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Dynamic Causal Interactions of Money, Prices, Interest Rate and Output in Pakistan

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Monetary policy has remained one of the most fundamental topics in macroeconomics. Since the beginning of macroeconomic history it has been argued that money has a strong role in affecting the real economic activity but the evidence remains inconclusive. Considerable empirical evidence has been produced on the stance of monetary policy using different approaches and still the process continues. The present study investigates the dynamic interactions among macroeconomic variables such as money supply, prices, interest rate, exchange rate and output level, using the quarterly data for Pakistan over the period 1972Q1 to 2009Q4. For the empirical analysis the Johansen multivariate cointegration technique, Granger causality test and variance decompositions are employed. The results from the cointegration test indicate that there exits a stable long run equilibrium relationship among the macroeconomic variables of the study. The outcome of causality tests tends to support the non neutrality of money view of the Keynesians and the Monetarists at least in the short run. Furthermore, it is seen that there exists a bi-directional causality between money supply and price level, and interest rate and price level. While, a unidirectional causality runs from money supply to output level and interest rate, the opposite does not happen. The findings tend to indicate that money supply, real output, interest rate and exchange rate is Granger causing prices in the short run as well as in the long run. This implies that inflation is not purely a monetary phenomenon rather structural factors also have a role in affecting price level in Pakistan. Hence, in combating inflation decision makers need not rely exclusively on the instrument of tight monetary policy rather due attention should also be given to the supply side of the economy.

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"Though many macroeconomists would profess little uncertainty about it, the profession as a whole has no clear answer to the question of the size and nature of the effects of monetary policy upon aggregate activity." Sims (1992)

1. Introduction

Considerable empirical literature exists on explaining the links between monetary and real macroeconomic activities. This literature culminates in near consensus on the long term relationship between monetary and real economic activities as the long run neutrality of money is well established in economic literature. However, the short run interactions among the monetary and real variables, which are of vital importance for the conduct of monetary policy, are still widely debated by the economists. While the New Classical economists maintain that prices are flexible and adjust *quickly* to clear the markets, the New Keynesians argue that market-clearing models are unable to explain short run economic fluctuations and believe in *stickiness of prices*. Based on the *sluggish adjustment* of prices, both the Keynesians and the Monetarists recognize the effects of monetary policy on production activities in the short run (Mankiw and Romer 1991). According to this view, if the money supply falls, people spend less money and the demand for goods falls. Because prices and wages are inflexible and do not fall immediately, the decreased spending causes a drop in production and layoffs of workers.

The linkages among money, output, interest rate and prices have been the focus of extensive debate and analysis. Much of the debate among the New Keynesians and the New Classicals is centered on the relative effectiveness of monetary policy for influencing the economy. The discussion however is still inconclusive, past empirical evidence on the relative contributions of money and credit in the propagation of monetary policy impulses still remains ambiguous. Sims (l972, 1980a), Thornton and Batten (1985), King (1983), Stock and Watson (1989), Romer and Romer (1990), Cover (1992), Christiano et.al., (1999) Mishkin (2002), Siregar and Bert (2002), Gilman and Anton (2004), Ravn and Martin (2004), Bernake et al., (2005), Hossain (2005), Dickinson and Jia (2007),Rafiq and Mallick (2008) and many others present evidence of monetary effects. While results of money neutrality

are reported, among others, by Feige and Pearce (1979), Sims (1980b), Litterman and Weiss (1985), Geweke (1986), Friedman and Kuttner (1993), King and Watson (1997), Cochrane (1998), Serletis and Koustas (1998), Ganev et.al., (2002) and Starr (2005).

While considerable evidence exists on the linkages between money and economic activity in developed countries, literature on developing countries is quite limited. In case of Pakistan the analysis on the subject is limited to a few studies: including Hussain (1982, 1991); Chishti et. al.,(1992); Momen (1992); Ahmed (2003); Mehmood and Mohammad (2005); Abbas and Fazal (2006); Khan (2008) ; and Husain and Rashid (2009). However, since these studies are beset with a number of methodological and theoretical shortcomings their findings do not provide reliable estimates as basis to frame effective economic policies, as described in section 2of the study. Hence, the main objective of the present study is to investigate the dynamic causal chain among key aggregate economic variables like stock of money, price level, interest rate and output level in Pakistan considering the methodoligical limitations of the existing literature. In order to examine the dynamic interactions of these variables with the foreign trade sector, we will also incorporate the exchange rate variable as well. For the causal analysis the study employs the Johansen cointegration, the vector error correction model (VECM) and the variance decompositions (VDCs) techniques.

