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Money, Output, and Inflation: Evidence from Pakistan

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1. INTRODUCTION

Pakistan has experienced inflationary episodes in the last thirty years. "Why has inflation been high in some of the periods?" is a debatable question. There are at least three possible candidate answers to this question; monetary policy actions, supply side factors and/or inflation in the rest of the world (trading partner countries). To test whether monetary policy actions are responsible for episodes of high inflation is the objective of this study. Khan and Schimmelpfennig (2006) studied the relative importance of monetary factors and supply side factors for inflation and found that monetary factors had played dominant role in inflation determination. Agha, *et al.* (2005), while studying transmission mechanism in Pakistan, found that inflation and output respond significantly to shocks in monetary policy instrument. However both studies depend on small data set.

In this study Near-VAR approach has been used to model inflation, real GDP gap and reserve money and then impulse response functions are estimated by imposing restrictions consistent with economic theory, [Enders (2004); Sims (1986)]. Our results show the standard hump shaped response of output and inflation to monetary policy shock, reaching at peak after several quarters. Next Granger causality test is applied to test the direction of causality between inflation and reserve money and real GDP gap and reserve money. It is seen that inflation is Granger caused by reserve money but not the other way around. This result does not hold in case of reserve money and real GDP gap.

Remaining study is organized as follows: Section 2 describes some basic statistical measures that reveal some important information about output, inflation and reserve money. Section 3 deals with estimation methodology. Data issues and estimation results of Near-VAR model and Granger causality are given in Section 4. Finally Section 5 concludes the paper.

2. SOME PRELIMINARIES

Before going in to sophisticated techniques, in this section some basic results are presented that give some important information about the variables included in the study. Although variables used in the study are taken at level, except CPI, and not the growth rates but to see the brief history some basic measures of growth rates of reserve money,

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real GDP and CPI are presented in Table 1. Average inflation was about 9 percent with standard deviation of 5.92 over the period 1975-2003. We can see that on average inflation and inflationary gap are very close to each other and except GDP growth rate all other variables (inflation, monetary growth rate and inflationary gap) have almost same volatility with standard deviation ranging from 5.70 to 5.97. It is clear from the table that inflation and one period lagged values of monetary growth rate, real GDP growth rate and inflationary gap are correlated moderately with the highest value of 0.29 in case of inflation and monetary growth rate. One basic result that we can draw from here is that inflation in Pakistan is correlated with and hence caused by monetary expansion. In Section 4, Granger causality test has been used to confirm this result.

Table 1

Some Basic Statistical Measures (1975–2003)

	CPI Inflation	Monetary Growth	GDP Growth	Inflationary Gap*
Mean	9.37	15.54	5.09	10.45
Minimum	3.10	3.60	1.70	1.50
Maximum	29.00	26.20	8.70	22.50
Range	25.90	22.60	7.00	21.00
Standard Deviation	5.92	5.97	1.90	5.70
Correlation with CPI**	1.00	0.29	0.21	0.23

* Inflationary gap is calculated as real GDP growth rate minus monetary growth rate.

** Correlation between current inflation and one period lagged values of the other variable.

Figure 1 shows the long run behaviour of detrended and seasonally adjusted real GDP, reserve money and annualized inflation from seasonally adjusted CPI. We can see that the movement is much correlated in case of inflation and money. Both are above their long run trend in periods 1978-81 and 1992-98. Although the long run co-movement of reserve money and inflation seems similar in direction the problem is to find what precedes what. Impulse response functions and Granger causality in Section 4 help finding the direction.

