Pakistan Journal of Applied Economics, Vol. 18 Nos. 1&2, (65–84), 2002–2008

BUDGET DEFICIT, MONEY SUPPLY AND INFLATION: Testing for Causality

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The relationship between budget deficit, money supply and inflation is not only an important but a controversial issue as well for both academicians and policy makers. The objective of the study is to investigate the relationship between budget deficit, money supply and inflation in Pakistan by using the quarterly data from 1971:1 to 2003:4. For this purpose vector error correction technique is employed. The results of the study show short run causality between budget deficit, money supply (M1 and M2) and inflation. There is unidirectional causality from all measures of inflation (CPI, WPI and GDP deflator) to budget deficit, and both measures of money supply also cause budget deficit in the short run. We also find evidence of bidirectional causality between money supply (M1) and budget deficit when CPI is used as a measure of inflation. There is long run bidirectional causality between all the variables used in the study. The results indicate long run mutual causality among budget deficit, money supply and inflation. The variables adjust to their equilibrium values with high speed when CPI is used as a measure of inflation. In brief, the results of the study provide evidence to support the hypothesis that money financed budget deficit leads to inflation which in turn causes the deficit to rise over time.

I. Introduction

The main objective of monetary policy in Pakistan, as in other countries, is to achieve price stability. The expansionary monetary policy created a large deficit in many developed and developing countries. The policy of financing government expenditures by printing curency notes has been one of the most attractive instruments for governments which are unable to introduce the adequate tax system or reforms in the tax system or administer it effectively and efficiently to get the

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required revenues. This form of deficit financing causes inflation through increase in money supply. The higher rate of inflation causes deficit to rise because the government has to increase money supply. The basic reason for the self perpetuating effect of fiscal deficit, inflation and money supply is that nominal revenues of government are generally fixed in the short run and their real values fall in the presence of rapid inflation. Whereas, the government spending commitments are mostly in real terms i.e., fiscal deficit (nominal spending) and inflation move in the same direction. Even if in the long run, government revenues match government spending, the lag in government's budgetary structure creates a deficit in the presence of inflation. Sajid (1991) found that average lags in the adjustment of real expenditures to the difference between desired and actual real expenditures in the previous period were 2.24 quarters, whereas, average lags in adjustment in government revenues were 3.556 quarters. It means that to keep pace with income and prices, government expenditures adjust more rapidly than revenues. This indicates that in a period of rising prices, revenues will continue to fall short of government expenditures. This results in increasing deficit.

The causal relationship between money and prices has been extensively tested for several countries including Pakistan. Cagan (1956) stressed that it was changes in money, that in some sense, caused changes in prices. This unidirectional nature of the result was questioned by Sargent and Wallace (1973), and Jacobs (1977). They suggested that money creation responded directly and systematically to inflation during periods of hyperinflation. Aghevli and Khan (1977) developed a dynamic model of inflation and concluded that budget deficit affected money supply on almost one-to-one basis. Frenkel (1977) suggested a two-way causality between money supply and inflation. Aghevli and Khan (1977) used the Haugh-Pierce test to investigate the causal relationship between money growth and inflation for the period 1964-1974. They found bidirectional causality between money and inflation for four developing countries over the study period.

Brillembourg and Khan (1979) examined the relationship between money and prices in the USA. Using Sims procedure for the period 1870-1975, they found unidirectional causality running from money to prices. Lee and Li (1983), and Ramachandran and Kamiah (1992) who investigated causal relationship for Singapore and India, respectively, found the direction for causality to be similar. Humburger and Zwick (1981) found that budget deficit had a significant impact on the growth of money supply in the USA. Mcmillin and Beards (1982) did not find a strong or consistent relationship between deficits and growth of money supply in the United States since 1961. Benderly and Zwick (1985) found that money supply affected prices in the USA for the period 1955-1982. Jones and Uri (1987) also found evidence of money supply influencing price level in the USA for the period 1953-1984. Protopapadakis and Siegel (1987) did not find any significant relationship between money, inflation and budget deficit for the developed countries. Hosain

(1987) found a two-way relationship between budget deficit and inflation for the Bangladesh economy for the period 1974-1983.