The rest of this paper is organized as follows: section 2 presents a brief review of the existing studies conducted in Pakistan; analytical framework for this study is given in section 3; section 4 describes the results of the study; and finally section 5 concludes the study with some policy implications.

2. Review of literature

In the empirical literature, the relationship between money, price, and output has been investigated by researchers for different countries over different sample periods and provided the conflicting evidences on this issue. In this section we just confine ourselves to review some of the past studies which have empirically investigated the relationship between money and some important macroeconomic variables in Pakistan. Hussain (1982) is a pioneer investigation into the

interrelationship among money, prices and output in Pakistan. Based on the annual data for the period 1949 to 1970, the study uses a single equation model to test the relative impacts of monetary and fiscal impulses on nominal income. The findings of the study show that the response of economic activity to fiscal actions compared with that of monetary actions is larger, more predictable and faster. However, it is important to note that while the single equation model is simple and easy to estimate, the equations are not derived explicitly from a larger model and therefore important feedback mechanism may be omitted. If the right hand side variables in the equations are not exogenous, the equation may be a part of system of equations where variables are interdependent. This is a serious flaw which renders the study to be a purely academic exercise without any policy substance.

Hussain (1991) applies Sims (1972) causality test procedure for the period 1971 to 1988 for determining the nature of relationship between money and income in Pakistan. M1, M2 and monetary base are used as money variables and GNP for income level. The F-tests are conducted by choosing one year past value and one year future value of the regresses. He summarizes his findings as follows: (i) a unidirectional causality runs from monetary base to GNP; (ii) a unidirectional causality runs from M2 to GNP; and (iii) a unidirectional causality runs from GNP to M1.The results of this study, however, are suspected due to two serious considerations with regard to methodology: (a) Sims test is particularly sensitive to the lag structure but the study reports one period lag without any statistical and economic justification; (b) the F-test used to determine the direction of causality is actually a t-test of a single coefficient. Results based on such methodological anomalies can have serious policy implications.

In the early nineties research on monetary issues in Pakistan adopted the multivariate approach and Chishti et al., (1992) was the first study to apply VAR model to the Pakistani data. The authors used annual data covering the period 1960 to 1988 and estimated a VAR model with ten macroeconomic variables: real GDP, consumer price index, terms of trade between agriculture and manufacturing sectors, unemployment rate, real investment, real value of remittances, real exports, real external resources, money stock and real government expenditure. The results showed that F-tests for causality found a unidirectional causality running

from money to output and price does not cause money but money does cause price. The Impulse response analysis revealed that money produced a strong positive impact on real GDP and general price level. A major limitation of the study is that it includes too many variables when data on variables spans only from 1960 to 1988. To save degrees of freedom lag length is truncated to only two periods, which is not sufficient to capture the dynamics of the issues involved. Furthermore, when too many variables are included in a VAR model, additional complications arise; the simultaneous relations among different variables and policy innovations make it difficult to correctly identify the shocks.

Momen (1992) has conducted a study for ten industrial and agricultural countries including Pakistan, for assessing the interaction among the rate of inflation, the rate of change in real gross domestic product, the rate of change in terms of trade, the rate of change in government expenditure and the rate of change in money supply. The study covers the time period from 1958 to 1985.The author constructs a reduced form VAR model where each of the five variables is regressed on past values of itself and past values of the other four variables in the system. He conducts F-tests to determine causal relationship among the variables and concludes that in the industrialized countries causality runs from money supply to real GDP, which is in conformity with the Monetarists view. In agricultural economies including Pakistan, causality runs in the opposite direction. Though this study is theoretically sound but it is subject to two shortcomings: (a) serious questions can be raised about the data set used. The study has used data from 1958 to 1985 for all countries but Bangladesh gained independence in 1971, before that it was a part of Pakistan. Thus, the author uses the same data for both the countries up to 1971, which is faulty and definitely gives misleading conclusions for both Bangladesh and Pakistan; and (b) he does not orthogonalize the shocks which is very important to isolate their effects. He employs the reduced form innovations to compute variance decomposition to draw different conclusions. But if reduced form errors are correlated, which is most likely, this methodology may lead to erroneous conclusions and that the estimated variance-covariance matrix of the errors reflects the seriousness of the problem.

Ahmed (2003) investigates the issue of causality among key aggregate macro-variables by conducting bivariate, multivariate and block causality tests. For Pakistan the study has used the quarterly data from1972-I to 1997-II. Causality tests suggest that bidirectional causality exists between money and prices in Pakistan. The policy implication of such a result is that an increase in money stock fuels prices in Pakistan, which in turn leads to an increase in money stock. This study has accurately conducted causality analysis among key aggregate macro-variables but for some reasons it ignores the dynamic analysis; it does not apply a single measure of dynamic analysis such as variance decompositions (VDCs) and impulse response functions (IRFs).

