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Money supply, exchange rate, industrial and agricultural product prices: Evidence from Pakistan

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The hypothesis of Saghaian et al. (2002) is tested in this study by employing the JJ Co-integration Method, Vector Error Correction Model (VECM) and Rolling Window Regression Analysis. Empirical results suggested long run relationship between money supply, agricultural prices, industrial prices and exchange rate in the case of Pakistan. The VECM demonstrates that agricultural prices adjusted faster than industrial prices in the long run due to the short run changes in money supply and exchange rate. The rolling regression results suggested that after 2004 the depreciation of local currency was the main reason to sharply increase the agricultural and industrial product prices.

Key words: Money supply, exchange rate, agricultural prices, industrial prices.

INTRODUCTION

The empirical literature of agricultural economics demonstrates that the researchers investigate the relationship between the monetary variables and agricultural product prices by using the co-integration methods. In the half of eighties number of studies confirms the impact of money supply on agricultural prices in develop countries (Bessler, 1984; Orden, 1986; Devadoss and Meyers, 1987; Orden and Fackler, 1989) by using the Granger causality test, forecast error decomposition and innovation accounting methods. Now the newly literature indicate that the researcher analyze the association between the money and agricultural prices in develop and developing countries by the used of modifying Granger Causality test, Toda Yam Motto, JJ co-integration, Vector Error Correction (VEC) Autoregressive Distributed Lag (ARDL) approach (Saghaian et al., 2002; Ivanova et al., 2003; Cho et al., 2004; Peng et al., 2004; Hye, 2009).

Taylor and Spriggs (1989) support the previous findings of Bordos (1984), Frankel's (1986), Devadoss and Meyers

(1987) that agricultural prices has faster response than manufacturing product prices in the short run to a change in money supply. They used the vector autoregressive (VAR) technique in order to provide the empirical evidence. Saghaian et al. (2002) developed overshooting hypothesis by including the agricultural prices in the Dornbusch's (1976) model. They utilized Johansen's co-integration and Vector Error Correction Model (VECM) to examine the overshooting hypothesis in the case of USA. They have rejected money neutrality and also suggested agricultural prices adjust faster than industrial prices to monetary shock in the short run. This overshooting hypothesis widely tested by the researchers in the later empirical studies. Bakucs and Ferto (2005) used JJ co-integration and Vector Error Correction Model (VECM) in the case of transition economy. They found the long run relationship between the agricultural prices, industrial prices, exchange rate and money supply. With the help of VECM they also concluded that the agricultural prices faster adjusted than compare to industrial prices to the monetary shock in the short run. Bakucs and Ferto (2009) examined Saghaian et al. (2002) hypothesis in the case of Hungary by using the same techniques that was employed by the Saghaian et al. (2002) and Bakucs and Ferto (2005). They supported the previous findings that the agricultural prices adjusted faster than the industrial prices due to monetary shock.

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Table 1. Correction matrix.

	LAP	LIP	LEX	LMS
LAP	1.00			
LIP	0.99	1.00		
LEX	0.97	0.97	1.00	
LMS	0.99	0.99	0.97	1.00

Hye (2009) used JJ co-integration and Toda Yamamoto Modified Granger Causality Test to examine the relationship between the agricultural prices and money supply in the case of Pakistan. He found that money supply causes agricultural prices and long run elasticity of agricultural prices with respect to money supply is 0.79. This study aims to examine Saghaian et al. (2002) hypothesis in the case of Pakistan. The present study is different from the previous of Hye (2009) in two ways. First, this study considers agricultural prices, industrial prices, exchange rate and money supply but previous study (Hye, 2009) only considers money supply and agricultural prices under empirical investigation. Second, it can be used in the old and relatively new co-integration techniques like JJ co-integration, Vector Error Correction Model (VECM) and Rolling Window estimation method. The outline of the remaining paper as follows. Section-B presents data and estimation methods. Section-C discusses estimation results and final section-D represents conclusion.

DATA AND ESTIMATION METHODS

The quarterly data of agricultural and industrial price index is derived by the author's. The annually data of real and nominal GDP of agricultural and industrial have taken from various publication of State Bank of Pakistan. Quarterly Money supply (in million of Rs.) and exchange rate (Rs./$) have taken from the International Financial Statistic (IFS). Table 1 shows the correction matrix. The results demonstrate that variables are highly correlated with each other.

