Exchange Rate and Macro-economic indicators: A Causal Study for India of the Past Decade

YAMINI KARMARKAR*, MUSKAN KARAMCHANDANI**, ASHIMA MANTRI***

Various reform measures since the early1990s have had a profound effect on the market structure, depth, liquidity and efficiency of the Indian foreign exchange market. Theory suggests that exchange rates volatility should affect macro-economic indicators, although there is ambiguity about the sign of the effect. This paper uses techniques designed to accommodate non-stationary data, and the major results shows that increases in the volatility of exchange rates exert a significant negative effect on sensex in the long run. With the help of various statistical tests along with multivariate VAR framework, Granger causality tests and other tests with respect to hetroscedasticity, autocorrelation and multicollinearity are employed to investigate the long run causal relationships between the exchange rates and other key macro-economic indicators of the economy. In this paper, the basis of analysis is the foreign exchange rates of (INR/USD), estimated on weekly data (Jan2000-June2009) for each of the variables taken into consideration in this research. Our empirical results show a significant causal relation between exchange rates and foreign exchange reserves, sensex and reserve money. We have also observed bi-directional causality between exchange rates and other three macro-economic variables i.e. foreign exchange reserves, sensex and RBI open market operations (net). India being a developing country, has its exchange rates still being affected mostly by the fundamental variables of the external sector, financial market and financial sector. But as found out there is a weak evidence in favour of Indian exchange rates being affected by the real sector.

Keywords: Exchange rates changes, external sector, financial market, financial sector and real sector.

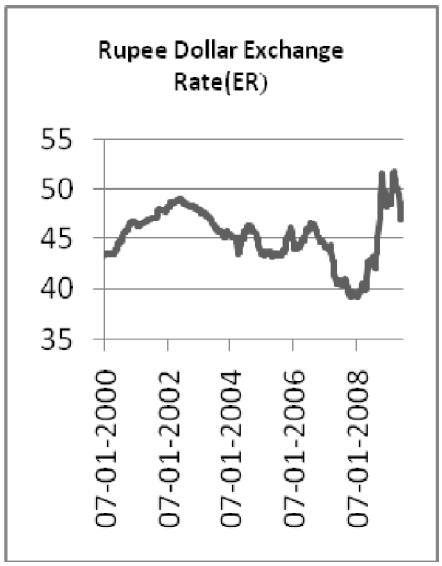
Introduction

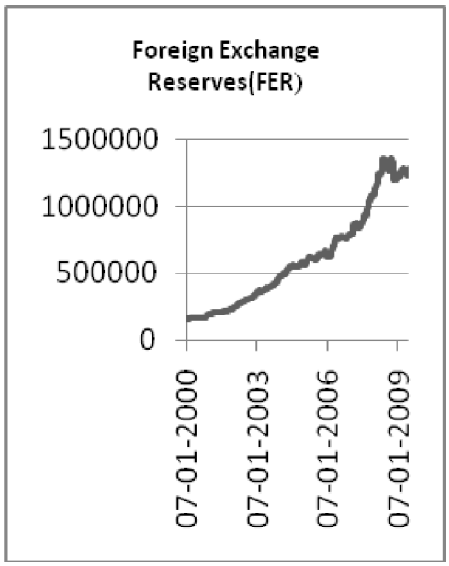
The foundation of credible national security is based on the level of economic prosperity and well-being of the population of any country. This is especially so for developing countries like India. A series of economic reform measures including liberalization of foreign capital inflows were initiated in India since the early nineties. Over the years, the foreign exchange market has emerged as the largest market in the world and the breakdown of the Bretton Woods system in 1971 marked the beginning of floating exchange rate regimes in several countries. The Post-Reform Period (1992 onwards) phase was marked by wide ranging reform measures aimed at widening and deepening the foreign exchange market and liberalisation of exchange control regimes. As a stabilisation measure, a two step downward exchange rate adjustment in July 1991 effectively brought to close the regime of a pegged exchange rate. To move towards the market-determined exchange rate, the Liberalised Exchange Rate Management System (LERMS) was introduced in March 1992, was essentially a transitional mechanism

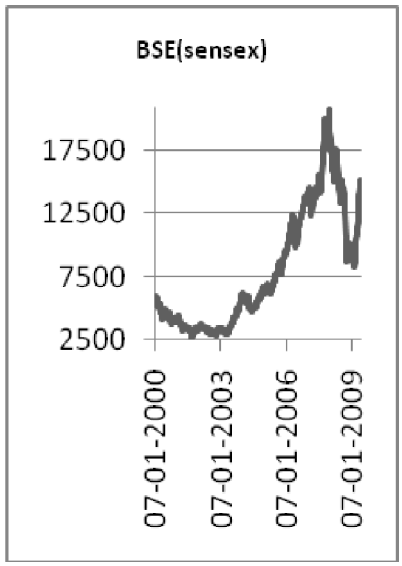
*Dr. Yamini Karmarkar, Reader, International Institute of Professional Studies, DAVV, Indore.
*Ms. Muskan Karamchandani, Lecturer, International Institute of Professional Studies, DAVV. Indore.
***Ms. Ashima Mantri, Student,MBA(MS), International Institute of Professional Studies, DAVV, Indore.