Mehmood and Mohammad (2005) attempt to estimate the long run and the short run relationships among the key macroeconomic variables *viz*., money, prices, interest rate and output in Pakistan. The study uses annual data over the period 1973 to 2003. Applying Johansen and Juselius (1990) cointegration technique, the study shows that there exists one cointegrating vector among the four variables. On the basis of error correction model (ECM), it is found that a unidirectional causality running from money to output and from money to interest rate exists. However no causality exists between output and interest rate. Money and prices have been found to be independent in the short run. In summary, the study shows that money supply is an appropriate intermediate target (with output growth being the final target) and not the interest rate. This study is a significant improvement over the previous studies, however it is subject to the following shortcomings: (a) though the authors have conducted the F-tests as multivariate tests but actually they are bi-variate causality tests because they consider lagged coefficients of a particular variable in a single equation of the system not the other equations of the model. Only a likelihood ratio test can do this job (see Enders, 2004); (b) the result of ECM indicates the exogeneity or endogeneity of a variable in the system and the direction of Granger-causality within the sample period. However, it does not provide us with the dynamic properties of the system. The analysis of the dynamic interactions among the variables in the post-sample period need to be conducted through variance decompositions (VDCs) and impulse response functions (IRFs) that are missing in the study.

Using annual data for fiscal years 1959 to 2003 and employing cointegration and error correction models as well as the standard Granger causality analysis Abbas and Fazal (2006) investigate the bi-variate and tri-variate causal relationships between money and income and between money and prices in Pakistan. Regarding the causal relationship between money and prices, the causality framework provides the evidence of bi-variate causality indicating that monetary expansion increases, and is also increased by inflation in Pakistan. However, money supply seems to take the lead in this case. But this study is beset with two weaknesses :(a) in the estimated regression equation lagged values of one variable are regressed on another variable. This is essentially a two variable single equation distributed lag model and is seriously subject to omitted variable bias; (b) the study has used the Engle-Granger cointegration approach which is beset with many defects as outlined in different text books (for example, see Asteriou and Stephen, 2007).

A study by Khan (2008) provides an empirical update on the impact of an unanticipated change in monetary policy on output growth and inflation in Pakistan. The study uses monthly data for the period 1991-VII to 2006-IX and adopts multivariate structural vector auto-regressions (SVAR) technique with long run restrictions based on standard aggregate demand and supply model of the economy. The results indicate that an unanticipated positive shock in monetary policy leads to: (i) an increase in industrial output, which reverts to its original level over 23 to 32 months horizon; (ii) an increase in inflation; and (iii) nominal shocks remained the dominant factor in explaining variation in inflation as compared to supply disturbances. Transmission mechanism is much faster in case of Consumer Price Index (CPI) and the CPI remains unchanged. Despite the fact that this study overcomes many of the shortcomings of past studies, its findings are subject to a major data weakness. GDP has been proxied compared to Industrial Production Index (IPI), as over 75 percent increase in CPI is realized during 12 months after the shock and this impact touches over 90 percent level during 18 months. Sensitivity of these results to another specification indicates that response patterns of both IPI and CPI remained unchanged. However, IPI does not constitute a major share of GDP in Pakistan, it is only around 20 percent of GDP. Hence, it is erroneous to use this as a proxy for GDP, the policy implications of the study cannot be broad based.

Husain and Rashid (2009) attempt to extend the analysis of causality between money and the two macroeconomic variables i.e., income and prices by taking care of the shifts in the variables due to the price hikes in the early 1970s and the economic liberalization program of the early 1990s. For introducing the expected shifts in the variables dummies have been used. The results indicate significant shifts in the variables during the sample period. In this context, the shift that occurred due to price hikes in the early 1970s seems to be more important to be incorporated in the analysis. This study finds the active role of money as the leading variable in changing prices without any feedback and this relationship is not affected by the shifts during the sample period. However, when both the shifts are introduced in the analysis it is seen that both the variables cause each other in the long run and they are independent of each other in the short run. No doubt the motive behind the study to examine how income and price are causally related with money in Pakistan in the presence of some shifts seems to be quite inspiring, but the way the study proceeds to achieve its objective is erroneous as acknowledged by the authors in stating the limitations of the study. These limitations include: (a) use of bi-variate causal analysis ;(b) inclusion of pre 1971 period in annual data set ;(c) use of OLS estimation technique. However, besides these limitations, the authors fail to realize that: a) with the inclusion of two dummies for the shifts in the money-income and money- price models, the regression analysis has become multiple in nature, while the use of Engel Granger cointegration technique only provides one cointegrating vector despite the possibility of more than one long run relationship among variables in a multiple regression model. Since the authors fail to provide evidence that there does not exist more than one cointegrating vectors, the findings of the study cannot be validated; b) the study is silent on the impact of unexpected component of one variable on the other variable in the causal analysis; c) the study does not provide any theoretical reasoning that how the inclusion of the two shifts in the analysis is expected to affect the causality pattern and long run relationship between the variables[2].

