INDIAN RUPEE/US DOLLAR EXCHANGE RATE

CASE STUDY ON EXCHANGE MODELS

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ABSTRACT

The paper analyzes Exchange rate of Indian rupee/us dollar which is governed by a managed floating exchange rate. This paper includes the forward premium, capital inflows, and volatility of capital flows, order flows and central bank intervention. The study therefore four examines, first the PPP Model Second monetary model, Third Portfolio balance model, fourth GARCH Model. The following section 1 briefly describes economic theories and section 2 reviews of the relevant literature, Section 3 describes the Theoretical exchange model, and Section 4 gives the empirical results. Section 5 concludes the findings support the view of references.

Key words: exchange rate, PPP Model, Monetary model, Portfolio balance model**,** GARCH Model,

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INTRODUCTION

The Indian Rupee and dollar exchange rate which is governed by a managed floating exchange rate. It considers extensions of the monetary model that include the forward premium, capital inflows, volatility of capital flows, order flows and central bank intervention. India has been operating on a managed flexible exchange rate regime from March 1993, making the start of an era of a market determined exchange rate regime of the rupee with provision for timely intervention by the central bank. Prior to that, up to 1990, the exchange rate regime was an adjustable nominal peg to a basket of currencies of major trading partners with a band. In the early 1990s, India was faced with a severe balance of payment crisis due to the significant rise in oil prices, the suspension of remittances from the Gulf region and several other exogenous developments. Amongst the several measures taken to tide over the crisis was a devaluation of the rupee in July 1991 to maintain the competitiveness of Indian exports. This initiated the move towards greater exchange rate flexibility. After a transitional 11-month period of dual exchange rates, a market determined exchange rate was established in March 1993. The current exchange rate policy relies on the underlying demand and supply factors to determine the exchange rate with continuous monitoring and management by the central bank. This study thus concentrates on the post March 1993 period and provides insights into forecasting exchange rates for developing countries where the central bank intervenes periodically in the foreign exchange market. All emerging economy currencies depreciated sharply against the US Dollar in the second-half of 2011 with the exchange rate of the Indian Rupee (INR) said to be the worst performing currency among them. Emerging market economies (EMEs) with a surplus or a small deficit in the current account were less hit than countries that have a sizeable deficit like India. Although the sharp fall and volatility in the exchange rate of the Indian rupee could be largely attributed to macroeconomic factors, *inter alia*, current account deficit and capital outflows, wherein spillover effects emanating from other volatile markets due to differences in timing of trading activity, bid-ask spreads and risk perceptions cannot be ruled out. Furthermore, the recent sharp fall in the exchange rate of the Indian rupee could also be attributed to the growing integration among the financial markets world over in which the confidence channel seems to have also played a significant role against the backdrop of the Euro zone sovereign debt crisis and the consequent external economic environment.

Methodology

We use three broad approaches, *viz*., cross correlations among exchange rates, PPP, Monetary, Portfolio balance and GARCH model to examine the spillover effect of volatility in the exchange rate of the foreign currency to the exchange rate of the Indian rupee. Although the first two approaches do not exactly verify the spillover effect, they give an idea beforehand about degree of correlation and the causal relationship, respectively. Since the advent of the concept of ARCH by Engle (1982), a host of studies applied and extended this methodology to capture the extent of changing volatility in a time series. In ARCH model, the conditional variance h is a linear function of past squared errors ε's derived from the mean equation, as well as possible exogenous variables. The ARCH model by Engle (1982), research on the Exchange rate mechanism of volatility between various segments of the financial market has been fast advancing. The application of ARCH and its generalized form, *i.e*., GARCH has advanced rapidly in examining volatility exchange rate among stock markets. Studies on volatility exchange based on low-frequency foreign exchange data are, however, relatively sparse. The initial application of GARCH model to the foreign exchange market could be traced back to the works of Diebold and Nerlove (1989).

Exchange Rate Models:-

The earliest and simplest model of exchange rate determination, known as the ***Purchasing power parity (PPP) theory***, represented the application of ''the law of one price''. This states that arbitrage forces will lead to the equalization of goods prices internationally once the prices are measured in the same currency. PPP theory provided a point of reference for the long-run exchange rate in many of the modern exchange rate theories. It was observed initially that there were deviations from PPP in short-run, but in the long-run, PPP holds in equilibrium. The failure of PPP models gave way to *monetary models* which took into account the possibility of capital/bond market arbitrage apart from goods market arbitrage assumed in the PPP theory.