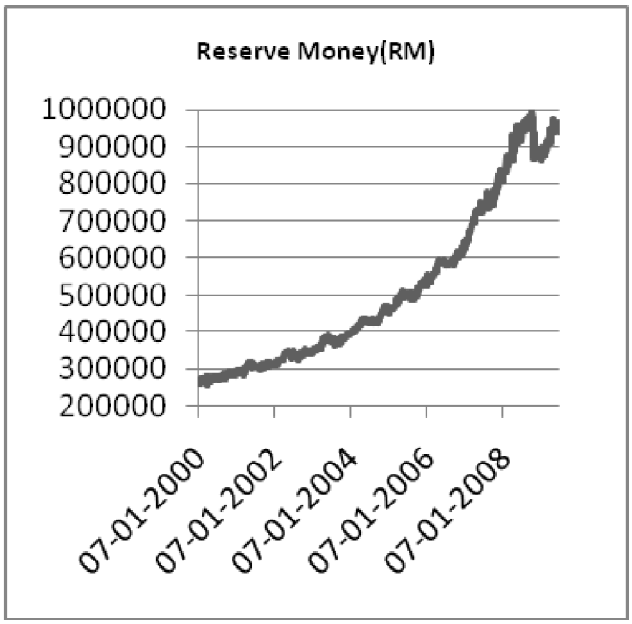
and a downward adjustment in the official exchange rate and ultimate convergence of the dual rates was made effective and a market-determined exchange rate regime was replaced by a unified exchange rate system in March 1993, whereby all foreign exchange receipts could be converted at market determined exchange rates. On unification of the exchange rates, the nominal exchange rate of the rupee against both the US dollar as also against a basket of currencies got adjusted lower. Thus, the unification of the exchange rate of the Indian rupee was an important step towards current account convertibility, which was finally achieved in August 1994, when India accepted obligations under Article VIII of the Articles of Agreement of the IMF. With the rupee becoming fully convertible on all current account transactions, the risk bearing capacity of banks increased and foreign exchange trading volumes started rising. This was supplemented by wide-ranging reforms undertaken by the Reserve Bank in conjunction with the Government to remove market distortions and deepen the foreign exchange market. Several initiatives aimed at dismantling controls and providing an enabling environment to all entities engaged in foreign exchange transactions have been undertaken since the mid-1990s. The focus has been on developing the institutional framework and increasing the instruments for effective functioning, enhancing transparency and liberalising the conduct of foreign exchange business so as to move away from micro management of foreign exchange transactions to macro management of foreign exchange flows. Along with these specific measures aimed at developing the foreign exchange market, measures towards liberalising the capital account were also implemented during the last decade. Present article focuses on analyzing the critical macro-economic variables which have impacted India's exchange rate in post-liberalization era. This general framework shows how different macro-economic policy variables are deeply interrelated and any change in one variable causes subsequent changes in the other variables. It is expected that the general framework will be applicable in the context of any developing economy, like, India and will aid the policy formulation. This paper specifically examines the impact of external sector, financial market, financial sector and real sector on exchange rate of India.extent of financial exclusion is shocking.

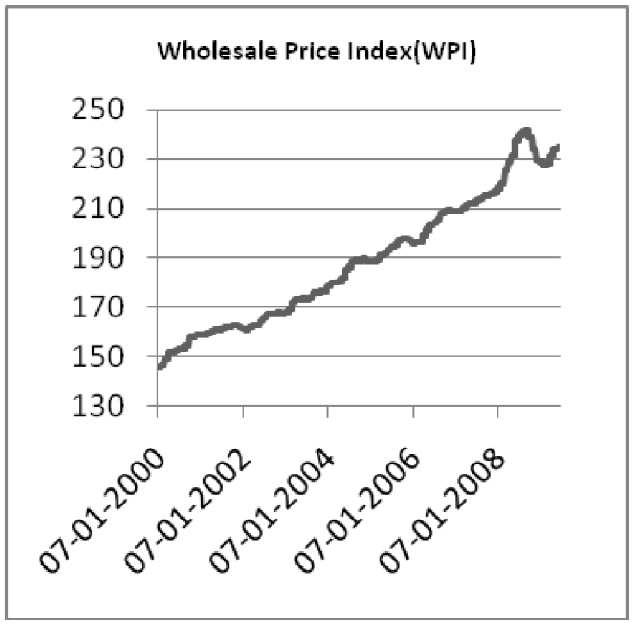
The external sector in India is witnessing significant momentum due to the growth in exports, increase in capital inflows and addition in the foreign exchange (Forex) reserves. Thus it includes one of the most important component as Foreign exchange reserves. Forex reserves are also maintained to achieve some











level of exchange rates. These levels are determined based on the policies and objectives of the country. Generally, developing economies, in order to increase exports and decrease imports, try to keep their exchange rates low (so that a given sum of foreign currency can buy more goods from them) and the value of their currency low and in order to do so build up reserves. The Indian financial market as a whole, happens to be one of the oldest across the globe and is definitely the fastest growing and best among all the financial markets of the emerging economies. Thus the various types of elements which help in the functioning of the India financial market includes Capital market, G-sec investments and Money market instruments. Another important factor affecting exchange rate of Rupee is the India financial sector. This sector includes banks, investment funds, insurance companies but amongst all Money and Banking plays a very important role to study the impact of financial sector on India's exchange rate. The relationship between banking and exchange rates has made a shift from concern about short-term volatility in the early post-float period to a focus on long term volatility. It has emphasised more in intervention strategy moving from generally small daily interventions with frequent changes in direction to less frequent but larger scale intervention once the exchange rate had moved a long way. With the pace of time the Indian real estate market is emerging as one of the most lucrative options for investment in the world real estate sector. Investing in real estate India is safer than other countries, as Indian economy is growing at a very fast rate and survey shows that real estate India shall maintain its steady growth in future. Thus, it includes the most important component that is, Prices (Wholesale Price Index). The relationship between real sector and exchange rate leads to the era of high liquidity, low interest rates and increasing leverage in financial markets, low inflation rates and low output volatility due to which it further leads to huge accumulation of foreign exchange reserves and high volatility in exchange rates.

This research tries to explore the cause and effect relationship if any between Exchange Rates and the four prominent sectors of Indian Economy.

Research Objectives

The purpose of the study is to investigate whether macro economic variables and exchange rate have a relationship. The objective is to identify and analyze the critical macro-economic variables which have impacted exchange rate of rupee with respect to dollar

in post liberalization era. Hence, the specific objectives of the study are as follows:

- To examine the cause and effect relationship if any, between exchange rate of rupee with respect to dollar and various indicators of external sector like foreign exchange reserves.
- To examine the cause and effect relationship if any, between exchange rate of rupee with respect to dollar and various indicators of Financial Market like central government outright buy and sale of g-sec, repo transactions, repo rate etc.
- To examine the cause and effect relationship if any, between exchange rate of rupee with respect to dollar and various indicators of Financial Sector like reserve money, RBI open market operations etc.
- To examine the cause and effect relationship if any, between exchange rate of rupee with respect to dollar and various indicators of Real sector like Whole Sale Price Index.