[2] While conducting causal analysis in the presence of two shifts in the model, the authors have certainly found the causal pattern between two shifts or among one or both of these shifts and other macroeconomic variables of the study. In such circumstances it is essential for the authors to provide a theoretical justification for such causal patterns.

In the light of the above review of the existing studies it is seen that literature on the dynamic relationship between money and other important macroeconomic variables in Pakistan does not converge on any specific conclusions, presumably, due to the methodological limitations. Therefore, the present study is of significance in that it attempts to explore the dynamic causal link between stock of money and other important macroeconomic variables in Pakistan using the Johansen cointegration, the VECM and the VDCs techniques. The VECM technique is suitable for examining the short and the long run casual links among the variables while for gauging the strength of the casual relations the VDCs technique is used. The past researches in the context of Pakistan did not make proper use of these techniques.

3. Analytical Framework

This study employs the multivariate cointegration analysis, the Granger-causality test within the environment of vector error-correction modeling, the variance decompositions, and the impulse response functions to analyze the dynamic relationships among money, price level, interest rate and real output in Pakistan.

3.1. Stationarity of Variables and Unit Root Tests

To diagnose stationarity of the variables a number of tests have been proposed in the literature. Among them the Augmented Dickey-Fuller (ADF) test of Dickey and Fuller (1979, 1981), and the Phillips-Perron (PP) test of Phillips and Perron (1988) are frequently used. However, because of their poor size and power properties these tests are not reliable for small sample data sets (Dejong et.al., 1992; Harris and Sollis, 2003)[3]. In such a situation, we prefer to apply a more efficient and powerful univariate Dickey-Fuller Generalized Least Square (DF-GLS) test. This test is basically a modified version of the ADF test in which data are detrended before the unit root test is conducted. It is developed by Elliot et.al.,(1996) and is based on the null hypothesis $H_0 : \alpha = 0$ in the regression:

[3] Both these studies conclude that the ADF and the PP tests have the tendency to over-reject the null hypothesis when it is true and under- reject it when it is false.

$$\Delta y_t^d = \alpha y_{t-1}^d + \alpha_1 \Delta y_{t-1}^d + \cdots\cdots + \alpha_p \Delta y_{t-p}^d + \eta_t \quad (1)$$

where y_t^d is de-trended series of variable y_t and η_i is the independently and identically distributed error term[4].

3.2 Cointegration Test

The econometric framework used for analysis in the study is the Johansen (1998) and Johansen and Juselius (1990) Maximum-Likelihood cointegration technique, which tests both the existence and the number of cointegration vectors. This multivariate cointegration test can be expressed as:

$$Z_t = K_1 Z_{t-1} + K_2 Z_{t-2} + ... + K_{k-1} Z_{t-k} + \mu + v_t \quad (2)$$

where,

$Z_t = (m, p, r, , gdp, er)$ i.e. a 5 x 1 vector of variables that are integrated of order one [i.e. I (1)],*m, p, r, rgdp* and *er* are broad money supply(M2), price level, nominal interest rate, real gross domestic product and nominal exchange rate respectively,

$\mu =$ a vector of constant and $v_t =$ a vector of normally and independently distributed error term.

The equation (2) can be reformulated in a vector error correction model (VECM) as follows:

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

Where $\Gamma_i = (I - A_1 - A_2 ..... - A_i)$ (i= 1,2,3…..k-1) and $\Pi = -(I - A_1 - A_2 - A_3 ..... - A_k)$. The coefficient matrix Π provides information about the long run relationships among the variables in the data. Π can be factored into $\alpha\beta'$ where α will include the speed of adjustment to the equilibrium coefficients while the β' will be the long run matrix of

[4] For detailed discussion on different unit root tests see Maddala and Kim (1998).

coefficients. The presence of r cointegrating vectors between the elements of Z implies that Π is of the rank $r(0 < r < 5)$. To determine the number of cointegrating vectors, Johansen developed two likelihood ratio tests: Trace test (λ_{trace}) and maximum eigenvalue test (λ_{max}.). The null hypothesis that there are at most r cointegrating vectors is evaluated by the trace test, the statistic of which is calculated as follows:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} \ln\left(1 - \hat{\lambda}_i\right) \tag{3}$$

