.933
	constant and trend	1	- 3.854
ΔM1	constant	5	- 3.402
	constant and trend	5	- 4.096

The critical values for 0.95 (0.99) confidence levels with constant are -1.943 (-2.585), with constant and trend are -3.015 (-3.562). The Schwarz Bayesian Criteria was used to determine the lag length.

4.2. Cointegration tests

To conduct cointegration tests, the VECM lag length was first selected. Three of the five usual lag length criteria, the LR test statistic, the final prediction error criteria (FPE) and the Akaike Information Criterion (AIC) suggested 4 lags, whilst the Schwarz Bayesian Criterion (SBC) and the Hannan-Quinn (HQ) suggested 2 lags. 4 lags in the VAR model were considered enough to result uncorrelated residuals. The number of cointegrating vectors depends on the model specification chosen (from M1 to M5), however at least one (trace statistic) or two (Max-Eigen statistic) cointegration vectors were found at 5 % significance level irrespectively of the model specification. Specification M5 (quadratic trends) was found to maximise the log likelihood function and also to minimise the AIC criteria. It might be difficult to argue in favour of quadratic trends in economic processes. It should be noted however, that all specifications are nested in M5. Therefore the misspecification bias is minimised by using this specification. Both the trace and max Eigen statistics select 3 cointegration vectors at 5% level of significance. Because of the ambiguous unit root test results, the three cointegration residuals are tested for unit roots. The test results (available on request) reject the unit root null hypothesis for all three residuals at 1% level of significance. The first part of Table 2 presents the normalised cointegration vectors.

The empirical long-run relationships between the agricultural producer price and money supply, industrial price and money supply, exchange rate and money supply are in line with our expectations. The money slope coefficients are all negative and significant, consistent with economic theory that expansionary monetary policy positively affects prices. The money neutrality hypothesis expects the coefficients associated with the money supply (M1) to be close to one (i.e. the long run increase in the agricultural, industrial and services prices to be unit proportional with the increase in the money supply). One percent increase in money supply results in 2.587%, 1.382% and 1.258% increase in the agricultural producer prices, industrial prices and exchange rate respectively, not supporting the money neutrality hypothesis.

To test the long run neutrality hypothesis of the individual long-run relationships, restrictions are imposed on the M1 coefficients. The restriction is rejected for the agricultural producer price ($p = 0.042$), but couldn't be rejected for the industrial prices and exchange rate equations ($p = 0.567$ and $p = 0.838$ respectively). However, it appears that money supply in Slovenia is not neutral.

4.3. Vector Error Correction Model (VECM)

Because the variables proved to be cointegrated, a VECM is appropriate to simultaneously depict the long and short run evolution of the system. The residuals of the long run cointegrating equations are used to construct the VECM in Table 2.

Table 2. Vector error correction model coefficients and some diagnostic tests[b]

Cointegrating Equations	CointEq1	CointEq2	CointEq3	
PPI_{t-1}	1.000000	0.000000	0.000000	
IPI_{t-1}	0.000000	1.000000	0.000000	
XR_{t-1}	0.000000	0.000000	1.000000	
$M1_{t-1}$	- 2.587346 [- 4.17340][a]	- 1.382735 [- 3.81612]	- 1.258575 [- 4.57480]	
TREND	0.026006	0.011515	0.010895	
C	28.45727	13.23992	10.89726	
Error Correction:	ΔPPI_t	ΔIPI_t	ΔXR_t	$\Delta M1_t$
Coint.Eq1	*- 0.580789* [- 5.18889]	0.054858 [2.06287]	0.029633 [1.53241]	0.077715 [0.57599]
CointEq2	0.062575 [0.43088]	*- 0.122915* [- 3.56234]	0.051831 [2.06581]	- 0.164856 [- 0.94172]
CointEq3	1.194650 [4.16526]	0.015664 [0.22987]	*- 0.142944* [- 2.88474]	0.275233 [0.79609]
C	0.006039 [0.82540]	0.003805 [2.18909]	0.002886 [2.28305]	0.021765 [2.46797]
Trend	- 7.26E-05 [- 1.16893]	- 1.22E-05 [- 0.82645]	- 1.88E-05 [- 1.74961]	- 6.16E-05 [- 0.82309]
Adj. R^2	0.208738	0.247946	0.520961	0.428191
Log Likelihood	300.7065	465.9863	502.6250	279.2203
Akaike criterion	- 4.934027	- 7.808457	- 8.445653	- 4.560352
Schwarz criterion	- 4.528254	- 7.402685	- 8.039880	- 4.154580
Jarque-Bera	5.052573*	2.658755	1.141660	41.58510***