Literature Review

The empirical literature provides conflicting findings regarding the dynamic linkage between FX and various macro-economic variables as mentioned above. Early studies including Chien-Hsiu (2011) suggest that there was extensive exchange rate exposure in the Asian emerging markets. More specifically, in spite of there being central bank intervention during the crisis periods in recognition of the increased volatility in foreign reserves, the evidence indicates that foreign exchange exposure became more significant or larger during these times. Mixed empirical evidence is accompanied by the lack of a theoretical consensus on the relationship between stock and FX markets. Although sophisticated econometric approaches have been implemented to research this topic, the evidence is somewhat mixed as to whether FX market volatility affects (or is affected by) stock market behaviour. Moreover, empirical investigations of the dynamic linkage between FX rate changes and stock markets volatility have tended to focus upon the major developed markets and only a very limited body of research is devoted to emerging stock markets. Sharmishtha Mitra, Basab Nandi, Amit Mitra (2007) observed that the relationship between stock market returns and inflation and the proxy-effect phenomena in the context of two contrasting economies, the developed economy of the United States and the developing economy of India. . In the Fama and Geske/ Roll frameworks, the relationship between stock returns and inflation is due to the conjunction of the inflation-real activity and the real activity-stock returns relationships. In the recent past, application of wavelets to various areas of finance has been developed. Notable among them are: application of wavelets in analyzing stock market dynamics and exchange rate dynamics [9-12], analysis of financial data and the role of fractional differencing was explored in [5-7]. From this point of view it is more appropriate to examine the relationship between the exchange rates (as dependent variable) and other four major sectors of an economy(i.e. External sector, Financial market, Financial sector and Real sector) as independent variables in the context of two contrasting economies, the developed economy of the United States and the developing economy of India. Mirza Allim Baig, V. Narasimhan, M. Ramachandran (2003) examined the direction of the foreign exchange market, to characterize the intervention policy of the authority, and to evaluate whether the volume and nature of official intervention is consistent with stated objectives of the authority regarding exchange rate and reserve management. An analysis of model estimates provides, to a limited extent, some information regarding the effectiveness of intervention in influencing the exchange rate. Therefore, we need to analyse the relationship between the foreign exchange reserves and exchange rates. Chkili Walid, Aloui Chaker, Omar Masood and John Fry (2011) found that the during the last two decades, emerging countries have experienced several

crises, namely the stock market crash in 1987, the Asian currency crises in July 1997, the Mexican currency crisis in 1994 and the subprime crisis of 2007-2008. These features have greatly increased foreign exchange (FX) rates volatility. Several other studies have also, investigated several economic and financial management implications. Firstly, portfolio managers and hedgers may be better able to understand the dynamic linkage between FX markets and equity markets. Specifically, they may be better able to adopt appropriate hedging strategies to better guard against currency risk during future crises that may occur in emerging countries. Secondly, such results may be helpful for policy makers from a financial stability perspective, providing governments and central banks with insights into volatility spillovers and risk transmission between FX markets and stock markets. Finally, results may also allow one to assess the level of emerging stock market informational efficiency. Sudipta Dutta Roy and Gangadhar Darbha (2000) studied the dynamic interactions between money, output and prices in a structural vector autoregression framework. The framework examine the sources of variations and response of one variable to changes in others in a system of economic variables in the Indian context. It also investigated that there is no single source of shock that can explain variations in most of the key macro-economic indicators. They also conclude that the changes in prices/costs have a significant effect on overall inflation in the short-run, with monetary variables (like interest rates, exchange rates etc) becoming significant only in the medium-long- run. The results also point out that the monetary authority had responded differently to different prices by changing the quantity as well as composition of money supply. Moreover, they also examined the asymmetric response of prices to exchange rates, increasing when supply of Rupee increases but not decreasing when supply of Rupee is contracted. Piti Disyatat and Gabriele Galati (2007) examined that developing countries tend to tolerate greater volatility in international reserves, domestic interest rates, and commodity prices than in exchange rates has been documented by Calvo and Reinhart (2002). It is important to keep in mind this background in reviewing the literature on emerging market countries. The connection between foreign exchange market intervention and both the level and volatility of exchange rates. Many studies also suggest that intervention can sometimes affect exchange rates temporarily in a manner that depends on market conditions and the firmness of agents'expectations. They also conclude that these results may appear somewhat contradictory to the perception that emerging market countries in Asia have been quite successful during the last few years in their intervention operations to resist, or at least make more gradual, the trend appreciation of their currencies with respect to the US dollar. Another research Renu Kohli (2007) found that the Indian authorities 'managed' the float to achieve specific exchange rate objectives, while declaring a floating exchange rate regime. They also investigated that empirical properties of the real exchange rate found for industrial economies, are not likely to hold for developing countries, where 'floating' currencies tend to be heavily managed. Tomoe Moore, Christoper.J.Green, Victor Murinde (2006) observed that the flow of funds model for India concentrating on the results of stochastic simulations aimed at identifying possible risks involved in the implementation of policies often associated with financial reform packages: especially reductions in reserve ratios and freeing up of interest rates. The results also show the reduction in the CRR does have the expected theoretical impact, increasing lending and reducing the loan rate. They also investigated that other relatively standard policies have less impact or pose certain risks on exchange rates. Naveen Shrinivasan, Sumit Jain, M.Ramachandran (2009) reveals the India's transition from a controlled economy to a more open economy in the early 1990s has exposed domestic firms to international competition.

