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CAUSAL ANALYSIS OF THE RELATIONSHIP BETWEEN EXCHANGE RATE AND GOVERNMENT DEFICIT: EVIDENCE FROM INDIA

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ABSTRACT

Causal relationship between the exchange rate and government deficit has a long time debate in economic circle. A number of theories emerged in the past explained their relationship, but still it is inconclusive. This paper attempts to investigate the dynamic relation between exchange rate and government deficit in India during a period from April 2001 to March 2017. The results of VAR Granger causality found unidirectional causality that moves from exchange rate to government deficit. ARDL co-integration test results exhibit no long run relation between the variables. The results of Impulsive Response Function indicate that government deficit responses positively to the one SD shock in exchange rate; exchange rate, in the similar fashion responses positively to the one SD shock in government deficit. The variance decomposition results indicated that a shock to the exchange rate causes 2.069 percent fluctuation in the government deficit in short run and up to 9.04 percent in long run, while a shock to government deficit does not cause any fluctuation in the exchange rate in short run and in long run a shock to government deficit causes 3.65 percent fluctuation in the exchange rate that is very less.

Keywords: Exchange Rate, Government Deficit, VAR Granger Causality, SVAR, Impulsive Response Function, Variance Decomposition

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INTRODUCTION

Huge variations in exchange rates and large budget deficits are among most serious problems in developing countries. The macroeconomic theories state that large budget deficits result in damaging effects on many macroeconomic variables, such as increased interest rates in domestic market, discouraged private investments and current account deficits. Feldstein (1987), through "twin-deficit hypothesis" stated that large public deficits cause the current account deficit. In order to correct budget deficit, the government maintains higher interest rates compared with their foreign counterparts. This results into inflow of foreign capital leading to domestic currency appreciation and thus deterioration in trade (Feldstein, 1985, 1987). Ricardo, in contrast viewed that increase in government debt results in to increase in future taxes for making payment of debt amount plus interest due on maturity. Thus, for private sector, public debt is not an addition to wealth as it does not have impact on consumption, interest rates, and aggregate demand (Barro, 1987). The consumers consider bonds as a net wealth and their maturity value as a future tax liability, so, do not increase the consumption expenditure. In this way there is no effect of debt on interest rates, consumption and aggregate demand and thus exchange rate remains unaffected.

REVIEW OF LITERATURE

A number of researchers in the past carried out studies to explore the causality relation between government deficit and exchange rate in different economies. Some economists, like Barro (1987), Evans (1985, 1987a, 1987b) and Hoelscher (1983) found no relation between budget deficits and interest rates. In contrast, Al-Saji (1992), Barth et al. (1985), Cebula (1988, 1993), Cebula and Koch (1989), Hoelscher (1986), Miller and Russek (1991) and Zahid (1988) observed that federal budget deficits have contributed to higher levels of interest-rate yields. Knoester and Mak (1994) in a study covering eight OECD economies observed that only in Germany, government budget deficit contributed significantly to the explanation of higher

interest rates. Alse and Bahmani (1992), Darrat (1988), and Miller and Russek (1989) in an empirical analysis demonstrated perverse relation. Cebula and Hung (1992) and Wijnbergen (1987) have shown that higher budget deficits in Canada have led to higher interest rates and an appreciation of the Canadian dollar.

Sachs and Wyplosz (1984) examined effect of fiscal policy on real exchange rate. They observed composition of government spending an important factor alongwith degree of asset substitutability, initial size of the public debt and net external position responsible for the effect of fiscal policy changes on real exchange rate. Wijnbergen (1987) studied the behavior of Inflation under floating and fixed exchange rate regimes. He observed that changes in inflation and exchange rate under floating exchange rate system are caused by the external shocks and internal structuring through their impact on government budget. He also noted that an underlying fall in government budget constraints facilitate the exchange rate crisis followed by inflation rate.

Apergis (1988), in a sample of four OECD countries found short term as well as long term causality between budget deficit and effective exchange rate. He also observed that budget deficit and interest rates are cointegrated having long run causal relation; budget deficit results in high interest rates because of government demand conflict with the financial requirements of the privates. Hakkio (1996) observed direct as well as indirect effect of Budget deficit on demand for funds that affects the exchange rate differently. As direct effect, deficit reduction leads to weaker exchange rate, as indirect effect it results in to stronger exchange rate. Rahman et al. (1996) investigated long run relationship between US budget deficit and exchange rate by using cointegration approach. The estimates of error correction model indicated a unidirectional long run and short run causality between selected variables at 5 and 10 percent level of significance.