Estimation methods

Ng-Perron (2001) unit root test has employed by this empirical work to determine the order of integration. The main advantage of this unit root test is that it gives reliable results in the case of small samples. Ng and Perron (2001) has based on four test statistics that is, modified forms of Phillips and Perron Z_α and Z_t statistics, the Bhargava (1986) R_1 statistic, and the ERS point optimal statistic. We write modified statistics as follows:

$$MZ_\alpha^d = (T^1 y_T^d)^2 - f_0)/2k$$

$$MZ_t^d = MZ_\alpha \times MSB$$

$$MSB^d = (k/f_0)^{1/2}$$

$$MP_T^d = (\bar{c}^2 k - \bar{c} T^1)(y^d T)^2 / f_0 \quad \text{if } x_t = \{1\}$$

$$MP_T^d = (\bar{c}^2 k + (1 - \bar{c}) T^1)(y^d T)^2 / f_0 \quad \text{if } x_t = \{1, t\}$$

where,

$$k = \sum_{t-2}^{T} (y_{t-1}^d)^2 / T^2$$

$$\bar{c} = -7 \quad \text{if } x_t = \{1\}$$

And

$$\bar{c} = -13.5 \quad \text{if } x_t = \{1, t\}$$

Like other unit root test the null hypothesis of unit root can be rejected if the test statistic is higher than the critical value. After determining the order of integration then long run relationship is explored by using the Johansen (1991; 1995) co-integration test. This co-integration method is based on λ_{trace} and λ_{max} statistics. Engle and Granger (1987) show regulatory conditions under the co-integrated process Z_t can be formulated as a Vector Error Correction Model (VECM):

$$\Delta Z_t = \mu_0 + \Gamma_1 \Delta Z_{t-1} + \Gamma_2 Z_{t-2} + \cdots + \Gamma_{\rho-1} \Delta Z_{t-(\rho-1)} + \Pi Z_{t-1} + v_t \quad\quad\text{---(1)}$$

The Johansen decomposed Π into two matrices γ and δ, both of which are $\rho \times r$ matrices $(r < \rho)$ such that $\Pi = \gamma \delta'$ and so the rows of δ may be defined as the r distinct co-integration vectors. The Johansen proposed first 'Trace test' co-integration rank r such that:

$$\lambda_{trace} = -T \sum_{j=r+1}^{n} In(1 - \hat{\lambda}_j)$$

Second, λ_{max} maximum number of co-integrating vectors against $r+1$ presented in the following way:

$$\lambda_{max}(r, r+1) = -T In(1 - \hat{\lambda}_j)$$

Table 2. Results of NG-perron unit root test.

	MZa	MZt	MSB	MPT
At level				
LAP	-7.49	-1.81	0.24	12.46
LIP	-11.86	-2.41	0.21	7.84
LER	-3.91	-1.24	0.32	21.32
LMS	-9.33	-2.13	0.23	9.88
At 1st Difference				
ΔLAP	-70.73*	-5.94	0.06	1.29
ΔLIP	-73.11*	-6.04	0.09	1.24
ΔLER	-74.46*	-6.11	0.11	1.22
ΔLMS	-24.48*	-3.49	0.14	3.73

*: 1% level of significance. Next, we apply the JJ cointegration approach in order to determine the long run relationship among the variables.

Johansen (1995) also recognized λ_{trace} and λ_{max} critical values. If the λ_{trace} and λ_{max} results show the different co-integration vector, then the result of λ_{trace} has valid that proposed by Johansen (1995). Thus, this study is used by the λ_{trace} to estimated the long run relationship among the variables.

Vector error correction model

Vector Error Correction Model (VECM) can write as follows:

$$
\begin{bmatrix} \Delta LAP \\ \Delta LIP \\ \Delta LEX \\ \Delta LMS \end{bmatrix} = \begin{bmatrix} \Pi_1 \\ \Pi_2 \\ \Pi_3 \\ \Pi_4 \end{bmatrix} + \sum_{j=1}^{k} \begin{bmatrix} n_{1j} & n_{12j} & n_{13j} & n_{14j} \\ n_{21j} & n_{22j} & n_{23j} & n_{24j} \\ n_{31j} & n_{32j} & n_{33j} & n_{34j} \\ n_{41j} & n_{42j} & n_{43j} & n_{44j} \end{bmatrix} \begin{bmatrix} \Delta LAP_{t-j} \\ \Delta LIP_{t-j} \\ \Delta LEX_{t-j} \\ \Delta LMS_{t-j} \end{bmatrix} + \begin{bmatrix} \Psi_1 \\ \Psi_2 \\ \Psi_3 \\ \Psi_4 \end{bmatrix} ecm_{t-1} + \begin{bmatrix} \varpi_1 \\ \varpi_2 \\ \varpi_3 \\ \varpi_4 \end{bmatrix}
$$