Haan and Zelhorst (1990) investigated the relationship between budget deficit and growth of money supply for developing countries. The results of the study did not provide much support for the hypothesis that budget deficit influences growth of money supply. There was, however, some support for a positive relationship between budget deficit and inflation during acute inflationary periods. Chaudhary and Parai (1991) used a rational expectations macro model of inflation to explore the effects of anticipated budget deficit on the rate of inflation for the Peruvian economy. They concluded that the country's huge budget deficit as well as the high rate of growth of money supply had a significant impact on the inflation rate.

A few useful attempts have also been made for Pakistan; inter alia, Jones and Khilji (1988), Shabir and Ahmed (1994), Aslam and Ahmed (1995), Hussain and Mehmood (1998) and Husain and Abbas (2000). Jones and Khilji (1988) evaluated causal relationship between growth in money supply and inflation by applying Granger direct test. Shabir and Ahmed (1994) empirically examined direct and indirect effects of budget deficit on inflation. The most important finding of this paper was that budget deficit had a positive and significant direct effect on inflation independent of its indirect effect via money supply. Aslam and Ahmed (1995) found that the domestic financing of budget deficit, particularly from the banking system, was inflationary in the long run. Their results provided support for a positive relationship between budget deficit and inflation during the acute inflationary period, i.e., 1970's. Hussain and Mehmood (1998) also investigated the causal relationship between money and prices in Pakistan after removing the methodological drawbacks of the previous studies, i.e., first they tested properties of time series and then applied the Error Correction Model. They found a long run relationship between prices and M2 definition of money supply. They also found unidirectional causality from money supply to prices. Husain and Abbas (2000) took into account the trends and interrelationship between income, money and prices in Pakistan. They concluded that the correlation between money measures and prices was not significant and showed a negative association between these two variables.

Previous research in this area for Pakistan, has the following short comings: First, they considered only two variables at a time – money supply and inflation or budget deficit and inflation.[1] Second, they have not examined the time series properties of the variables used in the study[2] or their results are inconclusive. Although, Aslam and Ahmed (1995) have already examined the relationship between money supply, budget deficit and inflation by using a simultaneous model, but they did not test the time series properties of the variables used in the analysis. Their study

[1] Aslam and Ahmed (1995), considered money supply, inflation and deficit simultaneously.

[2] Hassan and Mehmood (1998), have taken care of this issue.

suffered from other serious deficiencies as well. The variables were assumed to be stationary, even though the regression yielded serially correlated residual. The most economic time series are non-stationary and regression of one against the other is likely to lead to spurious results. Granger (1988) argued that any causal inference would be invalid if the time series involved are not co-integrated. It is, therefore, important to distinguish whether the series are trend stationary or difference stationary. If they are difference stationary and regressions are run in levels, the standard inference results do not hold. If non-stationarity is removed by taking first difference, Miller (1991) argued that long run information would be lost.

It is clear from the review of literature that the results of research conducted so far on the topic, both for the developed and the developing economies are inconclusive. The reasons might be the use of different methodologies, time periods and the nature of the economies. The review of literature also reveals that research conducted on the Pakistan's economy, so far, has the short comings mentioned above.

The objective of this study is to investigate the relationship between budget deficit, money supply and inflation in Pakistan after removing the shortcomings in the literature mentioned above. The rest of the paper is organized as follows. Section II consists of methodology employed in the study. Nature and sources of data are explained in section III. Estimation procedures and empirical results are discussed in section IV. Finally, section V consists of conclusions and policy implications.

II. Methodology

1. Unit Root Test

A number of tests are available in the literature to check for the existence of unit root problem both in levels of the variables as well as in their first difference form, i.e., to determine the order of integration. Some of them, for example, are the Dickey-Fuller (DF) Test, [Dickey and Fuller (1979)]. Augmented Dickey-Fuller (ADF) Test [Dickey and Fuller (1979)], Phillips-Perron (PP)[3] Test [Phillips-Perron (1988)], Sargan-Bhargava Test [Sargan and Bhargava (1983)], Variance Ratio Test developed by Cochrane (1988) and Perron-Ng test [Perron and Ng (1996)] which is the modified form of the PP Test.[4]

[3] The difference among these tests is that DF test assumes that the error term u_t is independently and identically distributed. The ADF test takes care of the possible serial correlation in the error term by adding the lagged difference terms of the regressor and, Phillips and Perron use nonparametric statistical methods to take care of the serial correlation in the error terms without lagged difference terms.

