CHAPTER – 1
INTRODUCTION

1.1 Introduction:

The decade of 1970s brought in a turning point in the realm of international economics and finance. The Britton Woods System broke down and flexible exchange rate system replaced the fixed exchange rate system in 1970s. Determination of exchange rates became the centre-price of deliberations in international economics while the management of balance of payments became almost a non-entity. Consequently, attention of economists was diverted from the Balance of Payments problems to issues relating to exchange rate dynamics. Variability of major world currencies in early seventies drew the attention of economists and they proceeded to provide theoretical explanations for such empirical phenomena. Consequently, over the last three decades a large number of theories on exchange rate grew up. On the other hand, the issues of dynamic adjustment of balance of payments were relegated to the background.

The important theories of exchange rate, developed during the last three decades which excited the imaginations of economists include Purchasing Power Parity Theory, Portfolio Balance Model, Asset Market Model, Covered and Uncovered Interest Parity Theories, Currency Substitution Theory and Monetary Approaches to Exchange Rate (MAER) Theory.

The most exciting feature of this period is the growth of renewed interest of economists in the 'Interest Arbitrage Parity Doctrine'. As a matter of fact, Interest Rate Arbitrage Parity Theory' is almost an invariable ingredient of the macroeconomic models of exchange rate whether by itself or the combination with other equilibrium conditions. Thus the 'Interest Rate Arbitrage Parity Theory' has emerged as an influential theory of the determination of the exchange rate since 1970s.

The 'Interest Rate Arbitrage Parity Theory' is theoretically attractive no doubt. But the empirical support for the theory is mixed. Some authors find in favor of the theory while others do not. Yet the research on Interest Rate Arbitrage Parity Theory is extensive. That so much research has been reported on this subject indicates, in past, a reluctance to reject the theory, at least in the short-run. The present study is an attempt in this direction with an objective of examining how far the Rupee/Dollar exchange rates conformed to the ‘Interest Rate Arbitrage Parity Doctrine’ over the period of study.

1.2 Uncovered Interest Rate Arbitrage Parity (UIRAP) Doctrine

Exchange rate usually represents the relative price of a unit of one currency in terms of the currency of another country. More specifically, exchange rate refers to the price of a unit of foreign currency in terms of home currency. Exchange rate, being essentially a price variable, is determined by the relative strength of the forces of demand and supply of currencies used in transections. Variations in the demand and supply of currencies occur when international flow of capital across countries takes place following investment in foreign countries concerned. Equilibrium flow of foreign investment is given by the ‘Uncovered Interest Rate Arbitrage Condition’. Exchange rate prevailing at that equilibrium level of foreign investment is the object of studies among economists under different assumptions about price level in the economic set-up.

There exists a fundamental difference between the measurements of returns from domestic investment and those from foreign investment. In domestic investment, the investor considers only the domestic interest rate. While deciding whether to invest at home or in a foreign country the investor considers following three factors:-

(i) Domestic interest rate

(ii) Foreign interest rate

(iii) Any expected change in the exchange rate at the time of maturity.

The first two factors taken together represent ‘interest rate differential’ which might motivate or initiate foreign investment. But whether foreign investment would really take place or not, and how much of foreign investment would really take place depends on the third factor.

For example, we consider a situation where an U.S. investor has $1 to invest. He may invest $1 in his home country (USA) or in the foreign country (India). What would make the U.S. investor to invest in India is our concern.

Now we have the following set of information.

Total capital to be invested = \$1

Home (U.S.) interest rate = i_h

Foreign (India) interest rate= i_f

Exchange rate at time t = s_t (Dollar/ Rupee exchange rate)

Expected Exchange rate at $(t+1)$ periode = s^e_{t+1}

The investor's net return at home $= \$\,(1+i_h) - \$1$ = i_h

Alternatively, he may invest in India. In that case, he will convert \$1 into rupees. He will then get = $\frac{1}{s_t}$ rupees.

His earning after one year = $[\frac{1}{s_t}]\,(1+i_f)$ (1.1)

Now he will have to convert rupees into dollar in $(t+1)$ period. But he does not really know what exchange rate will prevail after one year i.e., at $(t+1)$ period. In that case, he will form an expectation for exchange rate at $(t+1)$ period. Let the expected exchange rate be s^e_{t+1}.

Consequently, he will measure his earning in dollar at $(t+1)$ period.

His earning in dollar at $(t+1)$ period $=\left[\frac{1+i_f}{s_t}\right].\,s^e_{t+1}$ (1.2)

Therefore, the net expected earning abroad $= \left[\left\{\frac{1+i_f}{s_t}\right\}.\,s^e_{t+1}\right]-1$

$$= \left[\frac{s^e_{t+1}}{s_t}\right](1+i_f)-1$$

$$= \left(\frac{s^e_{t+1}}{s_t}\right) - 1 + i_f\left(\frac{s^e_{t+1}}{s_t}\right)$$

$$= \frac{s^e_{t+1}-s_t}{s_t} + i_f\left(\frac{s^e_{t+1}}{s_t}\right)$$

$$= i_f + \frac{(s^e_{t+1}-s_t)}{s_t} \tag{1.3}$$

[Assuming $s^e_{t+1} \approx s_t$]

The foreign investor will go on investing so long as his net earnings from abroad ≥ his net earnings from investment at home.