The reason behind this, was the sensitivity of domestic inflation to shocks was lower, because of increased competition may reduce the cyclical sensitivity of profit margins, as businesses have less scope to raise their prices when domestic demand increases. Though it is possible that lower inflation may have spilled over from the U.S. to other emerging market economies, due to dislike on the part of monetary authorities in smaller countries of large nominal exchange rate movements with respect to the United States. They also conclude that a fall in U.S. inflation forces monetary authorities in emerging markets to allow domestic inflation to fall too, so as to avoid exchange rate fluctuations. In a more recent study, Akhand Akhtar Hossain (2010) study monetary targeting for price stability in Bangladesh finds that monetary policy is now a key component of macroeconomic policy with the objective of maintaining macroeconomic stability in general and price stability in particular. The paper also investigated that there is an unstated third monetary policy objective of nominal exchange-rate stability. The Bangladeshi monetary policy regime therefore diverges significantly from the established principles of monetary targeting for price stability in which, under a floating currency, the monetary policy instrument is assigned to achieve a single goal such as price stability. Finally, after reviewing literature of so many research papers, a gap was identified which reveals that there is a significant relationship between India's exchange rate and its key macro-economic indicators. While most prior studies rely on monthly data, this research uses weekly data in the analysis. Thus, it is better to measure the interactions between exchange rate of Rupee and macro-economic variables of the Indian economy using higher frequency data.

Research Methodology

The main objective behind this research is to establish a relationship between India's exchange rate and key macro-economic indicators of the Indian economy. For this purpose, various macro-economic indicators have been taken into consideration which are as follows:

- External Sector
- Financial Market
- Financial Sector
- Real Sector

These macro-economic indicators in itself involves well diversified and broad concepts of Indian financial system. These indicators are further sub divided into various variables as per their roles and functions. If we see the external sector, it includes foreign exchange reserves. Moving on to the financial market, it includes capital market, government securities investments and money market instruments. Another important macro-economic indicator is the financial sector, it includes reserve money and RBI's open market operations. Finally the fourth sector i.e the real sector, it includes prices (Wholesale Price Index). So, the proposed model is represented as follows:-

EX Rate = f_n (External Sector, Financial Market, Financial Sector, Real Sector)

This relationship can be written in elaborate form which is as follows :-

EX Rate = f_n(Foreign exchange reserves, sensex, call money(max), central government outright transactions, central government repo transactions, central government securities turnover, reserve money, RBI open market operations(net), wholesale price index)

Therefore,

ER = f_n (FER, SENSEX, CM, CGOT, CGRT, CGST, RM, RBI (net), WPI)

As, all the variables in this study are time series data, they are expected to show the properties of any time series data i.e, heteroscedassticity, multicollinerity and autocorrelation. There is a possibility of lead lag relationships existing among variables. So, the modified relationship for the study is stated as follows:-

$$(ER)_t = \beta + \sum_{j=1}^{k} \beta_{1j}(ER)_{t-j} + \sum_{j=1}^{k} \gamma_j(ES)_{t-j} + \sum_{j=1}^{k} \alpha_j(FM)_{t-j} + \sum_{j=1}^{k} \lambda_j(FS)_{t-j} + \sum_{j=1}^{k} \theta_j(RS)_{t-j} + u_{1t}$$

A regression of above nature will be explored. There are a number of measures available to examine the relationship among different economic variables and exchange rate of Rupee/US dollar. This section is describes the basic testing procedure which includes, stationarity test, causality test and vector autoregressive analysis. The section also focuses on the detection of hetroscedasticity, autocorrelation and multicollinearity.

Empirical Testing Procedure

The data of Exchange rate, foreign exchange reserves, sensex, call money(max), central government outright transactions, central government repo transactions, central government securities turnover, reserve money, RBI market operations(net), wholesale price index were tested for stationarity by applying ADF test. The proper differencing was done for the data where non stationarity existed. To confirm the stationarity Philips perron test was also applied.

Next step was to check the causality between the variables. For this, GRANGER CAUSALITY TEST was applied. After testing causality, data series were further checked for hetroscedasticity, autocorrelation and multicollinearity. For autocorrelation, Durbin-Watson Test was applied. Multicollinearity was also found in some of the variables.

We further explore dynamic linkages between the variables using Sims' (1980) approach. For this purpose, Vector Autoregressive Model (VAR) was applied.

Estimation of VAR

When we could not reject the hypothesis that there is a bilateral causality between independent variables and dependent variables. That is, independent variables affects dependent variables and vice-e-versa. These kind of situations are ideally suited for the application of VAR. To explain how a VAR is estimated, we assume that each equation contains k lag values of Y(as measured by exchange rate) and other macro-economic variables(measured as external sector, financial market, financial sector and real sector).In this case, one can estimate each of the following equations by OLS.

$$(ER)_t = \beta + \sum_{j=1}^{k} \beta_{1j}(ER)_{t-j} + \sum_{j=1}^{k} \gamma_j(ES)_{t-j} + \sum_{j=1}^{k} \alpha_j(FM)_{t-j} + \sum_{j=1}^{k} \lambda_j(FS)_{t-j} + \sum_{j=1}^{k} \theta_j(RS)_{t-j} + u_{1t} \quad \ldots(1)$$

$$(ES)_t = \beta' + \sum_{j=1}^{k} \mu_j(ER)_{t-j} + \sum_{j=1}^{k} \gamma_j(ES)_{t-j} + u_{2t} \quad .....(2)$$

$$(FM)_t = \beta' + \sum_{j=1}^{k} \mu_j(ER)_{t-j} + \sum_{j=1}^{k} \alpha_j(FM)_{t-j} + u_{3t} \quad .....(3)$$

$$(FS)_t = \beta' + \sum_{j=1}^{k} \mu_j(ER)_{t-j} + \sum_{j=1}^{k} \lambda_j(FS)_{t-j} + u_{4t} \quad .....(4)$$

$$(RS)_t = \beta' + \sum_{j=1}^{k} \mu_j(ER)_{t-j} + \sum_{j=1}^{k} \theta_j(RS)_{t-j} + u_{5t}$$

Where ER(t) is the Exchange rate at time (t), ES(t) is the external sector at time (t), FM(t) is the financial market at time (t), FS(t) is the financial sector at time (t), RS(t) is the real sector at time (t), u's are the stochastic error terms, called impulses or innovations or shocks in the language of VAR.

Before we estimate above equations we have to decide on the maximum lag length, k. This is a empirical question. One way of deciding this question is to use a criterion like the Akaike or Schwarz and choose that model that gives the lowest values of these criteria. In short, the VAR analysis provides further insights into the dynamic linkages between foreign exchange and all the four sectors that has been taken into consideration in this paper.

