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Macroeconomic Variables: Evidence from
Pakistan (1960-2005). Sarhad J. Agric.
24 (1): 199-205.**

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2008

Online at <https://mpra.ub.uni-muenchen.de/42034/>
MPRA Paper No. 42034, posted 22 Oct 2012 13:16 UTC

INTER-DEPENDENCIES AND CAUSALITY IN THE MACROECONOMIC VARIABLES: EVIDENCE FROM PAKISTAN (1960-2005)

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ABSTRACT

This paper critically evaluates the inter-relationship, vulnerability to innovation, and causality among the macroeconomic variables (budget deficit, economic growth, unemployment and poverty). Annual data for the period 1960-2005 is used, taken from Economic Survey of Pakistan and International Financial Statistics. Vector Autoregressive (VAR) model with impulse response function (IRF), error variance decomposition and Granger Causality test is used for the analysis. The study revealed that any innovation of one standard deviation took seven years for economic growth and budget deficit, eight years for unemployment and more than ten years for poverty reduction. The response of the macroeconomic variables to innovation or impulses introduced is mostly explained in their own. Only two unilateral causality are found. Bilateral causality is not found, and mostly independent type relationships are detected. Based on the finding of the study it is recommended, that target oriented fiscal policies should be focused on and the gap between policy formation and implementation must be reduced.

Key words: interdependency in macroeconomic variables; causality in macroeconomic variables

INTRODUCTION

Pakistan sustained a large budget deficit throughout the 1990s due to the stagnation of fiscal efforts over the last fifteen years. Realizing the weaknesses of Pakistan's tax structure a concerted reform effort was launched in the early 2000. Total revenue was 17.1 % of GDP in 1990, it came down to 12.6 % of GDP in 2004-05. Total expenditure continuously decreasing from financial year 1999-00. Total expenditures in 1990 were 22.4 % of GDP, reduce to 16.4 % of GDP in 2004-05. Drastic reduction in expenditure reduces the gap between revenue and expenditure, and fiscal deficit reduce from 5.4 % of GDP in 1990 to 3.8 % of GDP in 2004-2005. Realizing the rising trends in poverty during the 1990s, the Government of Pakistan adopted a strategy for poverty reduction in 2001. This strategy has accelerated economic growth. Real GDP grew by 8.4% during the fiscal year 2004-05, which help to reduce poverty among the lowest segment of population. There is a steady rise in the quantum of employment over the years for both rural and urban parts of Pakistan. In 2003-04, rural employment (1.98 million increase) has increased more than urban employment (0.89 million). Whereas total employment has also risen considerably from last year (0.71 million increase) (Economic Survey of Pakistan, 2004-05).

The empirical evidence regarding the direction of causality between budget deficit and macroeconomic variables is not conclusive. Guess and Koford (1984) observed no causality among budget deficit, inflation, GNP and private investment. Al-Khedair (1996) observed that budget deficit led to higher short term interest rates. Dwyer (1982) found no evidence that

larger government budget deficits increase prices, spending, and interest rate. Hondroyannis and Papapetrou (1994) observed long-run relationship between the government budget deficits and price level, and support the hypothesis of a bi-directional causality between the two variables. Burney and Akhtar (1992) observed that budget deficits have significant positive impact on the real exchange rate directly as well as indirectly through the price level. Nishat and Saghir (1991) observed a unidirectional causality from stock price to consumption expenditure. Hussain and Mahmood (2001) observed a unidirectional causality from macroeconomic variables to stock prices. The study by Burney and Akhtar (1992) does not cover the period of 1990s, the post reform period. The present study is extending beyond 1990. Moreover this paper attempts to include different set of macroeconomic variables to find out the causal relationship between budget deficits and macroeconomics variables. The effects of macroeconomic variables by constructing the impulse responses as well as variance decompositions also have been demonstrated.

Objectives

The main objectives of this study are: (i) To appreciate the inter-relationships among the four macroeconomic variables (ii) To detect which of the four variables are more vulnerable to innovation (iii) To verify if we can detect causality links among some of the macroeconomic variables.