The error correction terms represents the speed of adjustment from short run disequilibrium to long run equilibrium. Higher error correction term in absolute form has represented the higher level of adjustment. Where, EC_{t-1} (in Equation 2) is the error correction term and if it is negative and statistically significance that confirms the long run relationship and also show the speed of adjustment from short run disequilibrium to long run equilibrium. This study also uses the rolling window estimation approach to analysis the stability of coefficients over the sample size. The rolling window regression method estimates the coefficient of each observation over the sample by fixing the window size. But the other econometric tools assumes that coefficients of the model constant over the sample. On the other hand, the economic condition and economic policies change over the time as a result the economic variables cannot remain same. So, the rolling window regression method captures this instability by estimating the coefficient of each observation.

C-ESTIMATION RESULTS

The present empirical inquiry verifies the level of integration by using the relative new Ng- Perron unit root test. The result demonstrate that LAP, LIP, LEX and LMS are integrated order one. Table 3 part: (a) shows the results of JJ approach to co-integration and part (b) shown the long run estimates of co-integrated vectors that estimated by using the vector error correction technique. In part-a, the no co-integration (r = 0) is rejected because the calculated value of Trace statistic is (135.88) above the critical value (76.97). Thus, we reject no co-integration (r = 0) at 0.00% level of significance. We also rejected null hypothesis in the case of r ≤ 1 and r ≤ 2 on the basis of comparing the calculated and critical values. Thus, we conclude that there are three co-integrating relationship among the fours variables. Part-b shows the long run slope coefficients that demonstrate easy monetary policy positively associated with agricultural, industrial product prices and exchange rate. The one percent (%) increase in money supply causes an increase in exchange rate, agricultural and industrial product prices, respectively 48, 61 and 59%. The results of Vector error correction model are shown in Table 4. The error correction terms (ECT) represent the speed of adjustment from short disequilibrium to long run equilibrium. In all three co-integrated equations the coefficient of error term has required negative sign and statistically significant. The first co-integrating equation of agricultural prices demonstrates ECT coefficient is '0.35' which is higher to the other co-integrated equations of industrial prices (Equation 2) and exchange rate (Equation 3). The agricultural price, industrial prices and exchange rate have adjusted, respectively, at the rate of 35, 25 and 19% on every quarter. This finding 'agricultural prices adjusted faster than industrial prices' to the shock of monetary policy has supported the results

Table 3. Results of JJ cointegration and vector error correction.

JJ cointegration				
Null hypothesis	**Alternative hypothesis**	**Trace statistic**	**5% critical value**	**Prob.**
r = 0	r ≥ 1	67.38	40.18	0.00
r ≤ 1	r ≥ 2	34.29	24.28	0.00
r ≤ 2	r ≥ 3	15.46	12.33	0.02
r ≤ 4	r ≥ 5	0.02	4.12	0.93
Long run coefficients of cointegrated vectors				
Cointegration Eq:		**CointEq1**	**CointEq2**	**CointEq3**
LAP(-1)		1.00	0.00	0.00
LIP(-1)		0.00	1.00	0.00
LEX(-1)		0.00	0.00	1.00
LMS(-1)		-0.61 (-13.92)	-0.59 (-25.26)	-0.48 (-9.05)
Constant		11.49(9.37)	11.32 (17.35)	8.77 (5.81)

Table 4. Results of vector error correction model.

Error correction	Δ **LAP**	Δ **LIP**	Δ **LEX**	Δ **LMS**
CointEq1	-0.35 (-2.78)	-0.14 (-1.32)	0.29 (2.78)	-0.27 (-1.76)
CointEq2	0.19 (0.92)	-0.25 (-1.47)	-0.31 (-1.74)	0.47 (1.92)
CointEq3	0.14 (2.51)	0.18 (3.59)	-0.19 (-3.98)	-0.07 (-0.93)
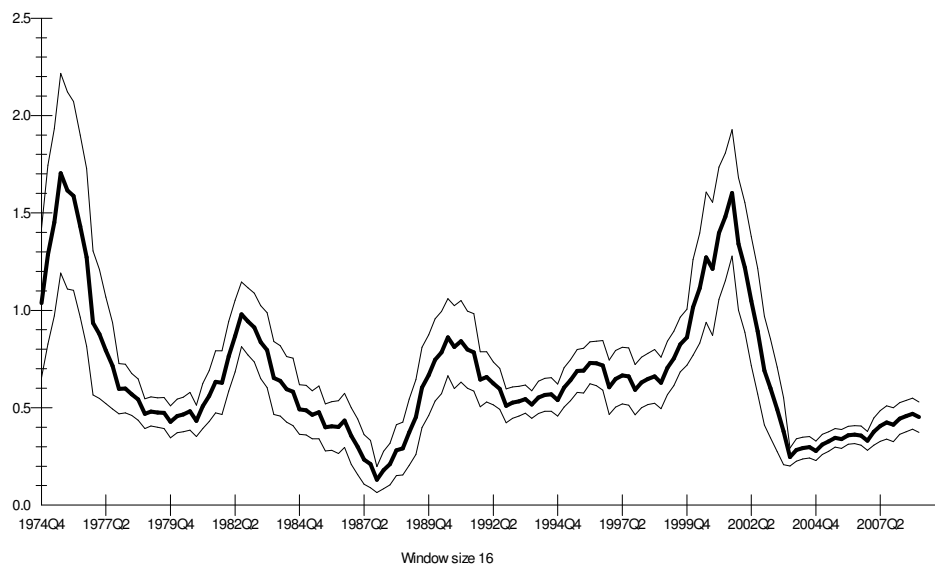
Figure 1. Coefficient of LMS (Dependent variable: LAP).