Sample Description

The study uses weekly time series data of foreign exchange reserves, call money rates, sensex, central government outright transactions, repo transactions, turnover in central govt. Securities, reserve money, RBI open market operations(Net), wholesale price index(WPI) and exchange rates (expressed in local currency per U.S. dollar). The sample period runs from January 2000 to June 2009. The primary reason behind taking 1991 as a starting point is that Indian economy faced a severe balance of payment crisis in 1991 and the level of international reserves depleted to a very low level. After that the economic reform process was initiated and as a result India's international reserve holding touched the height of USD 283.6 billion. This development has changed India's reserves holding pattern completely. The data are taken from Handbook on Indian economy published by Reserve Bank of India (RBI). The data on WPI are taken on monthly basis. The data on exchange rates of Rupee/US Dollar are collected from the OANDA Forex Trading and Exchange Rates Services online database. The data has been analysed using EVIEWS.

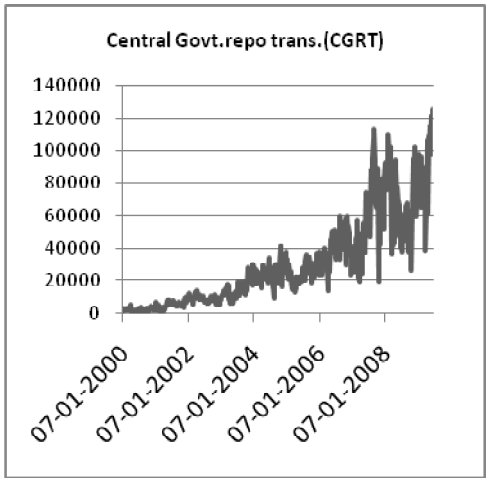
Findings And Discussions

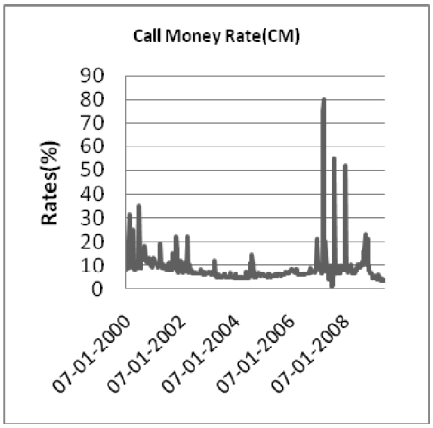
The main objective behind this research is to establish a relationship between India's exchange rate and key macro-economic indicators of the Indian economy. For this purpose four sectors were choosen- External Sector, Financial Market, Financial Sector and Real Sector. These macro-economic indicators itself involves well diversified and broad concepts of Indian financial system. These indicators are further sub divided into various variables as per their roles and functions. If we see the external sector, it includes foreign exchange reserves. Moving on to the financial market, it includes capital market, government securities investments and money market instruments. Another important macro-economic indicator is the financial sector, it includes reserve money and RBI's open market operations. Finally the fourth sector i.e the real sector, it includes prices (Wholesale Price Index).

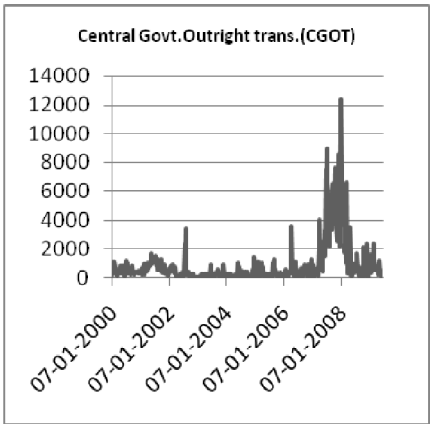
There are a number of measures available to examine the relationship among different economic variables and exchange rate of Rupee/USDollar. This section is divided into various sub-sections which deals with stationarity test, causality test and vector autoregressive analysis. The section also focuses on the removal of hetroscedasticity, autocorrelation and multicollinearity. In this section, we present the trend analysis of the above variables and data analysis results.

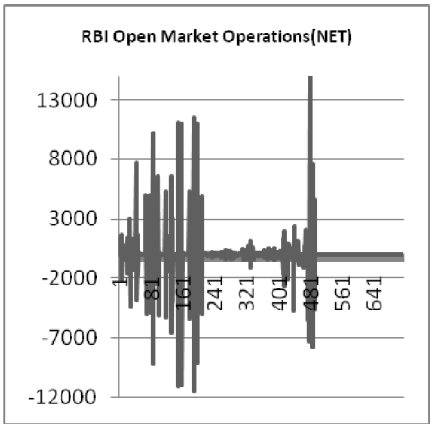
Trend Analysis

Here are the charts which show the trend analysis of all the macro-economic variables that has been taken into consideration in this research paper. The data on Foreign exchange reserves (FER), Call money (CM), Central government outright transactions (CGOT), Central government repo transactions (CGRT), Central government securities turnover (CGST), Reserve money (RM), RBI open market operations(net), Wholesale price index (WPI) are collected from the Handbook on Indian economy published by Reserve Bank of India (RBI). Further, the data on Sensex indices is taken from Bombay stock exchange (BSE) online database. Lastly, the data series on Foreign exchange rate is taken from OANDA Forex Trading and Exchange Rates Services online database.