[a] t-statistics in brackets
[b] because of the space limitations, the lagged first differences are not presented here
Note: ***1% significance level, **5% significance level, *10% significance level

The coefficients of the speeds of adjustment (**α** in equation 1) in the three cointegration equations in the VECM measure how quickly the system returns to its long run equilibrium after a temporary shock. More exactly, if say, the agricultural prices are overshooting their long run equilibrium path, then the associated **α** value must be negative, implying that prices must fall in order to re-establish the long run equilibrium between money supply and prices. By considering one flexible (agriculture and exchange rate) and one sticky (industry) sector, we would expect to have larger (in absolute value) **α** parameters associated with flexible sector prices than with the sticky sector prices (Shagaian et al. 2002). The speeds of adjustment to the long run equilibrium of the agricultural producer prices, industrial prices and exchange rate are -0.5807, -0.1229, and -0.1429 (Table 4, in Italic). They are all negative as expected and significant. Moreover, the values associated with flexible sector prices are bigger (in absolute values) than the one associated with the industrial prices, suggesting a faster adjustment of the flexible sector. This result is also consistent with the literature.

Because of the difficulty to interpret VAR coefficient estimates, it is common to employ impulse response functions to graphically depict the influence of a shock upon the VAR variables. The generalised impulse response functions of Pesaran and Shin (1998) are used to simulate the responses of the agricultural producer prices, industrial prices and the exchange rate upon a one standard deviation shock in the money supply (Figure 2).

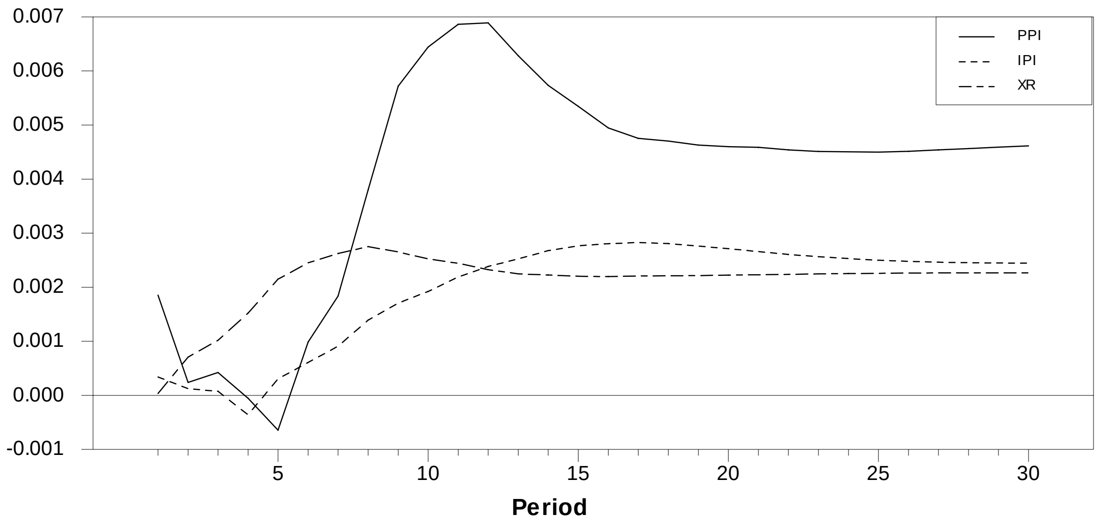

Figure 2. Impulse response to one standard deviation of money supply shock

The impulse response analysis reinforces the previous results. An exogenous shock to the money supply has a significant and volatile effect on the three price variables. First, both the agricultural producer prices and industrial prices undershoot their long-run path. The negative jump that affects agriculture producer prices is twice as large as the one for industrial prices. Industrial prices recover in 4, agricultural producer prices in 6 months after the initial shock, than overshoot their long-run equilibrium. Supporting both the theoretical model and previous results, the agricultural producer prices experience the largest overshooting (twice as much as exchange rates or industrial prices). The monetary shock has a persistent effect on all three analysed variables. They stabilise around a new equilibrium path in approximately 17 – 20 month after the original shock occurred.

A different tool to analyse the VAR results is the forecast error variance decomposition (Table 3).