The maximal eigenvalue test, instead, evaluates the null hypothesis that there exist r cointegration vectors against the alternative of the existence of r+1 cointegration vectors. This test statistic is calculated as follows:

$$\lambda_{\max}(r, r+1) = -T \ln\left(1 - \hat{\lambda}_{r+1}\right) \tag{4}$$

In both (3) and (4) T is the number of usable observations and λ represents the calculated values of the characteristic roots from the estimated matrix. If there is any divergence of results between these two tests, it is advisable to rely on the evidence based on the λ_{max} test because it is more reliable in small samples [see Dutta and Ahmed (1997) and Odhiambo (2005)].

3.3. Variance Decompositions

The VECM, F- and t- tests may be interpreted as within-sample causality tests. They can indicate only the Granger causality of the dependent variable within the sample period. They provide little evidence on the dynamic properties of the system, the relative strength of the Granger-causal chain among the variables. On the other hand, the variance decompositions (VDCs), by partitioning the variance of the forecast error of a certain variable into the proportions attributable to innovations (or shocks) in each variable in the system including its own, can provide an indication of these relativites[5]. The VDCs may be termed

[5] VDCs tells us the proportion of the movements in a variable due to it "own" shocks versus shocks to other variable.

as out-of-sample causality tests (Masih and Masih 1996). The variable that is optimally forecast from its own lagged values will have all its forecast error variance explained by its own disturbances (Sims, 1982).

3.4. Data

This study uses quarterly data for the period 1972Q1 to 2009Q4 for the empirical exercise. The price level is represented by the consumer price index (CPI) because it is a good indicator of the movement of prices (Crocket and Evan, 1980). The bank rate (discount rate) is used for the nominal interest rate variable. The bank rate is the main lever that a central bank uses to conduct monetary policy, it is the rate of interest rate that a central bank charges on short term loans to financial institutions and is considered as the trend setter for other short term interest rates. Real GDP is used as a measure of real output level, it is computed by deflating the nominal GDP by the CPI. Finally, M2 (broad money) represents the money stock variable. As in an open economy monetary policy operates through interest rate and exchange rate channels, so we have also included exchange rate in our analysis. Hence, monetary shocks are transmitted to the real sector of the economy through both the channels of monetary policy The exchange rate is represented by the ratio of Rupees per US dollar. All the variables are logarithmic except for the nominal interest rate. The required data are sourced from various *Quarterly and Annual Reports* of the State Bank of Pakistan, *Pakistan Economic Survey* (various issues) and *International Financial Statistics* (CD- ROM) ,IMF.

4. Results and Discussion

4.1. Stationarity Test

Therefore, to check the stationarity of variables, we use the DFGLS test. From the results of the DF-GLS test presented in table 1, it is evident that the null hypothesis of a unit root can not be rejected for all the variables in levels. This hypothesis, however, is rejected for the first-differences. Thus, all variables are stationary in their first-differences i.e., they are integrated of order one i.e., *I(1).*

Table 1. DF-GLS Unit Root Test

			Mackinnon Critical Values for Rejection of Hypothesis of a Unit Root			
Variables	Level	First Difference	1 %	5 %	10 %	Order of Integration
m	-1.37	-7.44	-3.51	-2.98	-2.69	*I* (1)
r	-2.27	-12.96	-3.51	-2.98	-2.69	*I* (1)
p	-0.59	-6.91	-3.51	-2.98	-2.69	*I* (1)
rgdp	-1.47	-9.88	-3.51	-2.98	-2.69	*I* (1)
er	-1.13	-8.52	-3.51	-2.98	-2.69	*I* (1)

4.2. Multivariate Cointegration Analysis

In the next step, we determine the optimal lag length for cointegration analysis because Johansen technique is known to be sensitive to the lag length. As far as this study is concerned the Schwarz Bayesian Criteria (SBC) suggests a lag length of 5 as optimal, which is not surprising for quarterly data. The cointegration test is conducted assuming an intercept in the cointegrating equation. Cointegration relationship among m , r , p , $rgdp$ and er has been investigated using the Johansen technique. Table 2 reports our cointegration test results based on Johansen's maximum likelihood method. Both trace statistic (λ_{trace}) and maximum eigenvalue (λ_{max}) statistic indicate that there is at least one cointegrating vector among all the five time series. We can reject the null hypothesis of no cointegrating vector in favour of one cointegrating vector under both test statistics at 5 percent level of significance. However, we cannot reject the null hypothesis of at most one cointegrating vector against the alternative hypothesis of two cointegrating vectors, from both the trace and max-eigen test statistics. Consequently, we can conclude that there is only one cointegrating vector among m , r , p , $rgdp$ and er . This implies that money supply, interest rate, price level, real GDP and exchange rate are bound together by long run equilibrium relationship in Pakistan.