Unit Root Test

Since VAR specifications depends upon the time series characteristics of the dataset, we first report results of stationarity. Though a number of unit root tests are suggested, we use Augmented Dickey- Fuller (ADF). Since a time series can have a stochastic trend or a deterministic trend therefore, ADF test was applied at two different levels i.e. at level data and 1 level differencing. The results shows that all the variables are integrated of order one and stationary upon differencing (see Table 1). When test was applied at level data, it was found that all the p-values of all the variables except call money rates, central govt. securities turnover and RBI open market operations (Net), were more than .05 which is not significant. Therefore, the test for unit root was applied at 1 level differencing which showed all the p-values are equals to zero except in case of WPI. For WPI series, unit

Table 1 : Augmented Dickey-Fuller (ADF) test-Results for Unit-Root Test

Variables	Level Data			1 level differencing			2 level differencing		
	t-value	p-value	Durbin Watson test	t-value	p-value	Durbin Watson test	t-value	p-value	Durbin Watson test
Foreign Exchange Rate (ER)	-1.678	0.759	1.95	0.839	0.999	1.12	-5.619	0	1.11
Foreign Exchange Reserves (FER)	-1.88	0.6608	2.03	-3.463	0.044	1.031	0	0	0
BSE(sensex)	-2.36	0.396	1.98	-5.098	0	1.24	0	0	0
Call Money-Max (CM)	-8.808	0	2.0005	-15.554	0	2.035	0	0	0
Central Govt.Outright trans.(CGOT)	-3.12	0.0257	1.979	-11.919	0	2.024	0	0	0
Central Govt. Repo trans.(CGRT)	-1.009	0.7512	1.991	-8.181	0	1.842	0	0	0
Central Govt. Sec Turnover (CGST)	-5.84	0	2.004	-17.314	0	1.988	0	0	0
Reserve Money (RM)	-1.5593	0.9995	1.994	-9.914	0	1.073	0	0	0
RBI Operations (NET)	-8.593	0	2.025	-14.773	0	1.964	0	0	0
Wholesale Price Index(WPI)	-0.3564	0.9135	2.0123	-1.414	0.855	1.013	-3.459	0.045	1.018

root was removed at 2 level differencing. Hence, there was no unit root present in the data series. Thus, the data found to be completely stationary for further empirical testings.

After achieving stationarity in the data series, next step involves, what will be the criteria for model selection? For this purpose two types of information criteria were taken into consideration. The Akaike information criterion (AIC) and Schwarz criterion (SIC) yielded optimal lag length of two, therefore results were reported for one and two lags. The Phillips-Perron (PP) has been added to test the robustness of our results and also to ensure that tests are consistent with the presence of a potential autocorrelation and hetroscedasticity in the data.

Table 2:- Phillips-Perron test-Results for Unit-Root Test

Variables	**Level Data**	**1 level differencing**
	p-value	**p-value**
Foreign Exchange Rate (ER)	0.63*	0
Foreign Exchange Reserves (FER)	0.74*	0
BSE (sensex)	0.44*	0
Call Money max (CM)	0**	0
Central Govt. Outright trans.(CGOT)	0**	0
Central Govt. Repo trans.(CGRT)	0**	0
Central Govt. Sec Turnover (CGST)	0**	0
Reserve Money (RM)	0.69*	0
RBI Operations (NET)	0**	0
Wholesale Price Index(WPI)	0.2*	0

(*)H0 is not rejected at the 10% significance level
(**)H0 is rejected in favour of H1 at the 5% significance level

This test was also conducted on two different types of data (see Table2). At level data it was found that at 10% significance level data series of exchange rates, foreign exchange reserves, sensex, reserve money and WPI were not consistent. In other words, presence of unit root or non-stationarity was there in the data collected. But at the same time if we consider other variables of this paper i.e. central govt. outright transactions, repo transactions, turnover in govt. securities and RBI open market operations at 5% significance level, non-stationarity was removed. Further, the test was conducted on differenced data which gave the same results as of above given by the actual data.

Granger Causality Test

To explain the Granger test, we will consider the basic objective of this research i.e. Is it Exchange rate(ER)

that "causes" all the other macro-economic variables. The test was conducted so as to identify which is a causal variable and which is a parameter. The main motive behind this test was to identify the independent and dependent variables in the entire series of the data. The test was applied on two different types of data. Since unit root test results, shown in (Table1 and Table2), indicate that there is a unit root in all the level series but not in the first-difference series. Therefore, all the lag level data can be described as an I(1) process, and hence the Granger causality test should be conducted on the first-difference data. Once the long-term relationship are establish between the variables, we examine the direction of causality between the variables represents in the results (see Table3) from the causality test. In the case of external sector i.e. foreign exchange reserves and exchange rate, changes in foreign exchange reserves are caused by changes in exchange rates and the reverse is also true. In case of financial market which includes sensex, central government outright transactions, repo transactions, turnover in central government securities and call money rates when compared with the exchange rates, it was found that changes in sensex indices and repo transactions cause changes in exchange rates but in case of central govt. outright transactions, turnover in central govt. securities and call money rates does not cause changes in exchanges rates. In financial sector, which comprises of reserve money and RBI open market operations(net), it was examined that changes in reserve money is caused by changes in exchange rates. It was also found that change in RBI open market operations causes change in exchange rates. In case of real sector i.e. wholesale price index (inflation), it was observed that changes in exchange rates causes change in inflation.

Table 3:- Results from Granger-causality test

Variables (Null Hypothesis)	Obs.	Lag	F-statistics	P-value
FER does not Granger Cause ER	489	6	2.14088	0.0476
ER does not Granger Cause FER	489	6	5.88969	6.00E-06
sensex does not Granger Cause ER	489	6	2.49182	0.022
ER does not Granger Cause sensex	489	6	4.86896	8.00E-05
ER does not Granger Cause CGRT	489	6	4.08391	0.0005
ER does not Granger Cause RM	489	6	6.95638	4.00E-07
RBI(Net)does not Granger Cause ER	489	6	3.32816	0.0032
ER does not Granger Cause RBI(Net)	489	6	3.67373	0.0014
ER does not Granger Cause WPI	489	6	7.54580	1.00E-07

Note: The variables are in lag difference form. Lags selected According to minimum Akaike Information Criteria.

The bi-directional causality was also found in many of the variables taking exchange rates as a benchmark. There was a two-way causality between foreign exchange reserves and exchange rate, sensex and exchange rate, RBI open market operations (net) and exchange rate.

This research paper also detect multicollinearity among the three variables i.e. foreign exchange reserves, sensex and RBI open market operations (net). The paper also observed that there is a bi-directional causality among the two independent variables i.e. sensex and foreign exchange reserves. The research

also investigated that though there was no cause and effect relationship between sensex and RBI open market operations (net) but multicollinearity exists between the two variables.