of previous studies by Saghaian et al. (2002) and Bakucs and Ferto (2009).

Rolling window results

Through rolling window estimation method this study estimate the coefficient of each observation. Figure 1 to 4 showed the plot of estimated coefficients. Figure 1 demonstrates that the cyclical impact of money supply on agricultural prices. The elasticity of agricultural prices with respect to money supply remained greater than one only in the years of 1975 and 2001, and show sharp decline in 2002. Then, steady increases in 2003 to 2008, but elasticity
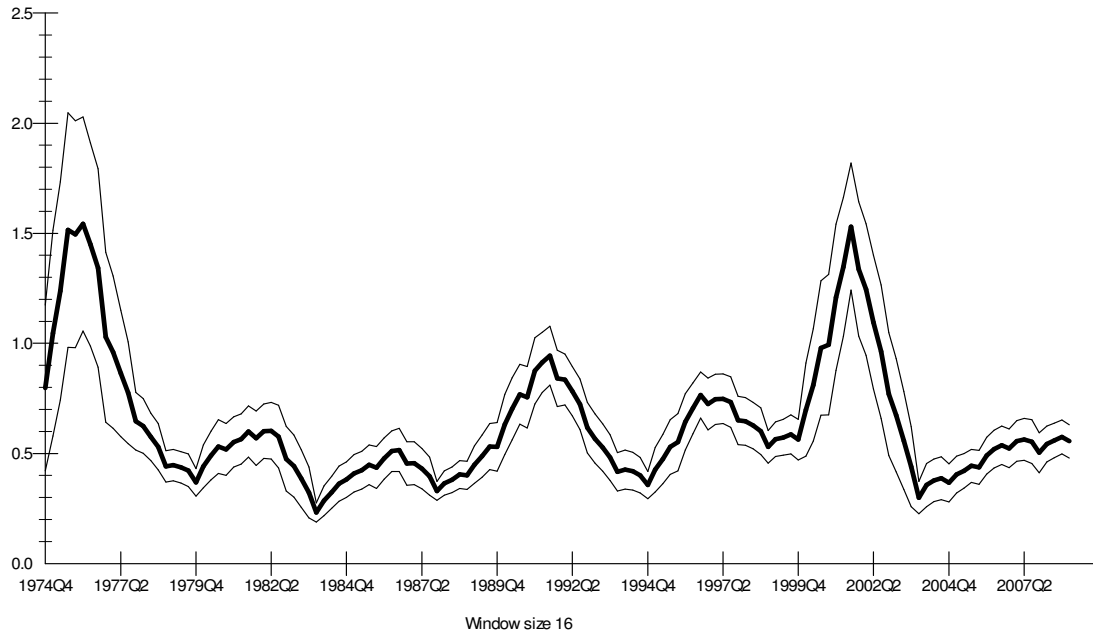
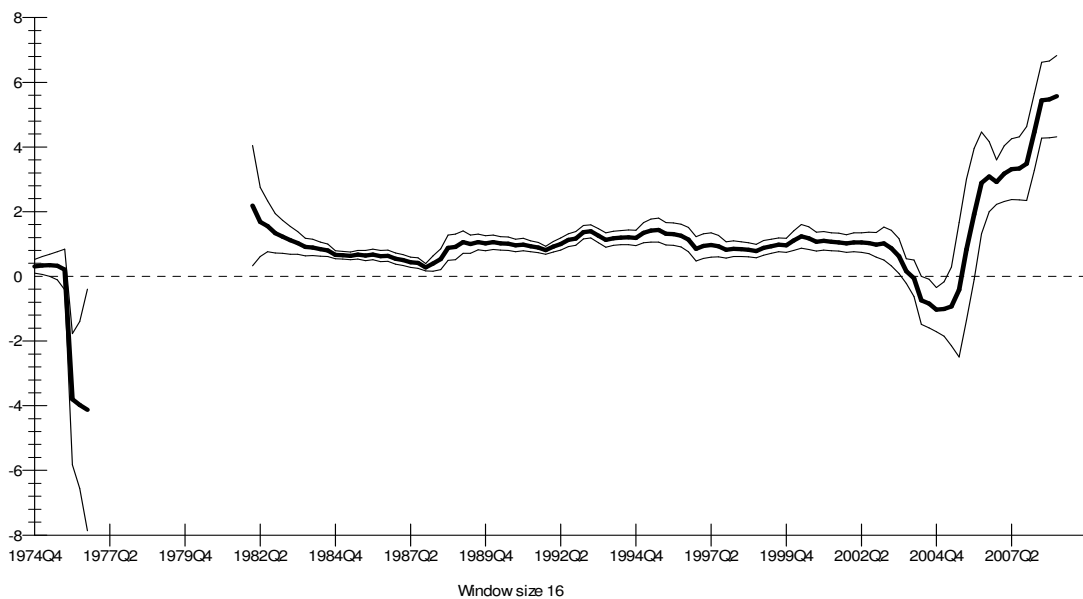**Figure 2.** Coefficient of LMS (Dependent variable: LIP).