[4] For detailed discussion of different tests to check the unit root problem and their robustness see Maddala and Kim (1998) Ch.4.

We use the ADF test to check the stationarity of the variables by estimating the following regression.

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta_{Y\,t-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{t-1} + U_t \qquad (1)$$

The DF test is applicable if error terms (U_t) are uncorrelated. In case the error terms (U_t) are correlated, DF test is useless. ADF test takes care of this problem by "augmenting" the equation (s) of DF test by adding the lagged values of the dependent variable.

In equation (1) U_t is a pure white noise error term and $\Delta Y_{t-1} = (Y_{t-1}-Y_{t-2})$, $\Delta Y_{t-2} = (Y_{t-2}-Y_{t-3})$, and so on.

2. Test of Co-integration

The concept of co-integration was introduced by Granger (1981) to protect the loss of long run information in the data due to differencing the series. If the linear combinations of variables of I(1) are I(0), then the variables are said to be co-integrated. To investigate the long run relationship we use vector autoregressive (VAR) model which was developed by Johanson (1988) and further extended by Johanson and Jusiluis (1990). One advantage of the technique is to estimate a long run relationship between more than two non-stationary variables involving co-integration vectors. The second advantage is that it provides a maximum likely test statistic to test a priori restriction imposed on the coefficient of the co-integrating vectors.

$$y_t = A_t\ y_{t-1} + ... + A_k\ y_{t-k} + Bx_t + \varepsilon_t \qquad (2)$$

where y_t is a k-vector of non-stationary I(1) variables, x_t is a d vector of deterministic variables, if any, and ε_t is a vector of error terms. We can write the VAR as

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{k-i} \Gamma_i \Delta y_{t-i} + Bx_t + \varepsilon_t \qquad (3)$$

where
$$\Pi = \sum_{i=1}^{k} \Gamma A_i - I \quad and \quad \Gamma i = \sum_{j=i+1}^{k} A_j \qquad (4)$$

Equation (3) is a traditional VAR except for the term Πy_{t-1}. The objective is to investigate whether coefficient matrix Π contains information about long run relationship between variables in the analysis. There are three possible cases:

1. Rank (Π) = p, i.e., the matrix has full rank that vector process stationary.
2. Rank (Π) = 0, is the null matrix and (3) is traditional differenced vector time series vector.
3. $0 <$ rank (Π) $= r < p$, implying that there are $p \times r$ matrices α and β each with r rank such that $\Pi = \alpha\beta'$.

The co-integrating β vector has the property that $\beta' y_t$ is stationary even though Y_t itself, is non-stationary. 'r' is the number of co-integrating relations and each column of β is the co-integrating vector. A number of methods are available to test the co-integration. The most popular test is Johansen test. In this test two test statistics are available for co-integration. First is the trace test which tests the hypothesis that there are most 'r' co-integrating vectors. The second, called the maximum eigen-value test, tests the hypothesis that there are r+1 co-integrating vectors versus the hypothesis that there are 'r' co-integrating vectors. Johansen and Juselius (1990) suggested that maximum eigen-value might be better than trace test.

If variables are found to be co-integrated, there is need for Vector Error Correction Modelling (VECM). This Error Correction Model captures the short run dynamics as well as the long run properties of the variables because it includes variables, both in levels and in difference forms.

3. VECM and Test of Causality

Granger (1969) and Sims (1972) approach the question of whether x causes y to see how much of the current y can be explained by past values of y and to see whether adding lagged values of x can improve the explanatory power. Y is said to be Granger-caused by x if x helps in the prediction of y, or equivalently if the coefficients on lagged x's are statistically significant. Note that two-way causation is frequently the case; x Granger causes y and y Granger causes x. It is important to note that the statement "x Granger causes y" does not imply that y is the effect or the result of x. Granger causality measures precedence and information content, but does not by itself indicate causality il the more common use of the term.