3. ESTIMATION METHODOLOGY

Consider the following three variables structural VAR,

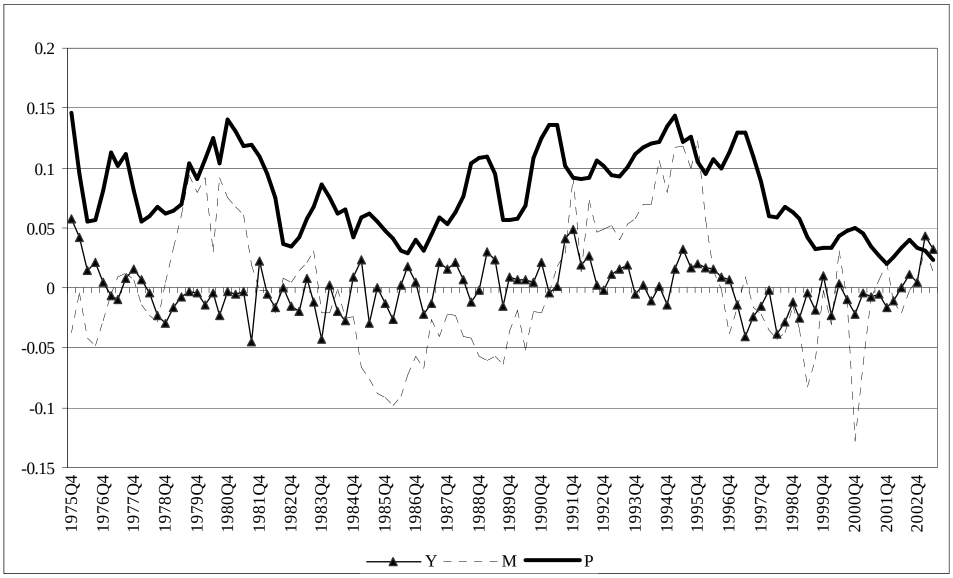
$$BX_t = B_0 + \sum_{i=1}^{p} C^i X_{t-I} + \xi_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

Where X_t is a vector given by,

$$X_t = [p_t\ y_t\ m_t]'$$

Where p_t is annualized CPI inflation, y_t is real GDP gap and m_t is reserve money. B is a matrix of coefficients with one on the diagonal and capturing the contemporaneous effects of variables on each other. B_0 is a vector of constant terms. C^i are the matrices of coefficients measuring the lagged effects of variables on each other. ξ_t is a vector of error terms that contains zero mean, constant variance and serially as well as cross uncorrelated innovations, i.e. these elements represent pure structural shocks. Equation 1 can be converted into standard reduced form VAR with only lagged variables on the right hand side.

Fig. 1. Real GDP, Reserve Money, and CPI Inflation



$$X_t = A_0 + \sum_{i=1}^{p} A_i X_{t-i} + e_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

Where, $A_0 = B^{-1} B_0$

$A_i = B^{-1} C^i$

and $e_t = B^{-1} \xi_t$

Here e_t contains the elements that have zero mean, constant variance and are serially uncorrelated. However, these errors might be contemporaneously correlated, i.e.

$E(e_{jt}) = 0$,

$Var(e_{jt}) = \sigma_j^2$,

$Cov(e_{jt}, e_{jt-1}) = 0$,

but $Cov(e_{jt}, e_{kt})$ may or may not be equal to zero.

Now the problem is to estimate Equation 2 and then using these estimated parameters to identify the structural parameters and to recover structural shocks from Equation 1 by imposing appropriate restrictions on structural parameters. Equation 2 can be estimated by OLS because right hand side variables of all equations are same. However if we allow different lag length in different equations then the system has to be estimated as seemingly unrelated (SUR) model, [Enders (2004)]. If the objective is to just identify monetary policy shocks then the assumption that the reserve money has no contemporaneous effect on output and inflation is enough, see for instance in Bernanke (1992); Bernanke and Mihov (1998); Giannoni and Woodford (2003); Christiano, *et al.* (2001) among others. However the appropriate number of restrictions to make model exactly identified is $\left(\frac{n^2-n}{2}\right)$, where n is the number of variables in the VAR, [Enders (2004)]. As we are primarily interested in estimating the impulse response functions of inflation and output to monetary policy shocks, the restriction that the reserve money has no contemporaneous effect on output and inflation is just enough. Here the monetary policy shocks are estimated residuals from the last equation in the system of Equations 1.

4. DATA AND ESTIMATION RESULTS

Quarterly data on CPI inflation, real GDP and reserve money are used for the period 1975:03 to 2003:02. Data on reserve money and CPI are taken from International Financial Statistics (IFS) and that on real GDP from Kemal and Arby (2004). First the data are seasonally adjusted and then real GDP and reserve money are detrended. Detrended GDP can be used as a measure of output gap, [see for example Giannoni and Woodford (2003); Taylor (1993)]. Inflation is calculated by annualized percentage change in CPI.