Table 3. Variance decomposition for PPI

Period	PPI	IPI	XR	M1
1	92.40038	0.227640	6.437224	0.934760
2	85.26632	0.549112	13.60832	0.576246
3	78.42139	0.736631	20.32645	0.515534
4	66.86413	5.248300	27.45670	0.430870
5	55.83511	8.297101	35.46780	0.399989
6	47.70034	9.832854	42.04403	0.422774
12	30.61714	9.839003	50.93145	8.612409
24	22.81957	9.038791	54.91346	13.22818

Variance decomposition separates the variation in an endogenous variable into the component shocks to the VAR. Thus, the variance decomposition provides information about the relative importance of each random innovation in affecting the variables in the VAR.

Interesting and perhaps intriguing results were obtained. On a 12 month horizon only 30% of the variation in the industrial prices is explained by its own shock (e.g. changes in the supply demand conditions), and only 8.6% of the variation is due to money supply factors. Exchange rate however, seems to play an unusually important role (50%) in the explaining the expected variance in the agricultural prices. On a 2 year horizon, the effect of the own variation further diminishes (23%), whilst the percentage of variation explained by money supply and exchange rate variation increases (13.2% and 55% respectively).

What could explain the importance of the exchange rate in the expected variation of the agricultural producer prices? Agricultural imports in Slovenia amount to around 30%, exports to approximately 5% of the total agricultural output (SORS, 2004 and Bank of Slovenia, 2005). One may argue that because Slovenia is a small, open economy, agricultural producer prices quickly adjust to the exchange rate. While pass-through of the exchange rate is fast, the agricultural trade policy for sensitive products was more restrictive, but this does not affect the international price transmission through the exchange rate.

The coefficients of determination (lower part of Table 2) are similar to those obtained by other studies, ranging between 0.12 and 0.44. Thus the model explains a relatively high percent of change in the macroeconomic variables. The Jarque-Bera statistics reject the normality null hypothesis at 10% for 2 equations. However, non-normality test implies that the test results must be interpreted with care, although asymptotic results do hold for a wider class of distributions (von Cramon-Taubadel, 1998).

Table 4. Residual serial autocorrelation LM and LB tests

Lags	LM-Stat	Prob.[a]	Lags	LM-Stat	Prob.
1	19.075	0.264	7	25.520	0.061
2	11.020	0.808	8	8.794	0.921
3	13.640	0.625	9	22.970	0.114
4	11.873	0.752	10	15.364	0.498
5	12.952	0.676	11	16.033	0.450
6	7.645	0.958	12	25.665	0.0589
Ljung-Box statistic (16)	Adj. Q-stat = 220.86 (p = 0.257)				

[a] Probabilities from chi-square with 16 degree of freedom

Multivariate LM tests for serial autocorrelation (Table 4) do not reject the no-autocorrelation null hypothesis at 5 % for up to the 12th order, and the Ljung - Box statistic indicates an absence of autocorrelation amongst the first 16 lags.

5. Conclusions

This paper has examined the overshooting hypothesis for the Slovenian agriculture employing a theoretical model developed by Shagaian et al. (2002). Slovenia has experienced monetary adjustments from the previous hyperinflationary former Yugoslav system with expansionary monetary policy towards own monetary policy, which has been rather restricted.

Nevertheless, Slovenia experienced some monetary shocks during the transition period that quickly found their transmission ways into the agricultural sector. The exchange rate pass-through on agricultural producer prices is even more remarkable. This is consistent with floating exchange rate policy, while agricultural trade policy for sensitive products has been more restricted. The greater trade liberalization has occurred more recently when Slovenia has been adjusting its agricultural sector towards the EU membership and particularly since Slovenia has joined the EU and borderless Single European Market.

The existence of three cointegration vectors amongst the Slovenian agricultural producer prices, industrial prices, exchange rate, and money supply, proves the existence of a long-run equilibrium relationship between the variables. It follows that adjustments and shocks in macroeconomic variables have found their ways into the agricultural sector. After identifying the cointegrating equations and examining the slope coefficient of the money supply, we found that the money neutrality hypothesis doesn't hold for Slovenia. We found evidence that agricultural producer prices adjust faster to monetary shocks than industrial prices. The exchange rate is found as flexible variable, which adjusts faster to temporary shocks than the sticky, industrial prices. This indicates that in a case of monetary shocks the sectors associated with flexible changes will have to bear the burden of adjustment vis-à-vis the sectors with sticky changes. These macroeconomic effects are reflected in the agricultural sector by reducing the financial viability of the Slovenian farmers.

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