SuYuli and SuTien-Ming (2003) examined the relationship between exchange rate and deficit in eight euro currency countries and seven Asian countries by applying Hakkio model (1996). The results revealed that currency value was inversely related

to budget deficit. Chatterjee and Mursagulov (1996) in a study on determinants of gross public debt tried to examine impact of deficit reduction episodes on exchange rate. In two scenarios, viz., deficit reduction by cutting spending and by increasing revenue, he observed that large deficit reduction due to spending cuts results into stronger exchange rate. Chinwendu et al. (2017) investigated causal relationship between fiscal deficit and exchange rate in Nigeria by applying VAR approach. The results indicated long run relationship between government deficit and exchange rate irrespective of options for deficit financing, viz., domestic and external.

Stoker (1999) made an attempt to analyze the effect of government spending on the exchange rate. The results simulation technique used in the study indicated minimal long term effect and strong short term effect of government spending on the exchange rate. Vuyyuri and Seshaiah (2004) examined the relationship between government deficit and macroeconomic variables in India by applying cointegration and VECM approach. He observed cointegration among all the variables and the bidirectional causality between budget deficit and nominal effective exchange rate. Waqas and Aswan (2012) tested the Recardian Equivalence Hypothesis in Pakistan in terms of interest rate and exchange rate. They applied ARDL approach of cointegration and found a long run relation among the variables. The results however indicated no impact of government deficit and debt on exchange rates.

Chatterjee and Mursagulov (2012) examined the dynamic system through which government expenditure, public infrastructure, and financial policies affect the exchange rate. Based on findings of study, they viewed that the impact of government spending on exchange rate appreciation or depreciation totally depends on the sectoral composition of government spending, financing policy, sectoral capital intensity in production, and the sectoral output elasticity of public capital. Saysombath and Kyophilavong (2013) applied ARDL cointegration methodology and VAR-SVAR techniques to analyze long and short run dynamic relation between exchange rate and budget deficit in Lao PDR. They observed no long run relation and causality between exchange rate and budget deficit in Laos.

RESEARCH DESIGN

Motivation

The findings of empirical studies conducted to examine dynamic relation between exchange rate and government deficit do not accord each other, rather ambiguous. Some researchers found unidirectional while others bidirectional causality between exchange rate and government deficit. Further, some studies observed that there exists no causal relation between exchange rate and government deficit. The inconclusive situation and contradictory results of studies motivated the researchers to examine the causal relation between the exchange rate and government deficit in India taking data for a period from April 2001 to March 2017.

Research Questions

- What is the nature of relationship between exchange rate (INR/USD) and government deficit?
- What is the direction of causality between exchange rate and government deficit?
- How and in what manner one variable (exchange rate or government deficit) affects other variable?

RESEARCH METHODOLOGY

To achieve above objectives, we have used econometric techniques on quarterly data of government deficit and exchange rate for a period from April 2001 to March 2017. VAR Granger causality test is used to check the direction of causality, ARDL approach of Cointegration is applied to investigate long term relation between variables, and Impulsive Response Function under SVAR environment is used to know the response function of the variable against exogenous shocks. In order to measure fluctuation in dependent variable due to shocks or innovations, Variance Decomposition in SVAR environment is applied.

Lag Selection: Lag selection is a crucial econometric exercise that determines the lag length of an autoregressive process of a time series. Though, there are number of criterions, e.g., Akaike information criterion (AIC), Schwarz Information Criterion (SIC), Hannan-Quinn Criterion (HQC), Final Prediction Error (FPE) and Bayesian Information Criterion (BIC) for selecting lag length, more often AIC is used to check the lag length. In our study, lag length is selected by using three main criterions, viz., AIC, SIC and HQC.

Tests for Stationarity: Most of the econometrics techniques are based on the assumption of stationarity of time series. When the statistical properties of a time series such as mean, variance and covariance are indifferent to time, the series is said to be stationary and vice versa. Most of the macroeconomic variables are non-stationary in nature, thus need to be transformed into stationary series before applying econometrics tools on them. There are number of parametric and non-parametric stationarity tests, called as Unit Root Tests. Researchers normally use more than one (or combination) stationarity tests, and based on majority in the results; they examine the nature of the series. In this paper, stationarity of the variables is tested by using parametric and non-parametric tests, i.e., Augmented Dickey Fuller test (ADF), Modified Dicky Fuller test (DF-GLS) and Phillips-Perron (PP) test.

Cointegration: As most of the macroeconomic variables are not stationary in nature, applying OLS or similar methods on such variables give spurious results about their relation. Cointegrated variables are linked to form an equilibrium relationship spanning the long run. In fact, one variable drags the other over the period and hence, both of them share the same movement (Shrestha & Bhatta, 2018). If variables are I(1) processes and their linear combination is I(0), the variables are said to be cointegrated and their long run relation is not spurious.