MATERIALS AND METHODS

Time series data for the sample period 1960-2005,

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which are taken from Economic survey of Pakistan various issues, and International Financial Statistics is used. To determine the stationarity of data, an Augmented Dickey-Fuller (ADF) test is used. The Akaike information criterion is used to select the optimum ADF lag. Stationarity of the variables are checked once with an intercept is included only, and again when both an intercept and a linear deterministic trend is included. Variables which are non-stationary at level make stationary after taking first difference. Vector Autoregression (VAR) model, which treats all the variables in the system as endogenous is used to analyze the dynamic impact of the random errors on the variable's system. In order to encapsulate the causality among the four main variables of the study (Budget deficit, Economic growth, Unemployment, and Per Capita Income used to measure Poverty) Granger causality test is used. A statistical package Eview is used for deriving the results. More specifically, the following multivariate VAR model of order P is used for estimation:

$$y_t = K + \sum_{i=1}^n \alpha_i x_t + \sum_{i=1}^n \beta_i y_{t-1} + U_t \quad (1)$$

Where x_t and y_t is a $(n \times 1)$ vector of endogenous variables being considered (economic growth, budget deficit, unemployment and per capita income), α_i and β_i is $(n \times n)$ matrix of coefficient, K is the vector of constant, P is the number of lags and U_t is a $(n \times 1)$ vector of uncorrelated white noise disturbances.

RESULTS AND DISCUSSION

Table I and II present the results of the unit root test, among the four variables, economic growth is stationary and the remaining three variables (i.e. budget deficit, unemployment and Per capita Income) are non-stationary at level whether trend is included or not.

The graphical illustration gives us the evaluation of the four variables in IRF terms to variations, shocks or unitary innovation (of one standard deviation). From Figure 1 we find the convergence of these functions, in some sense it translates the rapidity of absorption of the innovation by the four variables. It is found that the absorption takes 7 years for economic growth and budget deficit, 8 years for unemployment and more than 10 years for per capita income. Figure 2 indicates the response or the absorption rhythm of each one of the four variables to innovation or impulses of size 1 s.d. +/- 2 s.e. The first graph give us the response of the economic growth to innovations or impulses introduced by budget deficit, the second one shows response of budget deficit to innovations or impulses introduced by their own. In similar fashion the third and fourth

graph shows the response of unemployment and per capita income to innovations or impulses introduced by budget deficit.

In Table III we can find the numerical values that support the graphics referring the 4 variables responses to innovations introduced in the VAR model structure.

In figure 3 and Table IV we see the values of variance decomposition of the four variables. In this table we can see how the variance of each one of the series is decomposed during a period of ten years.

The first group of columns in Table IV is referred to economic growth. Those value of standard errors that economic growth explains by itself lies between 87% to 100%, with values descending slowly. Per capita income is the second variable to explain most the variation in economic growth with values from 4.39% to 4.41%. Budget deficit and unemployment explains 2.39% to 3.72% and 0% to 3.23% respectively the variation in economic growth. The second group of columns refers to the unemployment variance decomposition. Unemployment by itself explains variation between 89% to 95%. Budget deficit explains 2.81% to 4.42% of variation in unemployment. The other two variables economic growth and per capita income explain 1.7% to 4.08 and 0% to 2.17% variations in unemployment. The third group of columns shows the budget deficit variance decomposition. Budget deficit by itself explain variation between 83.48% and 99.43%. In the second place is economic growth which explains the variation in budget deficit is between .57% and 10.03%. Unemployment and per capita income explains 1.11% to 2.41% and .02% to 4.08% respectively the variation in budget deficit. The fourth and last group of columns refers to the variance decomposition of per capita income. The variation in Per capita income explains 65.6% to 94.2% by itself. In other variables economic growth is the second variables which explain variation in per capita income the most. Economic growth explains 2.94% to 30.48% variation in per capita income. Unemployment explains 2.88% to 3% variation in Per capita income, while budget deficit explains 0% to .87% variation in per capita income.

Granger (1969) and Sims (1972) Causality test is used to investigate the direction of causality among the four variables i.e. economic growth, unemployment, budget deficit and per capita income. Granger causality implies the estimation of a bivariate regression.