Table 2.Cointegration Test Based on Johansen's Maximum Likelihood Method

Null Hypothesis	Alternative Hypothesis			Critical Values	
				95 %	P-values●●
λ_{trace} rank tests		Eigen values	λ_{trace} rank value		
$H_0 : r = 0$	$H_1 : r = 1$	0.28	94.26**	69.81	0.00
$H_0 : r = 1$	$H_1 : r = 2$	0.15	43.78	47.86	0.13
$H_0 : r = 2$	$H_1 : r = 3$	0.11	23.99	29.79	0.21
$H_0 : r = 3$	$H_1 : r = 4$	0.03	6.88	15.49	0.59
$H_0 : r = 4$	$H_1 : r = 5$	0.01	1.98	3.84	0.16
$\lambda_{\max}$ rank tests			$\lambda_{\max}$ rank value		
$H_0 : r = 0$	$H_1 : r > 0$	0.28	47.48**	33.87	0.00
$H_0 : r \leq 1$	$H_1 : r > 1$	0.15	22.78	27.58	0.18
$H_0 : r \leq 2$	$H_1 : r > 2$	0.11	17.11	21.13	0.16
$H_0 : r \leq 3$	$H_1 : r > 3$	0.03	4.91	14.26	0.75
$H_0 : r \leq 4$	$H_1 : r > 4$	0.01	1.98	3.84	0.16

** denotes rejection of the null hypothesis at the 5 percent significance level.
●● MacKinnon-Haug-Michelis (1999) p-values.

Trace test indicates 1 cointegrating equation at 5 percent significance level.

Max-eigenvalue test indicates 1 cointegrating equation at 5 percent significance level.

4.3. Granger-Causality Tests

Although cointegration indicates presence or absence of a long run relationship, it does not indicate the direction of causality among the variables. In this regard, we estimate a VECM to conduct a causal

analysis. The VECM allows the long run behavior of the endogenous variables to converge to cointegrating (i.e., long run equilibrium) relationships while allowing a wide range of short run dynamics. Following Masih and Masih (1997) and Tan and Ahmad (1999), estimates from the VECM are used to conduct the short run and the long run dynamic causal analysis. By adding error correction term (ECT) in VECM, it provides an additional channel for long run causality which is ignored by Sims and Granger standard causality tests. Long run causality is confirmed through the significance of the coefficient of lagged ECT and short run causality is confirmed through the joint significance of coefficients of lagged variables. F-test is employed to check joint significance of the coefficients of the lagged variables and t-test is used to check significance of the lagged ECT. Table 3 reports the Granger causality test results based on the VECM.

Table 3.Dynamic Causal Chain Based on VECM

Dept Var						ECT_{t-1} (t-statistic)
	Δm	Δr	Δp	$\Delta rgdp$	Δer	
	F-statistic					
Δm	-	0.54	5.68**	0.42	0.33	-0.08 (-0.27)
Δr	12.29***	-	3.62*	1.46	0.88	0.06 (0.44)
Δp	10.74**	6.37**	-	6.19**	5.54**	-0.31 (2.98)**
$\Delta rgdp$	5.69**	4.19*	0.88	-	4.53*	0.15 (0.97)
Δer	4.16*	3.77*	1.51	1.18	-	0.11 (1.24)

Note: ***, **, *, indicate significance at 1 percent, 5 percent and 10 percent probability level respectively t- values are given in parentheses.

With regard to the short run analysis we find that there is a bidirectional feedback relationship between price level and money supply. This result is consistent with the conclusion of the Quantity Theory of Money that money supply expansion pushes price level up while it also suggests that price is helpful in predicting the current and future growth rates of money supply in Pakistan. However, there is a unidirectional causal link

from money supply to interest rate, exchange rate and output level. This finding signifies that the role of the interest rate and the exchange rate channels are operating in the economy as both these variables establish a significant relationship with output level. Furthermore, unidirectional causality from stock of money to real output implies that money is no more neutral and money is a lead output indicator in the short run in Pakistan. This outcome supports the Keynesians and the Monetarists view of non-neutrality of money. Hence, policy makers could influence the sustainable output growth with money supply stimulus. The presence of Granger causality from money to output and price suggests that exogenous monetary policy shocks are a major source of output and price variability in Pakistan. This result is in line with the findings of Ramachandra (1986), Chishti et al., (1992), Momen (1992), Masih and Masih (1997), Tan and Ahmad (1999), Das (2003), Dritsaki and Antonios (2005), Mehmood and Mohammad (2005) and Khan (2008).