Among various tests of cointegration, Johansen Cointegration test is most popular. It considers I(1) processes only. Hence, to examine the long term relationship between exchange rate and government deficit, we have used ARDL approach of

cointegration which considers I(0) and I(1) processes. The mathematical form of ARDL in the present study is as follows.

$$Logexrate = a+\beta_1 D(logexrate(-1))+\beta_2 D(loggovdef(-1))+\beta_3 logexrate(-1)+\beta_4 loggovdef(-1)$$

In this equation, Logexrate is log of exchange rate (Rs./$), Loggovdef is log of government deficit, β_3 and β_4 are long term coefficients which exclaim the existence of cointegration between the variables of interest.

Granger Causality Test: It determines if the current and lagged values of one variable (x) can cause the future value of the other variable (y). Its mathematical form is based on linear regression modeling of stochastic processes (Granger 1969). The Granger causal relation between government deficit and exchange rate can be expressed as:

$$logexchrate_t = \Sigma a_i\, loggovtdef_{t-i} + \Sigma b_j\, logexchrate_{t-j} + u_{1t}$$

$$loggovtdef_t = \Sigma \lambda_i\, loggovtdef_{t-i} + \Sigma \delta_j\, logexchrate_{t-j} + u_{2t}$$

Here, it is assumed that the disturbance terms, u_{1t} and u_{2t} are uncorrelated, and causality can be unidirectional or bidirectional, i.e., exchange rate causes government deficit, or government deficit causes exchange rate, or both the variables cause each other.

Structural Vector Autoregressive Model (SVAR): Structural VAR (SVAR), an improvement over VAR model overcomes the limitation of the traditional identification problem. It includes restrictions to identify exogenous or structural shocks. The short run restrictions are placed on the matrices A and B. The structural form of SVAR model is SVAR (1) $\Rightarrow AX_t = \beta_0 + \beta_1 X_{t-1} + \mu_t$. Here, X has two variables 'Exchange Rate' (r) and 'Govt. Deficit' (y).

This can take form $X_t = \begin{bmatrix} r_t \\ y_t \end{bmatrix}$. Accordingly, the system will be:

$r_t + a_{12} y_t = \beta_{10} + \beta_{11} r_{t-1} + \beta_{12} y_{t-1} + \mu_{rt}$

$a_{21} r_t + y_t = \beta_{20} + \beta_{21} r_{t-1} + \beta_{22} y_{t-1} + \mu_{yt}$

In matrix form it can be written as: $\begin{bmatrix} 1 & a_{12} \\ a_{21} & 1 \end{bmatrix} \begin{bmatrix} r_t \\ y_t \end{bmatrix} = \begin{bmatrix} \beta_{10} \\ \beta_{20} \end{bmatrix} + \begin{bmatrix} \beta_{11} & \beta_{12} \\ \beta_{21} & \beta_{22} \end{bmatrix} \begin{bmatrix} r_{t-1} \\ y_{t-1} \end{bmatrix} + \begin{bmatrix} \mu_{rt} \\ \mu_{yt} \end{bmatrix}$

In the above matrix, coefficients a_{12} and a_{21} are elements of matrix A; they represent a contemporaneous relation between the endogenous variables, i.e., government deficit and exchange rate. In SVAR model, restrictions based on economic concepts and theories are imposed on the contemporaneous relation among endogenous variables of the model. On multiplying matrix A with VAR estimation model, we get SVAR model. Further, on multiplying SVAR model by inverse A, we get reduced form VAR, i.e., $A^{-1}AX_t = A^{-1}\beta_0 + A^{-1}\beta_1 X_{t-1} + A^{-1}\mu_t$. It can also be expressed as $X_t = G_0 + G_1 X_{t-1} + e_t$. Matrix A relates with forecast errors of the reduced form VAR, e_t and structural shocks, μ_t; thus, $e_t = A^{-1}\mu_t$.

SVAR isolates exogenous shocks and measures the impact of these shocks on the variables included in the model. Forecast errors are linear combinations of the structural shocks. These shocks can be identified directly from reduced form residual (e_t) with matrix B; such as, $e_t = B\mu_t$. The more general way of relating errors and shocks in structural VARs used by Bernanke and Mihov (1998), Blanchard and Perotti (2002) and others is by combining these two matrices. Thus, $e_t = A^{-1}B\mu_t$

Restrictions imposed on matrix A, such that:

$$A = \begin{pmatrix} 1 & 0 & \ldots. & 0 \\ a21 & 1 & \ldots. & 0 \\ \ldots. & . & . & \ldots \\ ak1 & ak2 & \ldots. & 1 \end{pmatrix}$$