In estimation first of all the presence of unit root in deseasonalised and detrended series is investigated. Hylleberg, *et al.* [HEGY (1990)] test is applied separately to each series and lag lengths are chosen on the basis of removing autocorrelation from the test equation. Breusch-Godfrey Serial Correlation LM test is used for this purpose. There should be no autocorrelation in the residuals of unit root test equation if proper lag length is selected. As the data is deseasonalised and detrended, neither seasonal dummies nor deterministic trend are included in the HEGY test equation in case of all the three series. The results show that all the three variables; real GDP gap, reserve money and inflation are stationary at level or we can say that these are integrated of order zero. Same results are obtained at bi-annual and seasonal frequencies. There are neither seasonal nor bi-annual unit roots in all of the three series as given in Table 2.

Table 2

Unit Root Test (HEGY)

Coefficients	HEGY Test Statistic			5% Critical Values
	CPI Inflation	Real GDP Gap	Reserve Money	
π_1	–2.4159	–2.5610	–3.4441	–1.93
π_2	–4.1918	–3.8016	–2.0557	–1.94
π_3	–3.9907	–7.3992	–3.2289	–1.92
π_4	–4.8239	–0.6129	0.3597	–1.99
		F-Statistic		
π_3, π_4	18.6336	27.8117	5.2639	3.14

Note: Same results for Unit Root at zero frequency are obtained when other tests are applied like, Augmented Dickey and Fuller (ADF) Test, The Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) Test and Phillips and Perron (PP) Test.

To model the three variables, VAR in levels is applied. OLS gives efficient parameter estimates as long as the right hand side variables are same in all equations. At the same time over parameterization in VAR can be avoided by allowing different lags in different equations. But in that case the so called Near-VAR is estimated as a SUR model. Here a variant of this approach is used by including only those lagged variables in Near-VAR that have statistical significance and then the system is estimated as SUR model. However the significance level is relaxed to 10 percent. We have estimated both the simple VAR and Near-VAR in levels but results reported here in Table 3 are those of Near-VAR approach because same impulse response functions have been obtained in the other case.

Table 3

Near-VAR Results

Dependent Variable Inflation (P)			Dependent Variable Real GDP (Y)			Dependent Variable Reserve Money (M)		
Regressors	Parameter Estimates	Standard Errors	Regressors	Parameter Estimates	Standard Errors	Regressors	Parameter Estimates	Standard Errors
Const	0.0129	0.0044	Mt-2	0.069	0.043	Mt-1	0.831	0.067
Mt-3	0.0659	0.0282	Mt-4	-0.075	0.043	Mt-4	–0.184	0.102
Yt-2	0.1816	0.067	Yt-1	0.336	0.086	Mt-5	0.225	0.092
Pt-1	0.962	0.048	Yt-3	0.2	0.088	–	–	–
Pt-4	–0.508	0.084	Pt-4	0.258	0.097	–	–	–
Pt-5	0.385	0.075	Pt-5	–0.263	0.096	–	–	–

Note: Results of VAR are about the same as for as the statistical significance of variables is concerned.

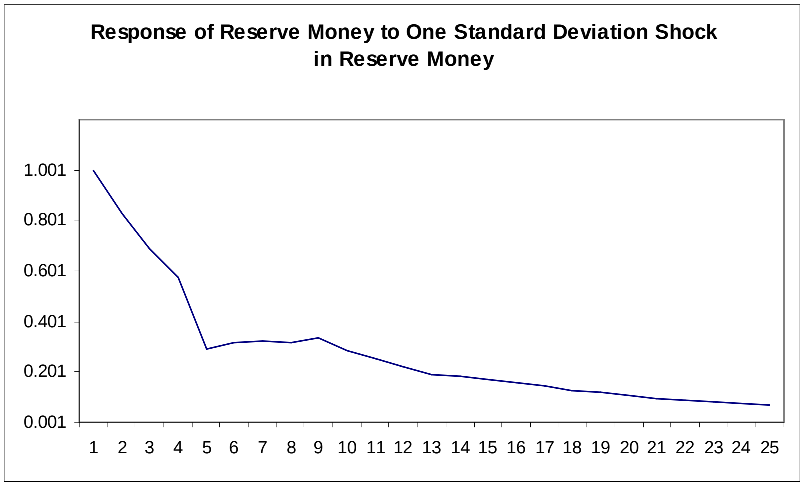
The important result is that reserve money does not respond to lagged values of both inflation and output gap. It means in deciding the stock of money each year central bank does not consider the past state of the economy. It might be the case that central bank, while deciding the stock of money, considers the next period's target growth rates of inflation and growth.