Exchange rate and real output level both Granger- cause the price level. From this finding it is evident that changes in the exchange rate are transmitting to domestic price level. Hence, the devaluation of the Pakistan rupee in terms of dollar tends to generate inflationary pressures in the economy. As both the stock of money and the real output level cause the price level, so, inflation is not only a monetary phenomenon but real sector also plays a role in its generation. The evidence of causality from real output to price suggests that the excess of aggregates demand generated by increase in real GDP is not absorbed by growth in aggregate supply. There is a strong evidence of a unidirectional short run causal effect running from interest rate to exchange rate. This causality is consistent with the traditional view whereby the interest rate is necessary to support the exchange rate, as changes in interest rates affect the returns for investing in a country and in turn affect the amount of capital outflows. Similar finding has been reported by Nwosa and Isiaq (2012) for Nigeria. Thus, the result shows that interest rate turns out to be the tool that can be used to influence the exchange rate, at least in the short run. There appears to exist a bidirectional causation between price level and interest rate. A good policy variable should be free from feedback from non-policy variables such as price and output in the model. So the interest rate does not deserve to be a good policy variable at least from the perspective of causality test in Pakistan.

From table 3 it can be inferred that coefficients of ECT carries the expected negative sign only in the functions of money supply and price level. However, coefficient of ECT is significant only when price level is used as a dependent variable. For the functions of all the four remaining variables coefficients of ECT are not significant. Hence, it suggests that in the long run money supply, interest rate, real output level and exchange rate Granger- cause price level without any feedback effect. This finding is consistent with our short run causal analysis. A significant negative coefficient means that whenever the actual value of price level rises above the value consistent with its long term equilibrium relationship, changes in the independent variables help bring it down to the long term equilibrium value, other things being equal. It is in this sense that the ECT provides an additional channel of causal relationship. The size of the coefficient of ECT is interpreted to indicate the speed of adjustment. Therefore its coefficient of - 0.31in the equation of price level implies that up to 31 percent of the adjustment in the imbalance is corrected in every quarter which is a reasonably good speed of adjustment. There is absolute absence of any causal pattern among money supply, interest rate, exchange rate and real output in the long run. As money supply does not cause real output, so money is neutral in the long run in Pakistan. Same conclusion has been reached by Moosa (1997), Wallace (1999), Bae and Ratti (2000) and Sulku (2011) for different developing countries.

4.4. Variance Decomposition Results

As stated earlier, although the VECM can give us an understanding of the direction of Granger-causality within the sample period it does not provide us with an indication of the dynamic properties of the system, nor does it allow us to gauge the relative strength of the variables beyond the sample period. In order to analyze the dynamic properties of the system the forecast error variance decompositions (VDCs) are computed. The results of the relative contribution of the explanatory variables in explaining the variation in the dependent variable in the post-sample period are presented in table 4. Though there is no hard and fast rule regarding the number of time periods to be examined but it should be enough to understand the dynamic interactions among the variables. We have examined 20 quarters, which is five years worth of time horizon. We adopt the methodology of orthogonalised forecast

error variance decomposition, which is based on Choleski factorization with particular ordering[6]—namely, m , r , er , $rgdp$ and p .

The decomposition is taken in percentage form at different horizons, and the results for the VDCs are found to be almost consistent with that of the causality tests. It may be seen from table 4 that the price level and the money supply own innovations remain a dominant source of inducing variations in the money supply for short, medium and long run. The results show that 98 percent of the forecast error variance of nominal interest rate is explained by its own shock in the first year; however, the impact of its own shock on interest rate declines over the remaining time horizon to 75 percent in the long run. After its own shocks, the money supply is the most important in explaining the variance in interest rate in the short run and the long run. Looking at the forecast error variance of exchange rate we note that exchange rate own innovations and money supply contribute relatively more as compared to other variables in the system, not only in the short run but also in the long run. In case of real output its forecast error variance is mainly explained by its own shock at 20 quarters horizon. The exchange rate is the next most important factor in explaining the variation in the real output, however, its contribution remained below 10 percent in the short run and the long run. Finally, the predominant source of variation in price level is the "own" shock. Money supply and real output are relatively more important source of the forecast error variance in price level which again confirms our earlier finding under the causality tests that in determining the price level both the monetary and real factors play their role. Overall, the results of the VDCs show a strong and leading role of money over the remaining variables.

[6] Other orderings also produce almost the same results.