The results of the regression in Table V suggest that there are two unilateral causality. One directed from economic growth to budget deficit and another directed from economic growth to per capita income. From the results it is seen that the coefficients of lagged values of economic growth as a group is statistically different from zero at 5% level of significance in both cases. The result further indicates that no bilateral causality is found as in none of the regression set both of the coefficient found to be statistically significant. Mostly independent type relationships are detected.

CONCLUSION AND RECOMMENDATIONS

The present study revealed that any innovation of one standard deviation taken place toward economic growth and budget deficit took 7 years for each one,

while for unemployment it took 8 years and for poverty reduction and more than 10 years to become effective. The results further indicate that response of the four macroeconomic variables to innovation or impulses introduced are mostly explained in their own. The results of causality indicate only two unilateral causality, one directed from economic growth to budget deficit and another from economic growth to per capita income. Bilateral causality is not found, and mostly independent type relationships are detected. From the facts and figures it is clear that in Pakistan either the policies are not objective oriented or took longer time in implementation. On the basis of these evidences it is suggested to formulate objective oriented fiscal policies, reduce the gap between policy formulation and implementation, and harmonize fiscal policies with monetary policy

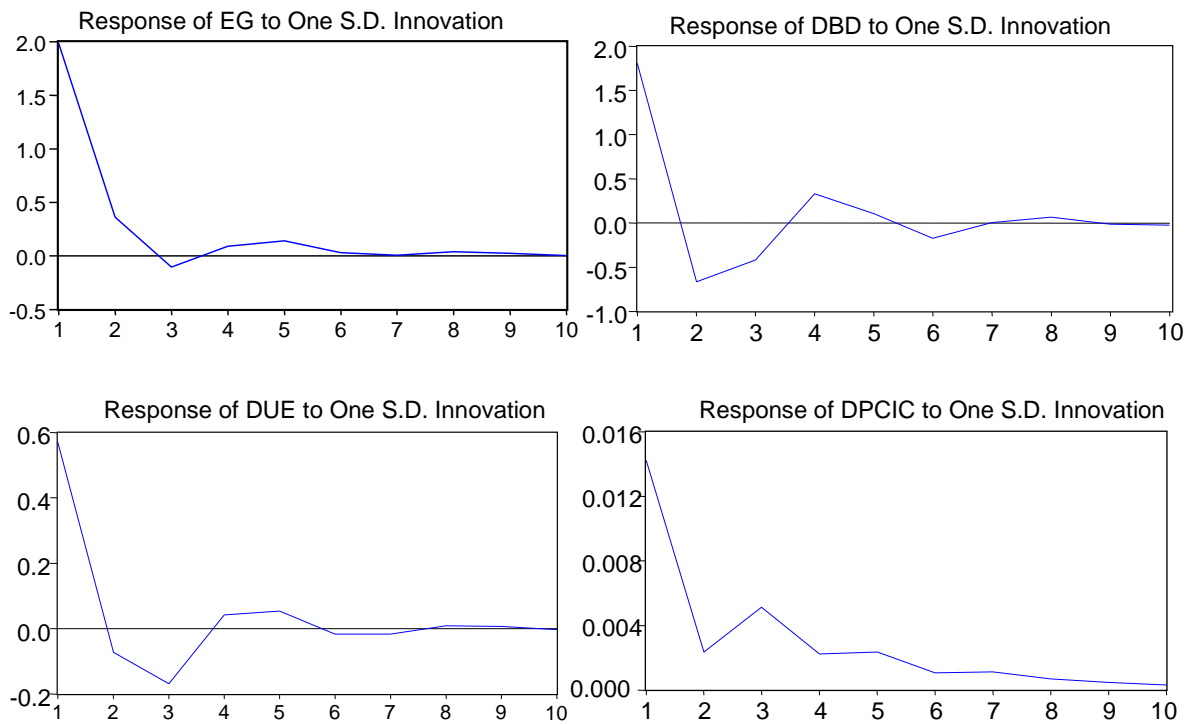


Fig. 1 Economical response to impulses of 1 standard deviation (D.V) innovations

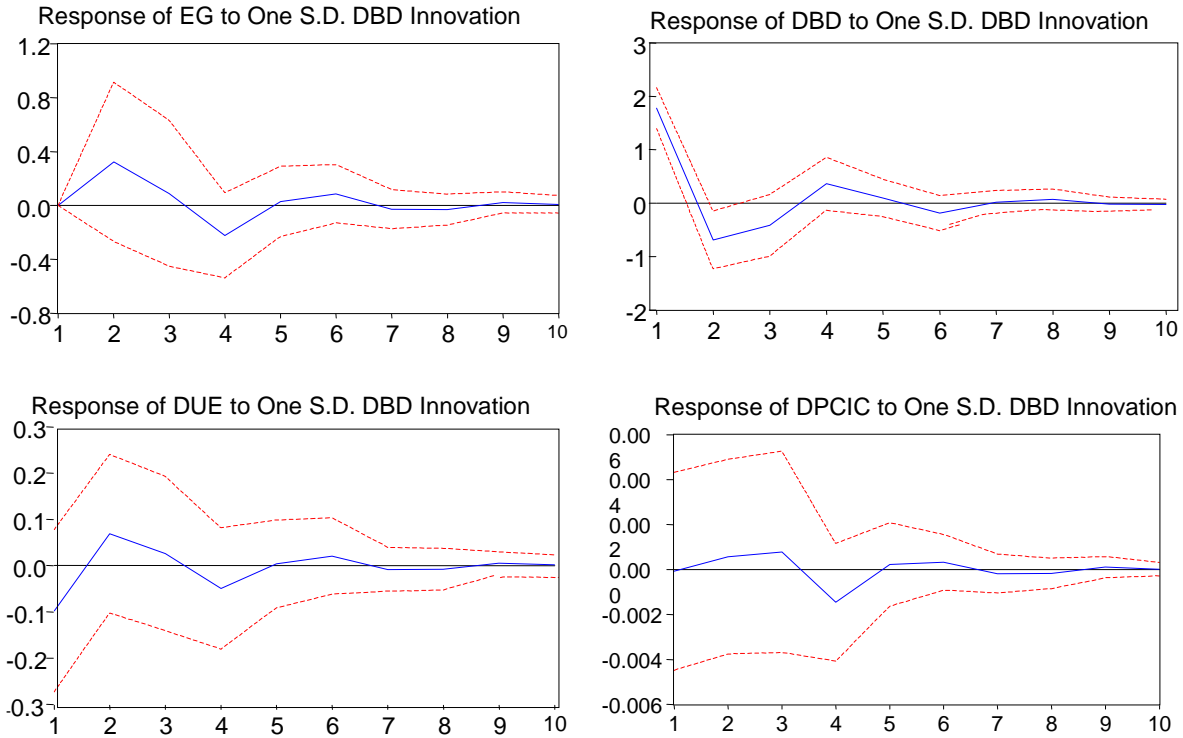


Fig. 2 Economical responses to impulses of 1 standard deviation (D.V) +/- 2 standard errors

