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Causality between Exchange Rate and Foreign Exchange Reserves in the Indian Context

Mayuresh S. Gokhale [α] & J. V. Ramana Raju [σ]

Abstract - Using a time series data of the variables between 1980 and 2010 the present study tries to establish a causal relationship between exchange rate and foreign exchange reserves in the Indian context. Emphasis has been laid on understanding the impact of foreign exchange reserves on the exchange rate. India has accumulated unprecedented foreign exchange reserves and synchronously has been experiencing a large depreciation in its Rupee vies avis US dollar. This trend prompted us to undertake this study to establish some association between the two trends. Our analysis uses Unit Root test, Johansson Co -integration test and Vector Auto Regression (VAR) and concludes that there is no long and short term association between exchange rate (EXR) and foreign exchange reserves (FOREX) in the Indian context. It can be concluded that the accumulation of fore reserves are only in anticipation of overcoming any global financial crisis and maintaining credit rating which in turn could repose faith in the investors and attract large investments in the form of foreign direct investment and portfolio investments. The accumulation of fore reserves may not be used as a tool to tame exchange rate as suggested by some authors.

Keywords : foreign exchange reserves, exchange rate, fore, ear, vector auto regression (vary) appreciation and depreciation of currency. money supply.

I. Introduction

Exchange rate fluctuation over a wide range bi - directionally (ceiling and floor) or in unidirectional way tends to have a debilitating effect on the overall trade. Nations following the policy of import linked export promotions will have a deep impact by currency depreciation on production costs there by triggering inflation. The firm level debt component rises increasing its liability. The appreciation of currency creates a dampening environment for the exporters. Today the global trend in currency management is to arrest appreciation and allow depreciation within limits thereby rendering the economies export driven. The exchange rate fluctuation can be intuitively governed by umpteen parameters which may include economic and non-economic factors like the capital inflows, interest rates prevailing in the economy, the rate of inflation, volume of foreign exchange reserves, current account balances, GDP growth rate, fiscal deficit, import to GDP ratios, export to GDP ratios, political stability, development indices, the corruption index, the health of global economy etc. The present study tries to understand the association between the foreign exchange reserves, and the exchange rate in Indian economy between 1980 and 2010. India has experienced an unprecedented increase of foreign exchange reserves (currency assets considered) which stands at 122.48 billion dollars in 2010-11 which is consistent with the Asian trend of accumulating excessive foreign exchange reserves. On the current account balance front India has always faced current account balance deficit except between 2001 and 2003 when the current account balance was in surplus which was largely attributed to enhancement in the export of services. In 2010 the current account deficit stood at -42.807 billion dollars. The exchange rate vis a vis US dollar is consistently on a depreciating mode .The question we are trying to investigate here is whether the independent variables under consideration namely for-eign exchange reserves(FOREX) have a bearing on the dependent variable exchange rate (EXR) ? We further want to contemplate on whether there is an optimization principle applicable in this context which would contain wide fluctuation of exchange rate.

II. Literature Review

Countries are known to maintain reserves to effectively manage their exchange rates and reduce adjustment costs associated with fluctuation in the international payments. The 'rule of thumb' of main-taining optimal reserves is equivalent to at least 3 months of imports (Mendoza 2004). High for reserves are maintained to tide over global, economic and financial instability. The 1997 SE-Asian crisis is a good testimony to this (Stieglitz 2006). It is a tool for maintaining lower exchange rate to promote trade and international competitiveness, mercantilist motive (Aizenmann & Lee 2005) High for reserves boost investor confidence and augment investment and growth. According to Dooley, Filbert Landau and Garber (2004) reserve accumulation reflects intervention of Asian Central Banks who want to prevent currency from appreciation against dollar to promote export led growth.

Researchers have come out with certain optimization principles in terms of certain ratios to check the quantum of fore exchange reserves accumulated. Excessive accumulation of the reserves would be futile; therefore a mechanism of judicious utilization of the prevalent for reserves in favor of the economy is imperative.

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a) Reserve to Import Ratio

Tiffin (1960) suggested that the constant reserve to import ratio ranging from 20– 40%. European Central Bank (2006) regards four months import coverage as a 'rule of thumb'.

b) Reserve to Domestic Money Supply (M2)

Matchup (1960), Freckle (1971) suggested that the quantum of fore reserves should be maintained anywhere between 5 to 20% of the money supply.

c) Reserves to Short Term Debt Ratio

Brown (1964) gives analysis of reserves to net external balance ratio on ground that the reserves function as cushion against future Bop deficits. This ratio reflects economy's financial ability to serve existing short term external debt flow. Greenspan and Guidotti (1990) suggested that the fore should at least cover short term debts in countries with limited access to international capital markets.

d) Opportunity Cost

Heller (1966) introduced cost benefit perspective. Aggarawal (1970) modified Heller's model on the ground that opportunity cost of reserve holding is value created by foreign currency held by monetary authority instead of imported productive goods.