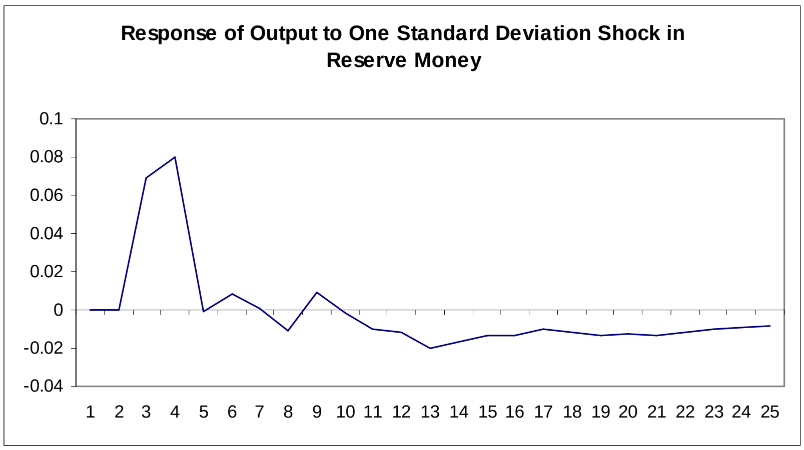
By imposing identifying restrictions discussed in Section 3, we next estimate the impulse response functions. Responses of reserve money, output and inflation to one standard deviation shock in all the three series are computed.

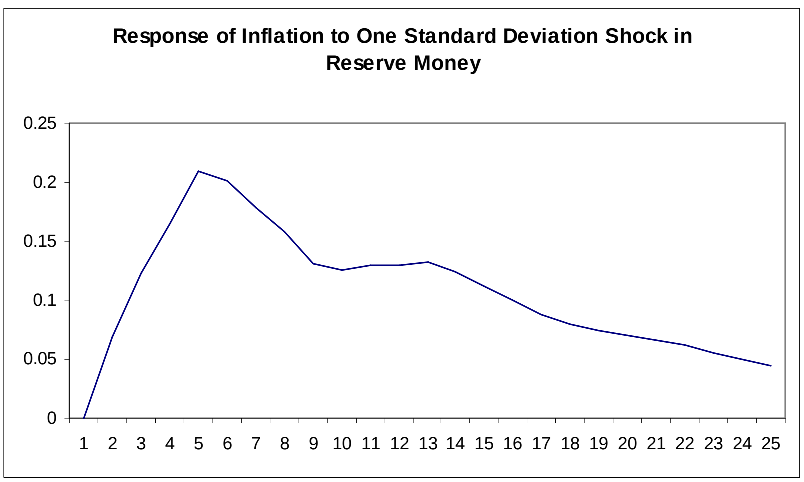
The following results (given in Figure 2) are obtained:

- Reserve money responds to shock in reserve money immediately by the magnitude of shock and that response dies out to one fourth of the magnitude of shock in one year.
- Standard hump shaped response of real GDP gap to shock in reserve money is obtained. The response started after one quarter, reaching the peak in one year and then coming to zero in about one and half year.
- Inflation also responds in the same way to shock in reserve money, starting the effect after two quarters and reaching the peak after one and half years.

The important result that we draw from here is that inflation responds positively to monetary shocks. It means money is an important determinant of inflation in Pakistan. This result is in line with that of Khan and Schimmelpfennig (2006).