Vector Autoregressive Analysis

The paper superficially resembles simultaneous-equation modelling in which it considers several endogenous variables together. But each endogenous variable is explained by its lagged, or past, values and the lagged values of all other endogenous variables in the model; usually, there are no exogenous variables in the model. A further finding of this study was the presence of multicollinearity between the explanatory variables(X) which allowed us to use vector autoregressive model as the appropriate test so as to meet the objectives of this research. Therefore, The study uses vector autoregression as the appropriate test for examining the relationship between India's exchange rate of Rupee and key macro-economic indicators of Indian economy. To illustrate the mechanics, we have used 2 lags (k=2) of each variables and Eviews 4 we have obtained the estimates of the parameters of the preceding equations which are given in (Table 4).

TABLE 4 - Vector Autoregression Estimates

Included observations: 492 after adjustments Standard errors in ( ) & t-statistics in [ ]				
	Foreign Exchange Reserves	**SENSEX**	**RBI NET open mkt op**	**Exchange Rate**
FER(-1)	**1.46E-16**	-1.14E-18	2.28E-18	-5.82E-07
	(1.3E-17)	(8.6E-19)	(2.9E-18)	(1.5E-06)
	[11.2099]*	[-1.32877]	[0.79148]	[-0.39264]
FER(-2)	**-7.85E-17**	-1.84E-18	-1.23E-18	-6.87E-07
	(1.3E-17)	(8.3E-19)	(2.8E-18)	(1.4E-06)
	[-6.23335]***	[-2.21662]	[-0.44011]	[-0.47905]
SENSEX(-1)	**1.33E-15**	-2.08E-17	**2.22E-16**	**-0.000227**
	(2.8E-16)	(1.8E-17)	**(6.2E-17)**	**(3.2E-05)**
	[4.75956]*	[-1.12835]	**[3.58457]***	**[-7.11141]*****
SENSEX(-2)	**-2.69E-15**	5.61E-17	**2.24E-16**	4.34E-05
	(3.0E-16)	(2.0E-17)	**(6.7E-17)**	(3.4E-05)
	[-8.89812]***	[2.81264]	**[3.35072]***	[1.25847]
RBI(NET)(-1)	**2.14E-16**	0.000000	**-1.42E-16**	-5.59E-06
	(5.7E-17)	(3.8E-18)	**(1.3E-17)**	(6.5E-06)
	[3.71760]*	[0.00000]	**[-11.1994]*****	[-0.85464]

RBI(NET)(-2)	**1.68E-16**	6.58E-18	0.000000	5.68E-06
	(5.0E-17)	(3.3E-18)	(1.1E-17)	(5.6E-06)
	[3.39822]*	[2.01405]	[0.00000]	[1.00757]
ER(-1)	-3.39E-13	3.18E-14	-1.69E-13	**0.254502**
	(4.0E-13)	(2.7E-14)	(8.9E-14)	**(0.04589)**
	[-0.84069]	[1.19582]	[-1.89946]	**[5.54566]***
ER(-2)	**1.28E-12**	**1.79E-13**	1.40E-13	-0.021789
	(3.7E-13)	**(2.5E-14)**	(8.2E-14)	(0.04240)
	[3.42657]*	**[7.31105]***	[1.69355]	[-0.51388]
C	1.73E-13	**-2.17E-14**	5.42E-15	-0.011674
	(1.0E-13)	**(6.8E-15)**	(2.3E-14)	(0.01168)
	[1.69099]	**[-3.20708]*****	[0.23879]	[-0.99918]
FER	**1.000000**	**6.45E-18**	-7.75E-18	**1.06E-05**
	(1.2E-17)	**(8.0E-19)**	(2.7E-18)	**(1.4E-06)**
	[8.2e+16]*	**[8.02762]***	[-2.86901]	**[7.61780]***
SENSEX	**1.78E-15**	**1.000000**	**-2.03E-16**	**-0.00027**
	(2.8E-16)	**(1.8E-17)**	**(6.2E-17)**	**(3.2E-05)**
	[6.34528]*	**[5.4e+16]***	**[-3.27190]*****	**[-8.46939]*****
RBI(NET)	2.32E-17	-4.48E-18	**1.000000**	-4.27E-06
	(4.9E-17)	(3.3E-18)	**(1.1E-17)**	(5.6E-06)
	[0.46917]	[-1.37339]	**[9.1e+16]***	[-0.75725]
CM	-7.77E-15	-2.54E-15	-9.24E-16	-0.000123
	(1.5E-14)	(1.0E-15)	(3.4E-15)	(0.00174)
	[-0.50899]	[-2.52825]	[-0.27355]	[-0.07100]
CGOT	1.97E-16	**-1.24E-16**	**7.98E-17**	-2.35E-06
	(1.1E-16)	**(7.2E-18)**	**(2.4E-17)**	(1.2E-05)
	[1.79704]	**[-17.2176]*****	**[3.29216]***	[-0.18878]

CGRT	1.10E-17	1.67E-18	**-9.45E-18**	-9.91E-07
	(9.0E-18)	(5.9E-19)	**(2.0E-18)**	(1.0E-06)
	[1.21953]	[2.80944]	**[-4.73510]*** **	[-0.96485]
CGST	1.33E-19	**1.56E-18**	1.87E-18	4.15E-07
	(4.3E-18)	**(2.8E-19)**	(9.5E-19)	(4.9E-07)
	[0.03111]	**[5.54324]***	[1.97681]	[0.85139]
RM	7.83E-18	**1.42E-18**	-4.07E-18	**2.31E-06**
	(7.1E-18)	**(4.7E-19)**	(1.6E-18)	**(8.1E-07)**
	[1.09838]	**[3.02167]***	[-2.57884]	**[2.84908]****
WPI	**9.00E-13**	7.03E-15	5.62E-14	0.019926
	(1.3E-13)	(8.5E-15)	(2.9E-14)	(0.01470)
	[6.97245]*	[0.82648]	[1.96919]	[1.35549]
R-squared	1.000000	1.000000	1.000000	0.426591
Adj. R-squared	1.000000	1.000000	1.000000	0.406026
Sum sq. Resids	2.04E-21	8.87E-24	1.00E-22	26.50112
S.E. equation	2.08E-12	1.37E-13	4.59E-13	0.236452
F-statistic	5.10E+32	2.14E+32	7.40E+32	20.74324
Log likelihood	12546.13		13288.18	20.52002
Akaike AIC	-50.92735		-53.94384	-0.010244
Schwarz SC	-50.77375		-53.79023	0.143359
Mean dependent	2294.862	18.98697	0.000000	0.010227
S.D. dependent	8724.415	372.5944	2326.238	0.306803
Determinant resid covariance (dof adj.)			9.38E-76	
Determinant resid covariance			8.08E-76	
Log likelihood			39742.69	
Akaike information criterion			-161.263	
Schwarz criterion			-160.6486	