The estimation of dyjamic model with lags of the dependent variable included in the regression has certain problems. One of the major problems in this context is the necessity to instrument the lagged tependent variable. In the causality test, it is a sever limitation, since the timing of the variable is the main focus of the analysis. One advantage of using the VAR approach is that the causality tests can be carried in a setting where variables are allowed to be determined simultaneously. A Vector Error Correction (VEC) Model is a restricted VAR that has co-integration restrictions built into the specification, so that it is designed for use with non-stationary series that are known to be co-integrated. The VEC restricts the long run behaviour

of the endogenous variables to converge to their co-integrating relationship while allowing a wide range of short run dynamics. The co-integration term is known as the error correction term since the deviation from long run equilibrium is corrected gradually through a series of partial short run adjustments. The VEC model will take the following form for three variables:

$$\begin{bmatrix}\Delta X_t\\ \Delta Y_t\\ \Delta Z_t\end{bmatrix} \begin{bmatrix}b^1_{11} & b^1_{12} & b^1_{13}\\ b^1_{21} & b^1_{22} & b^1_{23}\\ b^1_{31} & b^1_{32} & b^1_{33}\end{bmatrix} \begin{bmatrix}\Delta X_{t-1}\\ \Delta Y_{t-1}\\ \Delta Z_{t-1}\end{bmatrix} + \ldots + \begin{bmatrix}b^{p-1}_{11} & b^{p-1}_{12} & b^{p-1}_{13}\\ b^{p-1}_{21} & b^{p-1}_{22} & b^{p-1}_{23}\\ b^{p-1}_{31} & b^{p-1}_{32} & b^{p-1}_{33}\end{bmatrix} \begin{bmatrix}\Delta X_{t-p-1}\\ \Delta Y_{t-p-1}\\ \Delta Z_{t-p-1}\end{bmatrix} + \begin{bmatrix}a_1\\ a_2\\ \alpha_3\end{bmatrix} [\beta_1\beta_2\beta_3] \begin{bmatrix}X_{t-1}\\ Y_{t-1}\\ Z_{t-1}\end{bmatrix} + \begin{bmatrix}\varepsilon_{1t}\\ \varepsilon_{2t}\\ \varepsilon_{3t}\end{bmatrix}$$

The null hypothesis of non causality of X on Y can be expressed as restrictions on parameters in the following way: $b^1_{21} = \ldots = b^{p-1}_{21} = 0,\ \alpha_2 = 0.$

III. Nature and Sources of Data

In this section the nature and sources of data used in the estimation of the model are discussed. Regarding the nature of the data, all the time series are quarterly observations of the variables for the period 1971:1 to 2003:4.

The annual data on money supply for both M1 (currency in circulation plus demand deposits) and M2 (M1 plus time deposits) are taken from the Economic Survey of Pakistan (various issues).

The annual data on consumer price index (CPI), whole sale price index (WPI) and the GDP-deflator are also taken from the Economic Survey of Pakistan (various issues). The annual series of the price indices, which were based on different years, have been converted into one base year i.e., 1990-91 and then transformed into the actual rate of inflation by applying the following formula.

$$P_t^* = (X_t - X_{t-1}) / X_{t-1}$$

where 'X' denotes the price index and P_t^* is the actual inflation rate.

The annual data on budget deficit is taken from the various issues of International Financial Statistics. The annual data is interpolated into quarterly series by the method given in Khan and Raza (1989).

To avoid fluctuations in the data, we take natural logs of budget deficit and both measures of money supply. The log of price indices is not taken because they are already interpolated into rate of inflation. LNBD, LNM1 and LNM2 stand for natural logs of budget deficit, i.e., M1 and M2 respectively. GDP.DEF denotes the GDP deflator, and the prefix "D" with variables denotes the first difference of the variables.

IV. Estimation and Results

1. Unit Root Test

This test is used to test the stationarity of the variables. The degree of integration of each variable used in the analysis is determined by using the ADF test. The existence of unit root in a variable denotes non-stationarity. The null hypothesis of non stationarity of budget deficit, money supply and inflation is tested against the alternative hypothesis of stationarity. The results of the unit root test are reported in Table 1.

The ADF test statistics are less than critical values. In the level form, the null hypothesis for all the series cannot be rejected and the results indicate that the variables are non stationary at the 5 per cent level of significance. Therefore, all variables used in the analysis are random walk and require first difference to become stationary.

To check the white noise and well behaved property of residuals the LM (Lagrange Multiplier) and ARCH (Auto Regression Conditional Heteroskedasticity) tests are used.