Response of Reserve Money to One Standard Deviation Shock in Reserve Money
1.001
0.801
0.601
0.401
0.201
0.001
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25


Response of Output to One Standard Deviation Shock in Reserve Money
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25


Response of Inflation to One Standard Deviation Shock in Reserve Money
0.25
0.2
0.15
0.1
0.05
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

Finally to test the direction of causality and to see whether our result that inflation is caused by monetary expansion is true, we apply the Granger causality test. It is not the test of causality as such, however, [Maddala (1998)]. But by applying this test we can at least find, which variable takes the precedence over the other. This is exactly what the Granger causality test is. Test results confirm to what we have found in other test results. Causality is found between only two variables, i.e. inflation and reserve money and this causality is uni-directional. Only inflation is Granger caused by reserve money and result is not true the other way around. Reserve money is caused neither by output gap nor by inflation. Similarly reserve money does not Granger cause output gap. Results on Granger causality are given in Table 4. In all of the above discussion one result is found exclusively that inflation is caused by monetary expansion but most of the times monetary authority does not respond to previous period's high inflation.

Table 4

Granger Causality Test

	Chi-square	Probability
M does not Granger Cause P	5.45*	0.0196
M does not Granger Cause Y	3.31	0.1912
P does not Granger Cause M	0.00	1.0000
Y does not Granger Cause M	0.00	1.0000

5. CONCLUSION

Why have inflation been high in some of the periods in Pakistan? Three possible arguments can be given; monetary policy actions, supply side factors, foreign inflation. This study tests the first argument using Near-VAR approach. Results show that the effect of monetary policy transmits into inflation with a lag of half year and then take another year to reach at the peak. In episodes of high inflation monetary authority's degree of leaning against the wind is almost zero. Why is this so? There are at least two possible explanations. First, it might be the case that central bank, while deciding on the growth of money, gives more weight to future target level of inflation and growth rate of real GDP and ignores the previous deviations of inflation and real GDP from their trends. Second, it can be argued that monetary authority does so due to the fear of loosing higher growth. To say some thing with greater certainty, regarding the first one, a study is needed that would focus on target growth rates of real output and prices rather than the gaps. If the second is true, that may not be a right action however. Flexible inflation targeting can help improving the situation. A limited past history show that countries adopting inflation targeting achieved lower inflation without hampering output growth. However there are some pre-requisites for inflation targeting. A detailed study is needed to investigate with the help of simulations, whether the performance of inflation and output (in terms of their variability) would have been improved had we adopted inflation targeting rule. Also there is a need for a study that investigates the determinants of inflation variability by considering all the three factors discussed above.

APPENDIX

Consider the following system of equations:

$$p_t = b_{01} - b_{12}\, y_t - b_{13}\, m_t + \gamma_{11}^{i}\, p_{t-i} + \gamma_{12}^{i}\, y_{t-i} + \gamma_{13}^{i}\, m_{t-i} + \varepsilon_{p_t}$$

$$y_t = b_{20} - b_{22}\, p_t - b_{23}\, m_t + \gamma_{21}^{i}\, p_{t-i} + \gamma_{22}^{i}\, y_{t-i} + \gamma_{23}^{i}\, m_{t-i} + \varepsilon_{y_t}$$

$$m_t = b_{30} - b_{32}\, p_t - b_{23}\, y_t + \gamma_{31}^{i}\, p_{t-i} + \gamma_{32}^{i}\, y_{t-i} + \gamma_{33}^{i}\, m_{t-i} + \varepsilon_{m_t}$$

This system can be written in matrix form structural (VAR) as:

$$\begin{bmatrix} 1 & b_{12} & b_{13} \\ b_{21} & 1 & b_{23} \\ b_{31} & b_{32} & 1 \end{bmatrix} \begin{bmatrix} p_t \\ y_t \\ m_t \end{bmatrix} = \begin{bmatrix} b_{10} \\ b_{20} \\ b_{30} \end{bmatrix} + \begin{bmatrix} \gamma_{11}^{i} & \gamma_{12}^{i} & \gamma_{13}^{i} \\ \gamma_{21}^{i} & \gamma_{22}^{i} & \gamma_{23}^{i} \\ \gamma_{31}^{i} & \gamma_{32}^{i} & \gamma_{33}^{i} \end{bmatrix} \begin{bmatrix} p_{t-1} \\ y_{t-1} \\ m_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{p_t} \\ \varepsilon_{y_t} \\ \varepsilon_{m_t} \end{bmatrix}$$

$$\Rightarrow \; BX_t = B_o + \gamma^i X_{t-i} + \varepsilon_t$$

which can be written in standard reduced form VAR as:

$$X_t = B^{-1}B_o + B^{-1}\gamma^i X_{t-i} + B^{-1}\varepsilon_t$$

$$\Rightarrow \; X_t = A_o + \sum_{i=1}^{p} A_i X_{t-i} + \varepsilon_t$$

$$\Rightarrow \; X_t = A_o + A_1 X_{t-1} + \ldots\ldots\ldots\ldots\ldots\ldots + A_p X_{t-p} + \varepsilon_t$$

