An Econometric analysis pertaining to exchange rate dynamics in India

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Abstract; The volatile exchange rate has created ripples in economies across the world more so in emerging market economies(EME's). Almost all the EME's have witnessed deep depreciation of their respective currencies and India is not an exception to this trend . The current depreciation of Indian Rupee vis a vis U.S Dollar which created lots of concerns had a cascading effect on the economy. A developing country like India , which overwhelmingly relies on imports, which in turn is sensitive to the depreciating mode of exchange rate tends to splurge the production costs and thereby triggers an overall inflation in the economy. Also the level of interest rates prevailing in the economy tends to promote or curb the investments.

The current paper tries to empirically investigate the co rrelation between the exchange rate inflation , interest rate using a time series data between 1990 and 2010 .The Regression analysis shows that the model is suitable as the data is moderately fitted. The Unit root Test suggests that the data is not stationary at Level and thereby the VAR analysis is undertaken . It shows that both the inflation and interest rates do not exhibit any long run association with the exchange rates and therefore cannot independently influence the exchange rate. But in a short run both the interest rates and inflation jointly influences the exchange rates as substianted by Wald test.

Key words; Depreciation , Inflation , interest rate , Regression, Unit root , Auto regression

Introduction;

The current macroeconomic factors prevailing in the Indian economy are highly erratic. India has been experiencing unprecedented depreciation of its currency to an extent of above 12 %or so in a single year previous year. The rate of inflation continues to be at the higher end, the growth rate of the economy has virtually halved and is hovering around 5 % from a excessively high rate regime of 8-9% in 2007-08. The interest rates continue to be high thereby slows down the investments, production and overall growth phase of economy. The above mentioned economic indicators are instrumental in sustaining the economic growth engine. It is of utmost importance that these parameters are maintained within a region of a floor and ceiling or at a optimal level so that the economy can seek the desired impact ,that of growth , reducing unemployment and enter into a situation of stagflation.

The implications of the depreciation of exchange rates include dearer imports which tend to hike the production costs and the overall input cost of the product and thereby creating inflationary situation .This spurt in the inflation has a cascading effect on the economy. It is well established that the inflationary expectations gets embedded in the economy and sets in the stage for future spiralling effect of inflation. Although the condition of currency depreciation is a boon to exporters, it is largely restricted to the economies that exhibit a large export share. Indian export situation being rather sluggish and a there being a trade deficit over the years is an indication that imports override exports in the case of Indian economy. Secondly higher interest rates will dissuade investments which are an imperative in infrastructural projects, which in turn would help in capacity building and create a competitive environment for trade. Similarly a high level of inflation leads to the contraction in the demand which indirectly hampers economic activity and growth. The said macroeconomic indicators do not function in isolation and tend to affect each other and exhibit some correlation, which in turn brings about changes in the economies. The present study tries to investigate the behaviour of the exchange rate, inflation and interest rates with each other. The questions that could be raised for the purpose of the study are as follows: What is the relation between exchange rate and interest rates? What is the relation between the exchange rate and inflation? Can the exchange rate be stabilised by fine tuning or adjusting the interest rates and taming inflation? Is there a correlation among these variables or they tend to move independently?

Literarture review.

Exchange rate is a dynamic variable whose mobility is determined by wide range of economic, political, financial and social factors (Voinea, 2004). It is practically difficult to pinpoint the sole factor or indicator that drives exchange rates. The multitude of factors that directly or indirectly influence exchange rates makes it practically difficult to modeling the variable so complex and dynamic(Cema, 2005).According to Mundell-

Fleming model , an increase in the interest rate is necessary to stabilize exchange rate depreciation and curb inflationary pressure. The high interest rates in itself indicates the mechanism that signals to tame any fluctuation in the exchange rate. It helps in capital inflows thereby curbs exchange rate depreciation. It reduces demand and thereby curbs imports .But the contrarian view prevails pertaining to higher interest rates which is known to reduce the ability of domestic firms to pay back external debt leading to capital outflows resulting in the depreciation of the currency. In the Indian context the RBI manipulates interest rates to keep it at the higher end to contain fluctuations in the exchange rates and this is signalled through rise in the call money and repo rates from time to time. The mechanism involving interest rate tool to contain exchange rate depreciation has a blend of policy impacts. There are a number of well documented theories based on exchange rate determination There are many theories such as Purchasing Power Parity theory (PPP), Flexible Price Monetary Model (FPM), the Sticky Price Monetary Model (SPM), the Real Interest Rate Differential Model (RIRD), and the Portfolio Balance Theory (PBT) of exchange rate determination..