Monetary model **(**due originally to Dornbusch, 1976), changes in the nominal interest rate reflect changes in the tightness of monetary policy. When the domestic interest rate rises relative to the foreign rate, it is because there has been a contraction in the domestic money supply relative to the domestic money demand without a matching fall in prices. The higher

interest rate at home attracts a capital inflow, which causes the domestic currency to appreciate. This model retains the assumption of stability of the money demand function and uncovered interest parity but replaces instantaneous purchasing power parity with a long-run version. The change in the long-run exchange rate is assumed to be correlated with unanticipated shocks to the trade balance. They therefore introduce the trade balance in the exchange rate determination equation. A domestic (foreign) trade balance surplus (deficit) indicates an appreciation of the exchange rate. The four models can be derived from the following equation specified in logs with starred variables denoting foreign counterparts:

$$et = \gamma + \delta(mt-mt^*) + \varphi(yt-yt^*) + \alpha(it-it^*) + \beta(\pi t-\pi t^*) + \eta(tbt-tbt^*) + \mu t$$

Where e = price of foreign currency in domestic currency

m = money supply

y = real output

i = nominal interest rate

π = inflation

TB = trade balance

The alternative testable hypotheses are as follows: Flexible-price

Model: $\delta>0$, $\alpha>0$, $\varphi<0$, $\beta=\eta=0$

Sticky price model: $\delta>0$, $\alpha<0$, $\varphi<0$, $\beta=\eta=0$

Real interest differential model: $\delta>0$, $\alpha<0$, $\varphi<0$, $\beta>0$, $\eta=0$

Hooper-Morton model: $\delta>0$, $\alpha<0$, $\varphi<0$, $\beta>0$, $\eta<0$

These models can be further extended to incorporate portfolio choice between domestic and foreign assets.

The ***portfolio balance model*** assumes imperfect substitutability between domestic and foreign assets. It is a dynamic model of exchange rate determination that allows for the interaction between the exchange rate, current account and the level of wealth.. The portfolio approach thus introduces current account in the exchange rate equation. The theoretical model can be expressed as a hybrid model as follows:

$$et = \gamma + \delta(mt-mt^*) + \varphi(yo-yo^*) + \alpha(it-it^*) + \beta(\pi t-\pi t^*) + \eta(tbt-tbt^*) + \theta(cat-cat^*) + \mu t$$

Where CA denotes current account balance and $\theta > 0$ Capital flows, forward premium with an increase in liberalization and opening up of capital accounts the world over, capital flows have become important in determining exchange rate behavior. The relation between capital flows and exchange rates is hypothesized to be negative (with the exchange rate defined as the price of foreign currency in domestic currency). This is because capital inflow implies purchase of domestic assets by foreigners and capital outflow as purchase of foreign assets by residents. Since the exchange rate is determined by the supply and demand for foreign and domestic assets, the purchase of foreign assets drives up the price of foreign currency. Likewise, the purchase of domestic assets drives up the price of domestic currency. Thus, an increase in capital inflows leads to appreciation of the domestic currency when there is no government intervention in the foreign exchange market or if there is persistent sterilized intervention. In the case of unsterilized government intervention, the potential of capital inflows to influence exchange rates decreases to a great extent. Dua and Sen (2009) develop a model which examines the relationship between the real exchange rate, level of capital flows, volatility of the flows, fiscal and monetary policy indicators and the current account surplus, and find that an increase in capital inflows and their volatility lead to an appreciation of the exchange rate. The theoretical sign on volatility can, however, be positive or negative. The forward premium measured by the difference between the forward and spot exchange rate can provide useful information about future exchange rates. According to covered interest parity, the interest differential between two countries equals the premium on forward contracts. Thus, if domestic interest rates rise, the forward premium on the foreign currency will rise and the foreign currency is expected to appreciate. The exchange rate defined as the price of foreign currency in domestic currency and the forward premium are therefore expected to be positively related. Microstructure Framework The microstructure theory of exchange rates provides an alternative view to the determination of exchange rates. Unlike macroeconomic models that are based on public information, micro-based models suggest that some agents may have access to private information about fundamentals or liquidity that can be exploited in the short-run. In microeconomic models of asset prices, transactions play a causal role in price determination (Evans and Lyons, 2001, 2007). The causal role arises because transactions convey information that is not common knowledge. These models assume that information is dispersed and heterogeneous agents have different information sets. The trading process in foreign exchange markets is not transparent and features bid-ask spreads that reflect the costs to market makers / dealers of processing orders and managing inventories. Thus, a distinctive feature of the microstructure models is the central role played by transactions volume or order flows in determining nominal exchange