To recover the structural innovations of monetary policy from estimated reduced form VAR, following identifying restrictions are imposed:

$$b_{13} = 0 \; and \quad b_{23} = 0$$

In this case the matrix B becomes:

$$B = \begin{bmatrix} 1 & b_{12} & 0 \\ b_{21} & 1 & 0 \\ b_{31} & b_{32} & 1 \end{bmatrix}$$

REFERENCES

Agha, I. A., N. Ahmed, Y. A. Mubarik, and H. Shah (2005) Transmission Mechanism of Monetary Policy in Pakistan. *SBP Research Bulletin* 1: 1, 1–24.

Barro, R. J. (1995) Inflation and Economic Growth. *Bank of England Quarterly Bulletin*. May. 39–52.

Bernanke, Ben S. and Ilian Mihov (1998) Measuring Monetary Policy. *Quarterly Journal of Economics* 113:3, 869–902.

Bernanke, Ben S., and Alan S. Blinder (1992) The Federal Funds Rate and the Transmission of Monetary Policy. *American Economic Review* 82, 901–921.

Christiano, Lawrence J., Martin S. Eichenbaum, and Charles L. Evans (2001) Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy. (NBER Working Paper No. 8403, July.)

Enders, Walter (2004) Applied Econometric Time Series. John Wiley & Sons, Inc.

Giannoni, M. P. and M. Woodford (2003) Optimal Inflation Targeting Rules. (NBER Working Paper No. 9939.)

Janjua, M Ashraf (2004) History of the State Bank of Pakistan, 1977-1988—1988-2003. State Bank of Pakistan.

Kemal, A. R. and Farooq Arby (2004) Quarterisation of Annual GDP of Pakistan. Pakistan Institute of Development Economics, Islamabad. (Statistical Papers Series, No. 5.)

Khan, M. S. and S. A. Senhadji (2001) Threshold Effects in the Relationship between Inflation and Growth. *IMF Staff Papers* 48:1.

Khan, M. S. and Schimmelpfennig (2006) Inflation in Pakistan: Money or Wheat? (International Monetary Fund Working Paper.)

Maddala, G. S. and I. M. Kim (1998) *Unit Roots, Cointegration and Structural Change.* Cambridge University Press.

McCanless, G. T. Jr. and W. E. Weber (1995) Some Monetary Facts. *Federal Reserve Bank of Minneapolis Quarterly Review* 19: 3, 2–11.

Sidrauski, M. (1967) Rational Choice and Patterns of Growth in a Monetary Economy. *American Economic Review* 71: 3, 534–44.

Sims, Christopher (1980) Are Forecasting Models Usable for Policy Analysis? *Federal Reserve Bank of Minneapolis Quarterly Review* Winter : 3-16.

Taylor, J. B. (1993) Discretion Versus Policy Rules in Practice. *Carnegie-Rochester Conference Series on Public Policy* 39, 195–214.

Taylor, J. B. (1996) How should Monetary Policy Respond to Shocks while Maintaining Long run Price Stability?-Conceptual Issues. In Achieving Price Stability, Federal Reserve Bank of Kansas City, 181–95.

Comments

The author deserves appreciation for undertaking research on a topic that has been a moot point through the past decades. The study confirms the position taken by a number of authors that monetary factors are an important determinant of inflation in Pakistan. The study by employing a more sophisticated econometric technique viz. Near-VAR has given more credence the strand of literature that accords monetary factors an important role in determination of inflation in Pakistan.

This study refers to two recent studies, *viz.*, Schimmelpfennig (2006) and Agha, *et al.* (2005) that have examined the determinants of inflation in Pakistan. More studies that have investigated the issue specifically with reference to Pakistan are available. A brief mention of the results of such studies will add value to the paper.

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