Again, Bacchante, Racier and Roof (2006), found that real exchange rate volatility is harmful for the growth of the country and reduces it, this problem is more severe in countries with less financial development. Dooley, Folkerts– Landau and Garber (2003) viewed hoarding of reserves as a mechanism to facilitate growth and maintain undervalued real exchange rate in the context of China.

III. Objective of the Study

The excessive accumulation of fore reserves is been beyond absorption capacity and has distorted the primary ratios which are theoretically optimized. The present study tries to estimate whether such unprecedented levels of fore reserves have a bearing on the exchange rates, which otherwise would have a cascading effect on the trade. An appreciation of the Indian rupee is bound to hit the export valuations and the depreciation would severely distort import bills. The study focuses on estimating empirically long run and short run effect of the quantum of fore reserves on exchange rate using VAR - Vector Auto Regression technique.

IV. Methodology

The time series data (data source like RBI website) of the foreign exchange reserves (only foreign exchange currency reserves considered here) and the exchange rate (Indian Rupee versus dollar) between 1980 to 2010 is considered for the present study. EXR (Exchange rate) is the dependent variable and FOREX (Foreign Exchange Reserves) is the independent variable The data is being statistically processed using Unit Root Test to check the stationary of the variables under consideration, Johansson Co integration test to analyze the long run association between exchange rate and fore reserves and VAR (Vector Auto Regression) to find the long and short run association between the variables.

V. Mathematics of Analytical Tools

When we see a phenomenon over a period of time, observing certain variables in steps of time, then we are essentially generating "Time series data". The analysis of time series is based on the idea that each series is the empirical realization of stochastic process acting behind the economic evolution. In other words an underlying stochastic process generates time series observations.

Let it be a discrete time series. In our case Xt is the independent variable namely the foreign exchange reserve abbreviated as FOREX henceforth. Similarly let yet be the dependent variable which in our case is the exchange rate abbreviated as EXR. The standard technique of regression analysis is based on the tenet that the variable yet has a well defined relationship with Ex. In our modeling the initial assumption is that EXR is a function of FOREX. If one would like to fit a linear regression model then we are essentially looking out for an equation of the type $Y_t=aX_t+b$ (1).

But a critical observation shows that the residuals in the time series of At and Yet do not form a white noise process since there exists a unit root which we observed by running the augmented Dickey-Fuller test (ADF test) which implies that the repressors do not exhibit stationary. After taking first differences, the variables FOREX and EXR together exhibit stationary.

When two or more time series are involved, one needs to check for two way casualty for long run influences. The concept of co integration introduced by Granger and Clive is as follows. The variables Y1, Y2....Yen are said to be co integrated if these variables move together or have a long run association. More generally a vector of I(1) random variables Yet is said to be co integrated if there exists a vector if- such that βi-Yt is trend stationary. In such a case one looks at a linear combination of vectors which exhibits co integration. The rank of the co integration matrix indicates the number of co integrated variables. To test if the variables in our experiment are co integrated we run the Johansen test (MacKinnon-Hag-Michelins criteria) for checking the trace of the co integration matrix. The lack of cointegrationat 0.05 level in our case suggests that there is no long run equilibrium of association between the FOREX and EXR variables in our study.

Hence we proceed to the vector auto regression model without alluding to the adjustment parameters

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that ought to be sought through VECM method in case of a co integrated trend.

a) VAR Model

A typical autoregressive model (AR (p)) of order p is used when the variables concerned are depending on 'p' lags. In (2) below we write the equation that models such an autoregressive process.

$$y_t = c + a_1 y_{t-1} + \ldots\ldots a_p y_{t-p} + \varepsilon_t \quad (2)$$

We note that are stochastic terms incorporating the fluctuations or noises attributed to certain unexpected events happening. A vector auto regression model is considered when n number of variables together follows a correlation with influences from past (lagged) values of themselves. We also note that in our specific case the value of n is 4 and the value of p is 2. The AIS criteria is the one through which we have fixed two lags for our VAR model, since taking lag 2 we get the required stationary of the time series ensemble. The equation (2) is a typical autoregressive model for a single variable. Let represent the variable in the AR model corresponding to, represent the variable in the AR model corresponding to and so on. Thus we have the vector incorporating all the variables that we have considered which we denote for simplicity as indicating its value for the current time series. Similarly its lags are denoted by etc. Thus the autoregressive model considering all the macroeconomic variables reads as in equation (3).

$$Y_t = c + a_1 Y_{t-1} + \ldots\ldots a_p Y_{t-p} + E_t \quad (3)$$

VI. Findings

The ADF Unit root test shows that the exchange rate variable has a unit root at Level i.e. the data is non stationary which is indicated by p values greater than 5 percent. The Null Hypothesis states that the Variable is not stationary or it has a unit root. As the p value is > 5% we cannot reject the Null hypothesis. Therefore at level exchange rate exhibits a unit root or the data is non stationary. At First difference the significant p values for ADF are less than 5 percent. As the values of p are < 5% we can reject the Null hypothesis concluding that at first difference the exchange rate is stationary. The Unit root test for fore indicates significant p-values less than 5 percent indicating that the variable is stationary at Level. To ensure whether the variables under study are co integrated or to check whether they exhibit a long term association we use Johnson's Co integration test. Here we use Trace statistics for our analysis. The p-value at None (no variables being co-integrated) is 0.5561 and At most 1 (1 variable co -integrated) is 0.1922 indicating that EXR and FOREX are not co integrated and do not exhibit long term association among themselves. As the variables under consideration do not exhibit co integration we undertake unrestricted VAR (Vector Auto Regression) model.