The autoregressive conditional heteroskedasticity (ARCH) test (Engle 1982) is a spåcification oæ heteroskedasticity and was motivated by the observation that in many ninancial time series, the magnitude of residuals appeared to be related to the magnitude of recent residuals. The χ^2 statistic is the Breusch-Godfrey LM test

TABLE 1

ADF Test in Levels

(Regression with an intercept and trend)

VARIABLES	LAGS	CALCULATED ADF VALUES
LNBD	2	-2.222
LNM1	2	-1.290
LNM2	4	-1.828
CPI	1	-2.699
WPI	4	-3.089
GDP.DEF	8	-2.729

Note: The calculated values are less than critical value at 5% level of significance. The critical value at 5% is -3.44. The critical value is taken from McKinnon (1991). Lags are chosen according to minimum Akaike and Schwartz Criteria.

statistic The results of LM and ARCH tests are given in Table 2. The tabde shows that the residual terms are pure white noise i.e., they are well behaved and the null hypothesis of no autocorrelation and no heteroskedasticity among residuals is accepted by both LM and ARCH tests. The acceptance of hypothesis is shown by the insignificant values of $\chi 2$.

When the first difference of the variables is used the ADF test statistics rejects the hypothesis of non-stationarity for all the variables used in the study at 5 per cent level of significance. The results are reported in Table 3. This indicates that the

TABLE 2

The Results of LM and ARCH Tests

Variables	Lags	LM Test		ARCH Test	
		χ^2	Probability	χ^2	Probability
LNBD	2	77.42	0.94	66.80	0.25
LNM1	2	103.81	0.35	50.53	0.42
LNM2	4	90.34	0.72	60.34	0.46
CPI	1	87.40	0.79	33.92	0.99
WPI	4	86.02	0.82	62.34	0.39
GDP.DEF	8	0.34	0.34	62.94	0.37

Note: Residuals are proved to be white noise at the above lags by employing LM and ARCH tests.

TABLE 3

Results of ADF Test with First Difference

(Regression with an intercept)

VARIABLES	LAGS	ADF VALUES
D(LNBD)	4	-6.105
D(LNM1)	2	-6.430
D(LNM2)	1	-8.013
D(GDP.DEF)	1	-8.411
D(CPI)	3	-4.748
D(WPI)	1	-8.697

Note: All the calculated values are significant at 5% level of significance. The critical value at 5 % level is -2.88. D( ) in the table above shows the first difference of the variable.

variables are stationary in first difference form. Now, the co-integration test is applicable to all the series because they are integrated of order one, i.e., I (1).

The results in Table 4 show that the residuals are also well behaved. The null hypothesis of no auto correlation and no heteroskedasticity among residuals is accepted by both LM and ARCH tests. The acceptance of the hypothesis is shown by the insignificant values of χ^2.

2. Co-integration Test

The purpose of applying the Johansen Co-integration test is to investigate the long run relationship among the variables. If the linear combinations of variables of I(1) are I(0), then the variables are said to be co-integrated.

The method of trace statistics and the maximum eigen-value statistics is used for examining the co-integration relationship. The null hypothesis of no co-integration vector is tested against alternative hypothesis of one co-integrating vector. The trace statistics tells us whether there is any co-integration between the variables and the max statistics tells the number of co-integrating equations. The results of this procedure are presented in Table 5.

The null hypothesis of no co-integration between budget deficit, money supply and inflation (i.e., $r = 0$) is rejected at the 5 per cent significance level in all the cases. However, the null hypothesis of $r \leq 1$ and $r \leq 2$ is accepted at the 5 per cent level of significance in all the cases. This implies that there is one co-integration

Table 4

The Results of LM and ARCH Tests

Variables	Lags	LM Test		ARCH Test	
		χ^2	Probability	χ^2	Probability
D(LNBD)	4	84.60	0.84	62.97	0.37
D(LNM1)	2	98.18	0.50	50.05	0.81
D(LNM2)	1	128.81	0.27	63.28	0.36
D(GDP.DEF)	1	88.17	0.77	61.94	0.40
D(CPI)	3	110.61	0.20	57.94	0.55
D(WPI)	1	63.10	0.99	66.71	0.25

Note: Residuals are proved to be white noise, at the above lags by employing LM and ARCH tests.