Note that although the samples runs from Jan2000-Jun2009 i.e. 494 observations but we have used the sample size of 492 observations after adjustments. As we came to know through granger causality test, we have four endogenous (dependent) variables i.e. foreign exchange reserves, sensex, RBI open operations(net) and exchange rates and all the other as exogenous (independent) variables. Let us examine the results presented in the Table 4. First we consider the FER regression, Individually, ER at lag 2 and FER, sensex, RBI_NET at lags 1 and 2 are statistically significant where as from independent variables point of view FER, sensex and WPI are significant. Turning to the sensex regression, from lagged terms only ER at lag 2 is statistically significant and all the other variables i.e. FER, sensex, central govt. outright trans., turnover in central govt. securities and reserve money are also significant. If we go for RBI (net) regression, it was found that only sensex and RBI (net) at lag 1 and sensex at lag 2 are statistically significant and all the other variables i.e. sensex, RBI(net), central govt. outright trans. and repo trans. are also individually significant. But if we see the F statistics of all the three dependent variables i.e. FER, sensex and RBI (net), all the three values are so high that we cannot reject the hypothesis that collectively all the lagged terms and non-lagged terms are statistically significant.

From the research point of view, the main objective behind this paper was to establish a relationship between India's exchange rate and its key macro-economic indicators. Therefore, our main focus is on exchange rate. Let us examine the results of exchange rate presented in (Table 4). Consider the ER regression, individually, from the lagged values only sensex and ER at lag 1 were statistically significant and from non lagged value variables FER, sensex and reserve money were significant. The F statistics of this regression was also at a favourable level i.e. neither too high nor too low when compared with the F statistics of other variables. The R2 value of ER regression is 0.426 which was far better than the R2 values of all the other three variables regression i.e. FER, sensex and RBI (net). Apart from all the above statistical analysis i.e. t statistics, F statistics and R2, the Akaike and Schwarz information values for the ER regression in (Table4) were, respectively, -0.01 and 0.14 where as the corresponding values of other three variables regressions were not that much favourable and significant. Since lower the values of Akaike and Schwarz statistics, the better the model and is preferable.

Var And Causality

After discussing findings and results of the empirical testing, now the question arises, Is there any connection between VAR and causality? The answer to this question is YES, there is a relationship between VAR and causality. It was seen that at 1, 2 lags there was a bilateral causality between FER, sensex, RBI (net) and ER. Therefore, to illustrate VAR estimation equation theoretically, taking exchange rate (ER) as a dependent (Y) variable, it was found that there is a positive lag relationship between change in exchange rate (ER) and change in (ER) t-1 and negative lag relationship between change in (ER) and change in (sensex) t-1. The results also observed that there is positive relationship between change in ER and change in FER and change in reserve money (RM). Lastly, the paper also found that there is a negative relationship between change in exchange rate and change in sensex indices.

Conclusions

In this study, we examine the dynamic linkages between the foreign exchange rates of (INR/USD) and four important sectors of the Indian economy which mainly includes the external sector, financial markets, financial sector and real sector. The primary aim of this research was to investigate empirically the impact of India's foreign exchange rates (INR/USD) on its key macro-economic indicators of Indian economy by using combination of time series and cross sectional

data. Our empirical results show a significant causal relation between exchange rates and foreign exchange reserves, sensex and reserve money. We have also find a causal relation among the foreign exchange rates and past values of foreign exchange rates i.e.(ER)t-1.

In this paper, the basis of analysis is the foreign exchange rates of (INR/USD), estimated on weekly data (Jan 2000-June 2009) for each of the variables taken into consideration in this research. We have also observed bi-directional causality between exchange rates and other three macro-economic variables i.e. foreign exchange reserves, sensex and RBI open market operations (net). Our findings are robust with respect to various statistical tests used, including Granger causality tests, vector autoregressive (VAR) analysis. India being a developing country, has its exchange rates still being affected mostly by the fundamental variables of the external sector, financial market and financial sector. But as found out there is a weak evidence in favour of Indian exchange rates being affected by the real sector.

Recent Developments

This section of research focuses on the present scenario of exchange rate of Rupee with respect to Dollar. A lot of developments took place in this area which talks about major factors influencing Indian currency value. It also explains how a common man and regulatory bodies should understand currency fluctuations and take necessary steps accordingly. This section writes down few economic conditions when the currency value will be under pressure. The following are the three major factors influencing the changes in the currency values which are as follows:

- Inflation: As a general rule, a country with a consistently lower inflation rate exhibits a rising currency value, as its purchasing power increases relative to other currencies.
- Interest Rates: A higher interest rates offer good returns compare to other countries. It will result in the foreign capital come into the country. Lower interest rates decrease the currency value.
- Current Account Deficits: This situation is not good for a country because the country needs to buy more foreign currency to fulfill its need inside the country. A country needs to manage its deficit within control, otherwise it will lead to a economic problem. More demand for the foreign currency would reduce the value of that country's currency.

Policy Implications: The government of India and regulatory bodies should take corrective measures so as to control the down slide of the Rupee. It should focuses on foreign funds inflows and outflows i.e. FII's and FDI's policies, a keen watch on government finances which includes government deficit and surplus. Political uncertainty and corruption is another major factor for any country to have a stabilize economy. Therefore, these above areas are of major concern for a country like India for its growth and development of the economy.

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