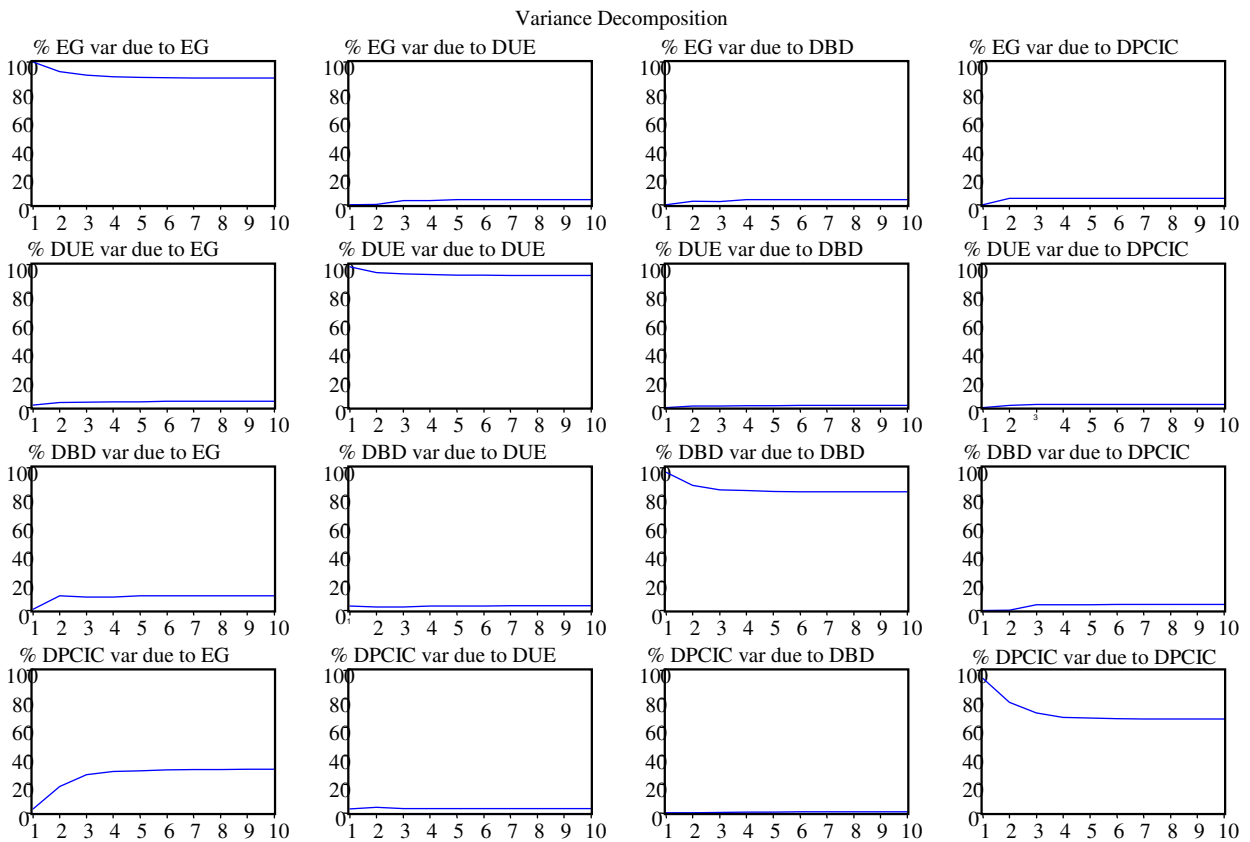


Fig. 3 Variance decomposition

Table I ADF Test for Stationarity (includes intercept but not a trend)

Variables	I(0)		I(1)		I(2)		Result
	Test statistics ¹	Critical value	Test statistics	Critical value	Test statistics	Critical value	
Budget Deficit(BD)	-1.5428[0]	-3.5814	-7.4811[1]	-3.5850			I(1)
Economic Growth(EG)	-6.3822[2]	-3.5814					I(0)
Unemployment (UE)	-0.8091[0]	-3.5814	-6.3643[1]	-3.5850			I(1)
Per Capita Income (PCIC)	0.2681[0]	-3.5814	-6.8389[0]	-3.5850			I(1)

¹Figures in square brackets besides each statistics represent optimum lags, selected using the minimum AIC value.

Table II ADF Test for Stationarity (include intercept and a trend)

Variables	I(0)		I(1)		I(2)		Result
	Test statistics ¹	Critical value	Test statistics	Critical value	Test statistics	Critical value	
Budget Deficit(BD)	-3.3144[0]	-4.1728	-7.3596[1]	-4.1781			I(1)
Economic Growth(EG)	-6.5463[0]	-4.1728					I(0)
Unemployment (UE)	-3.5134[1]	-4.1728	-6.3048[1]	-4.1781			I(1)
Per Capita Income (PCIC)	-2.1363[0]	-4.1728	-6.8160[0]	-4.1781			I(1)

¹Figures in square brackets besides each statistics represent optimum lags, selected using the minimum AIC value.