TABLE 5

Results of Johansen Co-integration Test

VARIABLES	LAGS	NULL HYPOTHESIS	ALTERNATIVE HYPOTHESIS	TRACE STATISTICS	MAX STATISTICS
LNBD	14	R = 0	r = 0	43.940*	21.224*
LNMI		r ≤ 1	r = 1	22.715	15.420
WPI		r ≤ 2	r = 2	7.295	7.295*
LNBD	13	R = 0	r = 0	51.251*	33.006*
LNM2		r ≤ 1	r = 1	18.244	14.385
WPI		r ≤ 2	r = 2	3.859	3.859*
LNBD	13	R = 0	r = 0	46.055*	26.767*
LNM1		r ≤ 1	r = 1	19.288	15.811
CPI		r ≤ 2	r = 2	3.477	3.477*
LNBD	13	R = 0	r = 0	53.238*	33.604*
LNM2		r ≤ 1	r = 1	19.633	15.060
CPI		r ≤ 2	r = 2	4.573	4.573*
LNBD	14	R = 0	r = 0	35.031*	20.624*
LNM1		r ≤ 1	r = 1	14.407	11.087
GDP.DEF		r ≤ 2	r = 2	3.319	3.319*
LNBD	13	R = 0	r = 0	48.017*	28.194*
LNM2		r ≤ 1	r = 1	19.823*	15.435*
GDP.DEF		r ≤ 2	r = 2	4.387	4.387

Note: * (**) Indicates the rejection of the hypothesis at 5% (1%) significance level.
The trace statistics critical value for the hypothesis r=0 at 5% is 29.50.
Max statistics critical value for the hypothesis r=0 at 5% is 20.77 and 25.52 at 1%.

equation in all the cases except in the case of budget deficit, money supply (M2) and GDP deflator. In this case there are two co integrating equations. This means that budget deficit, money supply and inflation are co-integrated in case of Pakistan. This suggests that there is a long run equilibrium relationship among the variables used in the study. The variables are found to be co-integrated; thus proving that the residuals obtained from the long run relationship are integrated of order zero. There is need for Vector Error Correction Modeling (VECM).

3. Vector Error Correction: A Test of Causality

Vector Error Correction Model (VECM) is estimated to examine the causal relationship between budget deficit, money supply and inflation in Pakistan. Akaike information criterion (AIC) and Schwartz Bayesian information criterion (SBIC) are used to choose optimum lag length of the variables included in the VECM. Long run causality is checked by using the t-ratios of the error correction terms whereas short run causality is determined by the t-values of the coefficient of the lagged terms of the independent variables. Note that the VECM approach does not require the use of economic theory to impose zero restrictions. We have therefore ordered the variables in the model according to the results of the co-integration test. The VEC restricts the long run behavior of the endogenous variables to converge to their co-integrating relationship, while allowing a wide range of short run dynamics. The co-integration term is known as error correction term since the deviation from long run equilibrium is corrected gradually through a series of partial short run adjustments. The results of VEC are reported in Tables 6, 7, 8, 9, 10 and 11. The results of causality test are judged by their respective t-statistics. They are significant at least at 0.05 levels. Tables 5, 6, 7 and 8 report results for long run causality. The first variable of the regression is the dependent while other two are the independent variables in these tables, e.g., D(LNBD) D(LNM1) D(WPI), where D(LNBD) is the dependent and D(LNM1) and D(WPI) are the independent variables.

Results in Table 6 indicate that there is mutual causality between budget deficit, money supply (M1, M2) and inflation (WPI), because the t-value of the speed of adjustment coefficient (á) is significant. In this table, $á_1$ and $á_2$ indicate the t-values of the error correction term of the independent variables. In the second case, the t-value of money supply (M2) is insignificant. This means that M2 does not Granger cause WPI and budget deficit.

In Table 7, the results on long run Granger causality indicate that there is mutual causality between budget deficit, money supply (M1, M2) and inflation (CPI), because the t-values of the speed of adjustment coefficient (á) are significant. It is also clear that in this case the speed of adjustment is strong as compared to the previous case, when WPI is used as the inflation rate.