The FPM argues that economic growth, Money Supply, inflationary expectations as the major determinants of the exchange rate SPM Dornbusch 1976 argues that in short run wages tend to be rigid and the desire of the investors to equalize expected returns across the countries is viewed as major determinant of short run exchange rates and a good market arbitrage as a determinant in a long run. Frankel (1979) developed a model of exchange rate known as real interest rate differential which incorporates the role of inflationary expectations of the FPM and the sticky prices of the Dornbusch's model of exchange rate determination. According to the portfolio balance model, risk factors, current account, fiscal policy, authorities' intervention in the foreign exchange market are the major determinants of exchange rates (Branson, 1976; Kouri, 1976). According to Sargent and Wallace (1981) a high interest rate policy may lead to a reduction in demand for money and increase in price level because an increase in interest rate implies an increase in government debt which, in turn, would be financed by seinorage. As a result there will be exchange rate depreciation. Similarly an increase in interest rate may adversely affect the future export performance which would reduce the future flow of foreign exchange reserves and thereby, leads to depreciation of currency (Furman and Stiglitz, 1998). Furman and Stiglitz (1998) argue that there are two important channels through high exchange rates are likely to be affected by the increase in interest rates. One of them is the risk of default and another one is the risk premium. Since the uncovered interest parity theory assumes no role for both these channels, the interest rate represents the promised return on domestic assets, i.e., actual interest receipts is equal to promised interest receipts. But in a post crisis situation, high interest rate policy may decrease the probability of repayment and increase the risk premium on domestic assets because of its adverse effect on domestic economic activity by reducing the profitability of domestic firms and increasing the borrowing costs. Therefore an increase in interest rate may lead to exchange rate depreciation. This could be stronger when the financial position of firms and banks is fragile.

But according to Bensaid and Jeanne (1997), signalling channel of an increase in interest rate to defend the currency, when the domestic economy is weak and the government's political position is precarious, may have an adverse effect on exchange rate. However, over a period of time the cost of an interest rate defence may gets reflected in terms of financial fragility of banks and financial institutions, deterioration of the fiscal position of the government, reduction in the share of export of national income and thereby, leads to the depreciation of currency.

According to one view uncovered interest parity theory which implies that domestic interest rate is the sum of world interest rate and expected depreciation of home currency is the basis of exchange rate determination. In other words, the interest rate differential between domestic and world interest rate is equal to the expected change in the exchange change in the domestic exchange rate. Therefore, a higher interest differential would attract capital inflows and result in exchange rate appreciation. On the other hand, monetarists believe that higher interest rate reduces the demand for money which leads to depreciation of currency due to high inflation. The latter view has also been supported by Furman and Stiglitz(1998) who argue that the high interest rates imperil the ability of the domestic firms and banks to pay back the external debt and thereby reduces the probability of repayment. As a result, high interest rates lead to capital outflows and thereby depreciation of the currency. There is a direct relationship between domestic and world inflation differential and domestic exchange rate. In other words, a higher domestic inflation results in high domestic exchange rate depreciation. This is so because an increase in domestic inflation as compared to world inflation would increase the domestic demand for foreign commodities and lowers the foreign demand for domestic commodities, which, in turn, would lead depreciation of domestic currency to maintain the exchange rate as per the purchasing power theory. Similarly a decrease in domestic inflation as compared to world inflation causes appreciation of domestic currency. Therefore, the higher the inflation differential between domestic and foreign countries, the higher will be the depreciation of domestic currency and vive versa . Fama (1975:269) concludes that, duringthe period 1953-1971, nominal interest rates correctly incorporated "all information about future inflation rates, that is, in time series of past inflation rates". Levi and Makin (1979:36) argue that the level of anticipated inflation is a function of various factors including changes in employment, output and the amount of uncertainty about future inflation movements. This could result in the real rate of interest not being constant, explaining why these aforementioned authors find contradictory results to Fama (1975).