Table III Values of the impulse response function (IRF)

Period	Response of EG:			
	EG	DUE	DBD	DPCIC
1	1.983119	0.000000	0.000000	0.000000
3	-0.102530	-0.342234	0.088505	-0.009424
6	0.032180	-0.014642	0.086901	-0.070666
9	0.025854	0.027565	0.021953	-0.022333
10	0.002854	-0.011912	0.008422	-0.011188
Period	Response of DUE:			
	EG	DUE	DBD	DPCIC
1	-0.076119	0.569532	-0.097726	0.000000
3	-0.047852	-0.168997	0.025949	0.056864
6	-0.020586	-0.016710	0.020577	0.010507
9	-0.004323	0.006429	0.005397	0.002350
10	-0.006291	-0.003800	0.001691	0.003139
Period	Response of DBD:			
	EG	DUE	DBD	DPCIC
1	0.136566	0.000000	1.802399	0.000000
3	0.061106	-0.020312	-0.420545	0.410246
6	-0.067041	-0.108497	-0.173586	0.084624
9	-0.040433	-0.041791	-0.016108	0.022255
10	0.000938	-0.005934	-0.025852	0.015757
Period	Response of DPCIC:			
	EG	DUE	DBD	DPCIC
1	-0.002510	-0.002486	-7.71E-05	0.014214
3	-0.006319	0.000201	0.000786	0.005121
6	-0.001810	-6.50E-05	0.000319	0.001073
9	-0.000596	0.000127	0.000104	0.000473
10	-0.000492	-2.46E-05	1.34E-05	0.000330

Table IV Values of the variance decomposition

Variance Decomposition of EG:					
Period	S.E.	EG	DUE	DBD	DPCIC
1	1.983119	100.0000	0.000000	0.000000	0.000000
3	2.120294	90.62178	2.617196	2.497447	4.263574
6	2.149390	88.81132	3.109302	3.675332	4.404048
9	2.152058	88.64265	3.233234	3.715522	4.408596
10	2.152138	88.63620	3.236056	3.716776	4.410969
Variance Decomposition of DUE:					
Period	S.E.	EG	DUE	DBD	DPCIC
1	0.582848	1.705612	95.48306	2.811329	0.000000
3	0.629150	3.738180	90.47906	3.785357	1.997399
6	0.637059	4.015287	89.46447	4.399100	2.121144
9	0.637884	4.075649	89.32938	4.425289	2.169683
10	0.637937	4.084707	89.31828	4.425266	2.171749
Variance Decomposition of DBD:					
Period	S.E.	EG	DUE	DBD	DPCIC
1	1.807565	0.570815	0.000000	99.42919	0.000000
3	2.123836	9.435843	1.033575	85.78079	3.749795
6	2.191186	9.981180	2.251524	83.70273	4.064566
9	2.195317	10.02759	2.406555	83.48832	4.077536
10	2.195534	10.02562	2.406810	83.48569	4.081880
Variance Decomposition of DPCIC					
Period	S.E.	EG	DUE	DBD	DPCIC
1	0.014647	2.937546	2.881566	0.002772	94.17812
3	0.018294	26.71655	3.138558	0.282955	69.86194
6	0.019281	30.04778	3.042901	0.869443	66.03987
9	0.019414	30.44771	3.012320	0.876838	65.66314
10	0.019423	30.48353	3.009672	0.876068	65.63073

Table V Appreciation of the causality direction in the four variables

Pairwise Granger Causality Tests			
Sample: 1960 2005			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Probability
DBD does not Granger Cause EG	43	0.69092	0.50730
EG does not Granger Cause DBD		2.88346	0.06825
DUE does not Granger Cause EG	43	0.99338	0.37973
EG does not Granger Cause DUE		1.10684	0.34102
DPCIC does not Granger Cause EG	43	1.06022	0.35640
EG does not Granger Cause DPCIC		4.03822	0.02569
DUE does not Granger Cause DBD	43	0.03237	0.96818
DBD does not Granger Cause DUE		0.52139	0.59788
DPCIC does not Granger Cause DBD	43	1.27210	0.29191
DBD does not Granger Cause DPCIC		0.16150	0.85144
DPCIC does not Granger Cause DUE	43	1.52102	0.23149
DUE does not Granger Cause DPCIC		0.09362	0.91083

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