Figure 3. Coefficient of LER (Dependent variable: LAP).

less that 0.5. The elasticity of industrial prices with respects to money supply is shown in Figure 2. The elasticity is greater than one only in the years of 1975 and 2002 and sharply decline in 2003. Figure 3 and 4 indicate the impact of exchange rate on agricultural and industrial prices. After 2004 the elasticity of agricultural and industrial prices with respect to exchange rate increases sharply, but industrial prices are more sharply increases as compare to industrial prices in that period.

Conclusion

This study aims to test the Saghaian et al. (2002) hypothesis by using the JJ co-integration method, Vector Error Correction Model (VECM) and rolling window regression analysis. The results confirm the long run relationship among the money supply, agricultural prices, industrial prices and exchange rate in the case of Pakistan. There are three co-integrating vector that are
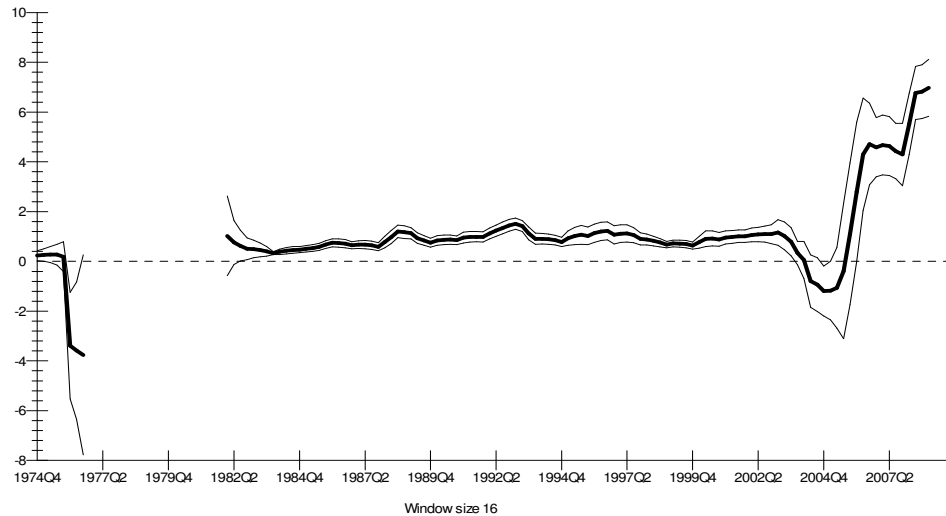
Figure 4. Coefficient of LER (Dependent variable: LIP).

found in the four variable. The one percent (%) increase in money supply cause to increase in exchange rate, agricultural and industrial product prices, respectively 48, 61 and 59%. VECM demonstrates that agricultural prices adjusted faster than industrial prices in the long run due to the short run changes in money supply and exchange rate. The rolling regression results suggested elasticity of agricultural and industrial prices with respect to exchange rate increases sharply after 2004 and coefficient of industrial product prices rapidly increases as compare to agricultural prices in that period.

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