The VAR output indicates that coefficients of fore at different lags C3 and C4 in the equation show p-value of 0.3114 and 0.2630 respectively which are insignificant indicating that the foreign exchange reserves variable does not exhibit a long run correlation with the exchange rate. neither the exchange rate coefficients C 6 and C7 as independent variables exhibit any long run correlation with fore reserves. The short run correlation between four and ear can be quantified by Wald test for C3 and C4 the chi square statistic p-value being 0.4805 which is>5% indicating that C3=C4=0 and jointly do not influence the exchange rate. Thus the statistical investigation clearly rules out booth long term as well as short term association among the variables considered.

VII. Conclusions

The quantum of foreign exchange reserves essentially does not exhibit a long run or short run correlation with the exchange rate in case of Indian economy. Although the accumulation of fore reserves are unprecedentedly high thereby exhibiting a marked departure from the thumb rule ratios suggested by several researchers, it does not have a direct bearing on the exchange rate as suggested by some authors and there could be many other parameters that contribute to excessive fluctuating in the currency exchange rate between a U. S dollar and Indian Rupee. The foreign exchange reserve accumulation in the Indian context could have been largely in anticipation of overcoming financial crisis than a tool for regulating the exchange rate. It could also be looked upon as a face lift to the Indian economy through enhanced credit ratings which in turn would attract investors to India in the form of foreign direct investment and portfolio investments thereby supplying the much needed capital for stimulating economic growth.

VIII. Future Cues

Working on the opportunity costs pertaining to the excessive accumulation of foreign exchange reserves, working out judicious ways of managing Fore reserves could be the areas where substantial academic work can be undertaken. We would like to indicate in our future studies an optimal model for managing fore reserves.

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Appendix

Statistical Data Processing Output

At Level	EXR	p-value	At 1 Diff	EXR	p-value	At Level	Forex	p-value
	Trend	0.6567		Trend	.001 2		Trend	0.0017
	Trand Int.	0.9643		Trand Int.	0.0049		Trand Int.	0.0135
	None	0.9848		None	0.0005		None	0.0001

Table 1 : Unit Root Test for ear and fore under intercept, trend and intercept and none

Co-Integration Test

Unrestricted Co integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	0.05 Critical Value	Prob.**
None	0.172344	7.185944	15.49471	0.5561
At most 1	0.056948	1.700382	3.841466	0.1922

Trace test indicates no co integration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level

Table 2 : Co-integration Test

Vector Auto regression test for Ear and fore to check long run correlation

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	1.195915	0.24141	4.953882	0
C(2)	-0.235663	0.250368	-0.941268	0.3513
		0.00081	1.023084	0.3114
C(4)	-0.000955	0.000843	-1.13266	0.263
		1.17681	.794769	0.079
C(6)	-25.86141	68.99923	-0.374807	0.7095
		71.5595	.720224	0.4749
C(8)		0.23241	5.103295	0
C(9)	-0.204015	0.24104	-0.846393	0.4015
C(10)	-332.6832	336.3561	-0.9890	0.3276
Determinant residual covariance		1335491		

Equation : EXR = C(1)*EXR(-1) + C(2)*EXR(-2) + *FOREX(-2) + C(5)

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R-squared	0.974092	Mean dependent var	32.05414
Adjusted R-squared	0.969774	S.D. dependent var	14.19296
S.E. of regression	2.467547	Sum squared resid	146.1309
Durbin-Watson stat	2.099706		

Equation: FOREX = C(6)*EXR(-1) + C(7)*EXR(-2) + C(8)*FOREX(-1) + C(9)*FOREX(-2) + C(10)

R-squared	0.976301	Mean dependent var	3049.069
Adjusted R-squared	0.972352	S.D. dependent var	4241.516
S.E. of regression	705.2694	Sum squared resid	11937719
Durbin-Watson stat	1.833393		

Table 3 : Short run association

Coefficient diagnostics to establish short run association

Wald Test:
System: Untitled

Test Statistic	Value	df	Probability
Chi-square	1.465951	2	0.4805

Null Hypothesis Summary:

Normalized Restriction (=0)	Value	Std. Err.
C(3)	0.000832	0.000813
C(4)	-0.000955	0.000843

Restrictions are linear in coefficients.

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