Table 4.Variance Decomposition Analysis

Horizon	Percentage of variance due to:					
	Relative variance in	Δm	$\Delta rgdp$	Δr	Δp	Δer
1	Δm	100.00	0.00	0.00	0.00	0.00
5		93.29	0.15	0.16	0.97	5.43
10		84.31	0.84	2.31	3.84	8.7
15		77..52	2.34	3.18	4.16	12.8
20		71.33	1.94	2.98	4.83	18.92
1	Δr	1.74	98.26	0.00	0.00	0.00
5		6.55	87.84	0.49	0.31	4.81
10		8.87	82.81	0.81	0.97	6.54
15		10.93	77.67	0.98	2.57	7.84
20		12.21	75.06	1.17	1.98	9.57
1	Δer	1.14	1.01	97.84	0.00	0.00
5		2.74	1.86	93.84	0.71	0.84
10		5.64	3.38	87.41	1.88	1.69
15		7.54	5.47	82.67	3.65	0.67
20		8.97	6.92	80.38	4.65	0.92
1	$\Delta rgdp$	1.87	0.97	1.25	95.91	0.00
5		2.87	2.57	3.13	90.79	0.63
10		5.57	3.14	2.64	87.37	1.28
15		4.12	3.87	4.85	85.11	2.04
20		3.39	3.19	8.14	82.73	2.55
1	Δp	2.97	0.85	1.14	5.9	89.14
5		5.54	2.57	4.55	12.97	74.37
10		8.56	3.85	6.32	10.64	70.62
15		10.33	3.84	7.84	11.46	66.53
20		14.32	6.13	5.29	12.67	60.94

5. Conclusion and Policy Implications

While considerable work has been done on the money, price and income relationship for both the developed and developing economies, the issue remains relatively under explored in case of Pakistan. Furthermore, the review in of the existing literature shows that it is beset with serious methodological problems and fails to converge on any specific

conclusions regarding the effects of different variables. Evidence produced so far makes it difficult to conclude whether money responds to economic activity or monetary policy does not supplement the process of output growth in a significant way.

The objective of this exercise was to overcome the deficiencies of the existing studies and to undertake a meaningful analysis of the situation in Pakistan by investigating the dynamic interactions between money and other macroeconomic variables such as prices, interest rate, output and exchange rate in Pakistan. The empirical analysis has been conducted employing the Johansen cointegration, the vector error correction model (VECM) and the forecast error variance decompositions (VDCs) techniques using quarterly data for the period 1972Q1 to 2009Q4. The Johansen multivariate cointegration test results indicate the existence of one cointegrating vector among the variables of the study which implies that money supply, price level, interest rate , real output level and exchange rate share a long run equilibrium relationship . From the results of cointegration test it can not be judged what kind of causal relationship exists among the variables. To this end the study has examined the short run and the long run causal patterns using the framework of VECM. The results indicate that money supply can be an independent stimulus to the economic activity in the short run. The results of the Granger-causal chain show that in case of Pakistan money is non-neutral in the short run. This outcome is consistent with the Keynesian and Monetarists macroeconomic paradigms. In the short run all the macroeconomic variables have significant effect on price level which validates the proposition that inflation is not just a monetary phenomenon in Pakistan. A bidirectional pattern is discovered among money supply, price level and interest rate. Furthermore, a unidirectional causality runs from interest rate and exchange rate to real output level which demonstrates the effectiveness of both these channels of monetary policy in affecting real economic activity in Pakistan, at least in the short run. Finally, money supply and interest rate have been found significantly causing exchange rate in the county. The Long run causality test shows that a unidirectional causal pattern runs from all the variables to price level which is quite consistent with the short run findings.

For analyzing the dynamic properties of the system, the VDCs have been computed. The results of the relative contribution of the explanatory variables in explaining the variation in the dependent variable in the post-sample period tend to almost confirm the conclusions obtained by within sample VECM analysis. The predominant sources of variation in all the variables are the "own" shock.

The policy implications of the study are straight forward. First, the results show that interest rate turns out to be the tool that can be used to influence the exchange rate, at least in the short run. Secondly, since the prices are being affected by both money supply and real output level in short run as well as in the long run, this implies that inflation is not just a monetary phenomenon, and structural factors also have a role in affecting price level in Pakistan. Thus complete reliance on tight monetary policy to combat inflation would not be sufficient, rather due attention to supply side of the economy is imperative. Third, since money supply is found to Granger cause output in the short run, monetary authorities have to keep a balance between price stability and high economic growth to avoid overheating and dampening of the economy. This implies that an effective coordination between the monetary and fiscal policy would be required to achieve price stability within the environment of high and sustainable economic growth.

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