rate changes (Medeiros 2005, Bjonnes and Rime 2003 Order flow is the cumulative flow of transactions, signed positively or negatively depending on whether the initiator of the transaction is buying or selling. Order flow takes positive values if the agent purchases foreign currency from the dealer and takes negative values if it sells at the dealer's bid. Conventionally, order flow is taken as purchase minus sales of foreign currency. Hence an increase in order flow (i.e. an increase in the volume of positively signed transactions) will generate forces in the foreign exchange market such that there is pressure on the domestic exchange rate to depreciate. Hence the order flow and the exchange rate are positively related. The explanatory power or information content of order flow depends on the factors that cause it. Order flow is most informative when it is caused due to dispersion of private information amongst agents with respect to macroeconomic fundamentals (Lyons 2005). Order flow is less informative when it is caused due to management of inventories by the foreign exchange dealers in response to liquidity shocks. Hence the overall effect of sterilized intervention on exchange rates is ambiguous. Recognizing the importance of both monetary models as well as micro structure theory in determining the exchange rates, the paper uses a combination of both the models. Exchange rate is determined by monetary variables as well as order flows. Theory has been further expanded to include forward premium, capital inflows, volatility of capital flows and central bank intervention as determining the exchange rate behavior. The theoretical model so generated can be expressed as follows:-**GARCH model** to examine the spillover effect of volatility in the exchange rate of the foreign currency to the Indian rupee. The concept of ARCH by Engle (1982), a host of studies applied and extended this methodology to capture the extent of changing volatility in a time series. In ARCH model, the conditional variance he is a linear function of past squared errors ε's derived from the mean equation, as well as possible exogenous variables.

$$R_t = X + \varepsilon_t \quad \text{---------- (1)}$$

where Rt is the variable of interest and εt is a white-noise disturbance term with constant variance.

$$H_t = C\varepsilon_t - 1 + gX_t \quad \text{----------(2)}$$

where a>0 and c, g ≥0.

The conditional variance equation in ARCH models does not include a stochastic component, but the models can include additional squared error terms from past periods. To circumvent the difficulties in estimating ARCH models with large number of parameters, Bollerslev (1986) introduced GARCH model by allowing the conditional variance h

to be a function not only of last period's error squared but also of its conditional variance. The GARCH (1,1) model defines the conditional variance of R at time t to be of the form:-

$$ht = a + \beta ht\text{-}1 + C\varepsilon t\text{-}1 + gXt \text{----------} (3)$$

The above GARCH formulation can also be extended to include squared errors from the prior periods in the conditional variance equation. The stability property of the above GARCH process requires that the coefficients of the lagged errors and lagged conditional variances must sum to less than one. In practice, the choice of conditional mean specification as given in equation (1) above is an important, yet largely ignored, issue in tests for volatility spillovers. Engle, *et al*. (1987) extended the GARCH model to allow the conditional mean to be a function of the conditional variance at time t, which is popularized as GARCH-M model. A typical GARCH(1,1)-M model takes the form

$$Rt = x + \beta ht + \varepsilon t \text{----------} (4)$$

Where the conditional variance is defined in the same way as the GARCH (1,1) model. We estimate three conditional mean specifications, *viz*., simple conditional mean, including conditional variance in the mean equation and a first-order autoregressive process while examining the volatility pattern in the exchange rates. We follow a two-step approach developed by Hamao *et al*. (1990) that applied the univariate GARCH methodology to analyze relations between international stock markets.

Conclusion

While there is availability of a large volume of literature in examining exchange rate volatility, research on spillover effects emanating from volatilities in major foreign currencies to the volatility in the exchange rate of the Indian Rupee is still lacking. This study makes an attempt to bridge this gap by investigating not only the own volatility factor of the Indian Rupee but also the spillover effects emanating from exchange rates of the Brazilian Real, the Russian Ruble, the South Korean Won, the Singapore Dollar, the Japanese Yen, the Swiss Franc, the British Pound Sterling and the Euro. Among the class of ARCH and GARCH models, the study employs a two-step multivariate AR(1)-GARCH(1,1) framework to examine the dynamics of exchange rate volatility and its spillovers which is also corroborated by examining

simple pair-wise Granger causality tests. We found evidence of conditional autocorrelation and persistence of volatility in daily exchange rates of all nine currencies. The findings also support the view that volatilities observed in the exchange rate of the leading currencies transmit to volatility in the daily exchange rate of the Indian Rupee. However, as the spillover coefficients are smaller than the ARCH and GARCH parameters, the volatility in the exchange rate of the Indian Rupee could also be driven by domestic macroeconomic and global factors. It is also worthwhile to mention that the study can be further extended by incorporating news factor in examining intraday variations which would provide greater insights into the heat waves and meteor showers hypothesis.

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