Objectives of the study

The current scenario of rapid depreciation of Indian currency viv a vis US dollar is a matter of serious concern . The rupee is known to have depreciated unprecedentedly over 10-15 % in a single year thereby making the imports dearer. This in turn has pushed up production costs and triggered an overall inflationary situation. A higher level of interest rate environment is known to dissuade investment and there by slows down economic growth . The present study undertakes regression analysis to statistically understand the influence of inflation and interest rates on the exchange rates . However the study has certain limitations as the study is restricted to the Indian context only and thereby may not provide an holistic understanding of the reasons of currency fluctuations in other emerging market economies. Secondly the use exchange rate between US dollar and Indian rupee as an index of currency volatility may not be prudent.

Methodology

The present study uses a time series data between 1990 and 2010 for the variables under consideration . The data source is retrieved from RBI website. The study uses exchange rate (exr) as an independent variable and inflation (infl) and interest rates (inr) as dependent variables. An average exchange rate between Indian Rupee and U.S dollar is used. CPI(Consumer Price Index) index is used as proxy for inflation and The Call rates or Money rates are taken as a proxy for interest rates. The study tries to understand the correlation between the exchange rate , inflation and interest rates using Regression analysis.The method involves involves testing the regression model , unit root test ,

Auto regression model to arrive at findings and conclusions. On the basis of the findings some cues to policy decisions may be suggested.

A brief review of Mathematical techniques:

We see the phenomenon of changing exchange rates over a period of time, observing certain variables in steps of time. Thus 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 X_t be a discrete time series. In our case Xt is the independent variable namely the interest rate of the indian currency abbreviated as INR henceforth. Also we have the inflation figures for the same time steps abbreviated as INFL. Let Y_t 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 Y_t has a well defined relationship with X_t. In our modeling the initial assumption is that EXR is a function of INR. 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 X_t and Y_t 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 regressors do not exhibit stationarity. After taking first differences the variables INR and EXR together exhibit stationarity. We proceed to use the vector autoregression model

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.

$$y_t=c+a_1y_{t-1}+.....a_py_{t-p}+\varepsilon_t \quad \text{……(2)}$$

We note that e_t and ε_t are stochastic terms incorporating the fluctuations or noises attributed to certain unexpected events happening. A vector autoregression 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 1. The AIS criteria is the one through which we have fixed two lags for our VAR model, since taking lag 1 we get the required stationarity of the time series ensemble. The equation (2) is a typical autoregressive model for a single variable. Let y_{1t} represent the variable in the AR model corresponding to x_{1t}, y_{2t} represent the variable in the AR model corresponding to x_{2t} and so on. Thus we have the vector $(y_{1t}, y_{2t}, y_{3t}, ...y_{nt})$ incorporating all the variables that we have considered which we denote for simplicity as Y_t indicating its value for the current time series. Similarly its

lags are denoted by Y_{t-1}, Y_{t-2} etc. Thus the autoregressive model considering all the macroeconomic variables reads as in equation (3)

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

Findings

Firstly the regression model (Figure 3) is tested by using the variables under consideration. The regression model undertaken exhibits the following results. R square value for the model is 0.6209 (62.09%) which indicates that the regression line is moderately fitted. Out of the two independent variables interest rate with p=0.0005 is significant to explain the influence on exchange rate, where as inflation p=0.4221 is non-significant to explain the influence on the exchange rate. Therefore the independent variables namely the interest rates and inflation cannot jointly influence the exchange rates. cannot jointly influence the de The residuals are not auto correlated as indicated by Breush –Godfrey serial Correlation LM test where Obs* R 0.2827 ,p=0.8682 .The variance of residual is homoskedastic as indicated by Breush –Pagan –Godfrey test wherer Obs*R 2.52 ,p=0.2824 . The residuals are normally distributed as indicated by Jarque –Bera Statistics where p= 0.1935. Therefore the regression model is found to be suitable and relied upon.

The Unit root test (Figure 3)which checks the stationarity of the data for exchange rate , inflation and interest rate largely remains non stationary at Intercept , Trend and intercept and None (with a very few exceptions like EXR at Intercept 0 .0176 ,INR at intercept and trend 0.0326 and None 0.0277)

The Unit root test for exchange rate i.e.ADF at Level for Intercept, Intercept and Linear trend and None are converted into stationary at First difference in all the variables. As the data is largely not stationary at Level, we use Vector Auto Regression model (VAR) .