TABLE 6

Long Run Causality Results with WPI

(t- Statistics of lagged coefficients)

Regression	t-values of α_1	t-values of α_2
D(LNBD) D(LNM1) D(WPI)	1.64***	1.60***
D(LNM1) D(LNBD) D(WPI)	-3.97	1.60***
D(WPI) D(LNBD) D(LNM1)	-3.79	1.64***
D(LNBD) D(LNM2) D(WPI)	-1.21*	2.58
D(LNM2) D(LNBD) D(WPI)	-3.41	2.58
D(WPI) D(LNBD) D(LNM2)	-3.41	-1.21*

Note: The t-values are significant at least at 0.05 and 0.025 levels.
***denote significance at 0.10 levels and *denotes insignificant t-values.

TABLE 7

Long Run Causality Results with CPI

(t- Statistics of lagged coefficients)

Regression	t-values of α_1	t-values of α_2
D(LNBD) D(LNM1) D(CPI)	-2.61	-2.86
D(LNM1) D(LNBD) D(CPI)	-2.27	-2.86
D(CPI) D(LNBD) D(LNM1)	-2.27	-2.61
D(LNBD) D(LNM2) D(CPI)	1.56***	-2.34
D(LNM2) D(LNBD) D(CPI)	-4.06	-2.34
D(CPI) D(LNBD) D(LNM2)	-4.06	1.56***

Note: The t-values are significant at least at 0.05 and 0.025 levels.
***denote significance at 0.10 levels.

TABLE 8

Long Run Causality Results with GDP Deflator

(t- Statistics of lagged coefficients)

Regressions	t-values of α_1	t-values of α_2
D(LNBD) D(LNM1) D(GDP.DEF)	-2.00	-2.24
D(LNM1) D(LNBD) D(GDP.DEF)	-2.66	-2.24
D(GDP.DEF) D(LNBD) D(LNM1)	-2.66	-2.00
D(LNBD) D(LNM2) D(LDP.DEF)	-1.92***	1.15*
D(LNM2) D(LNBD) D(GDP.DEF)	-3.51	1.15*
D(GDP.DEF) D(LNBD) D(LONM2)	-3.51	-1.92***

Note: The t-values are significant at least at 0.05 and 0.025 levels. ***denote significance at 0.10 levels and *denotes insignificant t-values.

TABLE 9

Short Run Causality Results with CPI

(t- statistics of lagged coefficients)

Regression 1	D(LNBD)	D(LNM1)	D(CPI)
D(LNBD)		-1.81(-4)	
D(LNM1)	-2.09(-4)		
D(CPI)	2.84(-4)		
Regression 2	**D(LNBD)**	**D(LNM2)**	**D(CPI)**
D(LNBD)			
D(LNM2)			
D(CPI)	-1.7 (-2)		

Note: Figures in brackets indicate significant lag, while the other lags shows insignificant results. The free space in the table show insignificant results, which are not reported. The variables in columns are dependent, whereas, row variables are independent variables.

Table 8 shows that there is also long run Granger causality between budget deficit, money supply (M1) and GDP deflator because all the three t-values in this case are significant, but in case of money supply (M2) the t-value of GDP deflator is insignificant. This indicates that in the long run there is bi-directional causality between budget deficit and money supply (M1), and GDP deflator and budget deficit, but not with money supply (M2). It means that the speed of adjustment is stronger in case of money supply (M1) with GDP deflator as compared to money supply (M2) with GDP deflator.

The short run causality among the variables is checked by the t-values of the coefficient of lagged terms of independent variables in VECM. The results of short run causality are given in the Tables 9, 10 and 11. In these tables, only the significant t-values of the coefficient of lagged terms of independent variables are reported.

In Table 9, t-values of the coefficients of lagged terms of independent variables are given. The results of regression 1 shows that there is bidirectional causality between budget deficit and money supply (M1) and unidirectional causalty from CPI to budget deficit. The t-values are significant only in case of CPI and money supply (M1), but insignificant in other cases. The results of regression 2 indicate that there is short run causality from inflation (CPI) to budget deficit, but the same is rejected for other variables.

TABLE 10

Short Run Causality Results with WPI

(t- statistics of lagged coefficients)

Regression 1	D(LNBD)	D(LNM1)	D(WPI)
D(LNBD)			
D(LNM1)			
D(WPI)	-1.91(-2)		
Regression 2	**D(LNBD)**	**D(LNM2)**	**D(WPI)**
D(LNBD)			
D(LNM2)	-1.98(-4)		1.54
D(WPI)	-1.69(-3)	-2.22(-4)	

Note: Figures in brackets indicate significant lag, while the other lags shows insignificant results. The free space in the table show insignificant results. The variables in columns are dependent, whereas, row variables are independent variables.