Restrictions in A matrix are imposed on the off diagonal terms based on economic concepts. The diagonal terms indicate unit change effect of the variable on itself that should be one; while off diagonal terms indicate contemporaneous relation among the variables that are given restrictions according to economic theories. The matrix is

always in a square form, thus for two variables model 2x2 matrixes, for three variables model 3x3 matrixes and so on is used. The number of restrictions are identified as k(k-1)/2, where k is the number of variables included in model.

$$A = \begin{pmatrix} r \to r & y \to r \\ r \to y & y \to y \end{pmatrix}$$

In our study there are two variables, hence, it is a 2x2 matrix and the number of restriction is one. The diagonal terms are indicating relation of variables i.e. government deficit (y) and exchange rate (r) with themselves. That would be positive and equal to unity, as own effect has to be one. The off diagonal term in second row and first column is indicating covariance coefficient for effect of exchange rate on government deficit, while the term in first row and second column indicates covariance coefficient for government deficit effect on exchange rate.

The SVAR model assumes structural shocks orthogonal; it means the innovations or shocks (μ_{rt}, μ_{yt}) are not correlated. With this idea structural shocks are identified with the help of matrix B that is a variance-covariance matrix in which covariance is restricted to zero. B matrix places restrictions on error structure which is not changed usually. $B = \begin{pmatrix} . & 0 \\ 0 & . \end{pmatrix}$

Impulse Response Functions and Variance Decomposition: The Impulse Response Functions (IRF) generated in SVAR environment depicts the response of one variable to an impulse in another variable in a system that may involves a number of further variables as well. IRF is the path that x follows if it is kicked by one unit shock. It means $e_{t-j} = 0, e_t = 1, e_{t+j} = 0$ (Cochrane, 2005). It transforms the SVAR vector $AX_t = \beta_0 + \beta_1 X_{t-1} + \mu_t$ into a sum of shocks or Wold representation, such as, $Xt = u_t + S_{i=0}^{\infty} (c_i u_{t-1})$.

The variance decomposition depicts the fluctuation or variance in dependent variable throughout the lags, caused by shocks or innovations or impulses to the independent variable. It shows proportion of the movements of a variable due to shocks to itself and to shocks to other variables.

RESULTS AND DISCUSSION

Based on majority criterions, viz., AIC, SIC and HQC, the lag length considered is one. The results of ADF, DF-GLS and PP tests applied on log transformed data series (ln) of exchange rate and government deficit revealed that government deficit is stationary at level, but exchange rate is stationary at I(1) process (table 1).

The ARDL long term coefficients β_3 and β_4 (table 2) are tested by using Wald test to confirm if there exists any long run relation between variables. Since, P value of Wald test is more than 0.05, the hypothesis $\beta_3 = \beta_4 = 0$ is accepted. This indicates that the government deficit and exchange rate do not move together in long run (table 3).

The test results of VAR Granger Causality (table 4) indicate that government deficit does not cause exchange rate (p value, 0.1364 > 0.05); but exchange rate causes government deficit (p value, 0.0480 < 0.05). Thus, there exists unidirectional relation between the variables moving from exchange rate to government deficit (r to y) and not from government deficit to exchange rate (y to r). The restriction zero is given on covariance coefficient for government deficit effect on exchange rate, i.e., $A = \begin{pmatrix} . & 0 \\ 0 & . \end{pmatrix}$. The covariance coefficient of effect of exchange rate on government deficit, as indicated by SVAR results, is - 0.386199. (Table 5)

The results of Impulsive Response Function under SVAR environment indicate that the response of government deficit to one SD shock in exchange rate is positive and perishes after 5.5 quarters. It means there is no long run effect of exchange rate on government deficit. The response of exchange rate to one SD shock in government deficit is also positive, but dies after 4.5 quarters. Thus, here also no long term effect has been observed (figure 1). The results of variance decomposition indicate that in short run (lag 1), a shock to the exchange rate causes 2.069 percent variance in the government deficit, while in long run (lag 10) it is 9.04 percent. Similarly, a shock to the government deficit in short run (lag 1) causes zero variance in exchange rate, while in long run (lag 10) it causes 3.65 percent variance in exchange rate (table 6).

CONCLUSION

This paper is an attempt to examine the causality relation between government deficit and exchange rate in India under SVAR environment. The results of the analysis clearly indicate no long run relation, but a unidirectional causality that moves from exchange rate to government deficit in short run. A shock to government deficit does not explain much variance in the exchange rate, while a shock to exchange rate explains the variance of government deficit 2 to 9 percent. So far as direct causal relation is concerned, it can be concluded that exchange rate affects the government deficit in short run, while the effect of government deficit on exchange rate is negligible.

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