The VAR model residuals exhibit that inflation C(3) p value 0.2769 is not significant and interest rate C(4) with p=0.1719 is also not significant indicating that they do not show a long run correlation or cannot independently influence the exchange rate. The Wald test (Figure 5) conducted shows Chi square p value 0.0216 hints that there is a short run correlation and the interest rate (INR) and inflation (INFL) jointly influence the exchange rate.

Conclusion

Although inflation and interest rates do not independently influence the exchange rate movement in a long run, but can jointly influence the volatility of the exchange rate. From the study it is practically difficult to pertinently trace from the interest rates and inflation time series data the real variable that influences the exchange rate. There could be several factors that may affect the exchange rate (not considered in the present study) or the depreciating mode of currency is a global trend and which cannot be curtailed and remains a contagious phenomenon. Or both interest rate and the level of inflation in India may have stalled further unprecedented depreciation of the Indian Rupee against the dollar as witnessed by major emerging market economies. The levels of interest rates and inflation could have been the effect of exchange rate dynamics rather than a cause.

Figure1; Raw data of the exchange rate, inflation and interest rates

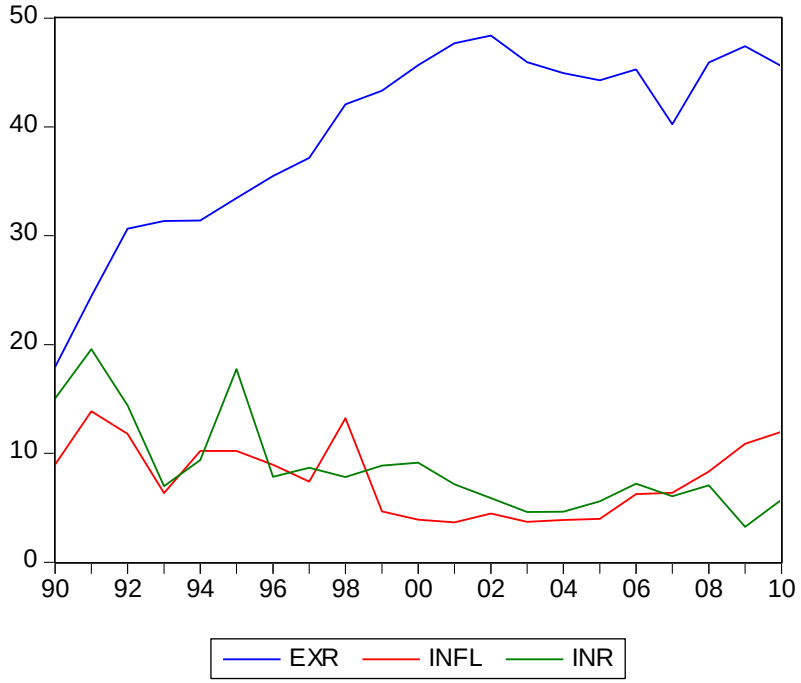

Figure 2 ;Regression model

R- Square value .6209
INFL p=0.4221
INR p=0.0005
Serial Auto correlation
Breusch –Godfrey Serial Correlation LMTest Obs*R squared .28709 p=.8682
Homoskedasticity
Breush-Pagan –Godfrey test Obs*Rsquare 2.528 , p=.2824
Normal distribution
Jarque- Bera 3.284 , p=.1935

Figure 3; Unit Root Test (ADF) for variables Exchange rate (exr), Inflation (infl) and Interest rate (inr)

Variables Test Equations

	Test	Intercept	Intercept , Trend	None
Exr	Level	.0176	.4226	.9548
	1st diff.	.0081	.0111	.0009
infl	Level	.2381	.5874	.4506
	1st diff.	.0001	.0002	.0000
inr	Level	.4731	.0326	.0277
	1st diff.	.0003	.001	.0000

Figure 4;VAR model Exr as dependent variable and inflation ,interest as independent variables.

Sample: 1992 2010
Included observations: 19
Total system (balanced) observations 19

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.918696	0.212949	4.314165	0.0006
C(2)	0.024734	0.208077	0.118867	0.9070
C(3)	0.209895	0.186030	1.128283	0.2769
C(4)	0.237786	0.165727	1.434806	0.1719

Figure 5 Wald test to check short run association between the coefficients

Wald Test:
System: Untitled

Test Statistic	Value	df	Probability
Chi-square	7.667911	2	0.0216

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