Table 10 reveals that in case of regression 1 only WPI causes budget deficit. In case of regression 2, money supply (M2) Granger causes budget deficit and WPI. The table also shows that WPI measure of inflation Granger causes budget deficit and money supply (M2). In these cases, t-values of the coefficient of lagged terms of independent variables are significant.

Table 11 shows that, in case of regression 1, there is unidirectional causality from GDP deflator to budget deficit, and from money supply (M1) to budget deficit at the fourth lag. This means that inflation (GDP deflator) and money supply (M1) causes budget deficit in the short run. There is bi-directional causality between budget deficit and money supply (M1). Table 11 also shows that in case of regression 2 there is unidirectional causality from GDP deflator to budget deficit. The other t-values reject any short run causality between the other variables. This means that GDP deflator as a measure of inflation causes budget deficit in the short run, but GDP deflator is not causing money supply (M2). Budget deficit is also not causing money supply (M2) and GDP deflator in the short run.

TABLE 11

Short Run Causality Result with GDP.DEF

(t- statistics of lagged coefficients)

Regression 1	D(LNBD)	D(LNM1)	D(GDP.DEF)
D(LNBD)		-1.91(-4)	
D(LNM1)	-2.42(-4)		
D(GDP.DEF)	1.75(-4)	-1.98(-4)	
Regression 2	**D(LNBD)**	**D(LNM2)**	**D(GDP.DEF)**
D(LNBD)			
D(LNM2)			
D(GDP.DEF)	-1.60 (-2)		

Note: Figures in brackets indicate significant lag, while the other lags shows insignificant results. The free space in the table show insignificant results, which are not reported. The variables in columns are dependent, whereas, row variables are independent variables.

V. Conlusions and Policy Implications

The objective of the paper is to investigate the causal relationship among budget deficit, money supply and inflation in Pakistan. The co-integration and vector error correction techniques are used to explore direction of causality for the period 1971:1 to 2003:4. The results of ADF test show that budget deficit, money supply (M1 and M2) and inflation are integrated of order one, which means that the variables are stationary in their first difference form. We therefore applied Johansen's Co-integration test on budget deficit, money supply and inflation.

The results indicate the existence of short run causality from inflation (WPI) to budget deficit. Budget deficit is not causing money supply (M2) and CPI. There is short run causality running from CPI to budget deficit. Money supply (M1) is causing budget deficit in the short run. The results also show that WPI Granger causes budget deficit and there is bi-directional causality between WPI and money supply (M1).

The results also indicate that there is short run causality from GDP deflator to budget deficit and from money supply (M1) to budget deficit at the fourth lag. It means that GDP deflator as a measure of inflation and money supply (M1) causes budget deficit. The GDP deflator is also causing money supply (M1) at the fourth lag in the short run. Budget deficit is causing money supply (M1) but not GDP deflator. There is bi-directional causality between budget deficit and money supply (M1). Finally, the results support the presence of short run as well as long run Granger causality. The results of VECM suggest that a bi-directional relationship exists among budget deficit, money supply and inflation. There is strong speed of adjustment among all the variables. Conclusively, we can say that results indicate long run causal relationship among budget deficit, money supply and inflation.

According to the results, policies should be implemented, which would control budget deficit as well as inflation, and as a result, money supply will be controlled automatically. The control of inflation requires the control of money supply and the control of money supply in turn requires the control of budget deficit. To manage the budget deficit, government should not emphasize the control monetary base only, but steps also need to be taken to improve the tax system that generates revenues and reduces budget deficit.

The budget deficit can also be controlled by increasing revenue and/or decreasing government expenditures. To accomplish the objective, the following is proposed:

1. To increase government revenues, a thorough reform of the tax system and administration is required. By tax reforms we mean simplification of tax structure, broadening of tax base, depersonalization and streamlining of tax administration and a drastic reduction in the discretionary authority of tax administration.

2. To decrease the government expenditures, public debt needs to be controlled because debt servicing liabilities make fiscal adjustment more complicated. The declined or low public debt has its own beneficial effects as it will decrease interest payment by the government in the future. Government should also try to control its non-development expenditures to reduce the budget deficit.

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