$$\text{or, } i_f + \frac{(s_{t+1}^e - s_t)}{s_t} \geq i_h$$

$$\text{or, } i_f - i_h \geq -\frac{(s_{t+1}^e - s_t)}{s_t} \qquad (1.4)$$

The investor will reach equilibrium when

$$i_f - i_h = -\frac{(s_{t+1}^e - s_t)}{s_t} \qquad (1.5a)$$

$$i_h = i_f + \frac{(s_{t+1}^e - s_t)}{s_t} \qquad (1.5b)$$

Or, interest rate differential = Expected Depreciation of the foreign currency (here Rupee)

Now, Earnings from the home investment = i_h

Earnings from the foreign investment = i_f + Expected change in the price of foreign currency

$$= i_f + \dot{s}_t^e$$

$$\text{where } \dot{s}_t^e = \frac{(s_{t+1}^e - s_t)}{s_t}$$

Equilibrium will be reached when

Earning from the foreign investment = Earnings from home investment

$$\text{or,} \quad i_f + \dot{s}_t^e = i_h \qquad (1.6)$$

$$\text{or, } (i_f - i_h) + \dot{s}_t^e = 0$$

$$\text{or, } (i_f - r_h) = -\dot{s}_t^e \qquad (1.6a)$$

Or, interest rate differential = Expected Depreciation of the foreign currency.

Equation (1.6a) represents the Uncovered Interest Rate Parity Condition for equilibrium in foreign investment. This condition also speaks about the potential variations in exchange rate expected over the period of investment. This condition states that

(i) if foreign interest rate exceeds the domestic interest rate, then foreign currency is expected to depreciate over the period of investment.

(ii) the extent of depreciation of the currency with higher interest rate equals the interest rate differential.

It, therefore appears that

(a) country with higher interest rate vis-a-vis its trading partner country is expected to experience depreciation of its currency.

(b) country with lower interest rate vis-a-vis its trading partner country is expected to face appreciation of its currency.

(c) given an initial equilibrium exchange rate, the percentage of expected depreciation equals the percentage of increase in interest rate differential.

The UIRP Doctrine does not explain how equilibrium exchange rate is determined. However, it explains how, given the equilibrium level, variations in exchange rate occur around the equilibrium level. The extent of expected variation in exchange rate is also defined. An example may be cited in this instance. In November, 2011 Rupee/Dollar exchange rate was Rs.42/Dollar. Interest rate on one-year bond was 6%. In December, 2011 interest rate on one-year bond rose to 7.5% while US interest rate on the equivalent bonds remained unchanged. Thus there was 25% rise in Indian interest rate. Consequently, Rupee was expected to depreciate by 25% over time. As a matter of fact, since December, 2011 there was almost sustained depreciation of rupee and rupee depreciated by almost 25% at the end of February, 2012 and it become higher than Rs. 52/Dollar.

1.3 Covered Interest Arbitrage Parity (CIAP) Doctrine

UIRP Doctrine is based on the proposition that the investor is risk-neutral such that the investor considers both the domestic and foreign bonds equally risky. However, the investors may be risk-averse and may consider foreign bonds more risky. It is risky because investor finds that depreciation of foreign currency reduces the gain from the interest earning from the foreign bonds.

In that event the investor seeks to minimize the risk of losing from foreign currency depreciation through hedging. The hedging is done through covering the interest arbitrage. The investor does this through two simultaneous operations:

(i) The investor exchanges the domestic currency for the foreign currency at the current spot rate in order to purchase the foreign bonds, and

(ii) At the same time the investor sells forward the amounts of the foreign currency which include his invested principal plus the interest earned on the maturity of the foreign investment.

Thus the 'Covered Interest Rate Arbitrage' involves the spot purchase of foreign currency in order to make investment and off-setting simultaneous forward sell (i.e., SWAP) of the foreign currency to cover the foreign exchange risk.

$$\text{Now} \quad \dot{s}_t^e = \frac{s_t^e - s_{t-1}}{s_{t-1}}$$

Substituting $s_t^e = F_t$ we get

$$\dot{s}_t^e = \frac{F_{t-} s_{t-1}}{s_{t-1}} \tag{1.7}$$

$$\dot{s}_t^e = f_t \tag{1.7a}$$

Here F_t is the quoted forward exchange rate and f_t is the forward premium (discount) i.e. proportion by which a country's forward exchange rate exceeds (follows below) its spot rate.

Now substituting $f_t = \dot{s}_t^e$ in equation (1.6)

$$\text{We get,} \quad i_f - i_h = -f_t = \frac{F_t}{s_{t-1}} - 1 \tag{1.8}$$

Equation (1.8) indicates that the forward premium equals the interest rate differential where foreign interest rate exceeds the domestic interest rate.

In the example cited above, the spot rate was Rs42/$ in November, 2011. Indian interest rate registered a rise by 25% in November, 2011 on 1- year bonds. So the forward rate quoted by the banks changed. Indian currency suffered depreciation as the forward rate for Dollar was raised. Rupee suffered a forward discount of about 25%.

1.4 Forward Rate is the Unbiased Predictor of Future Spot Exchange Rate:-

In the Covered Interest Rate Parity Arbitrage Doctrine the risk of investment is minimized simply by substituting f_t for $\dot{s}_t^e$. Therefore, in CIRAP *'Unbiased Forward*

Rate Hypothesis' asserts that forward rate at t is an unbiased predictor of the spot rate at $(t + 1)$ period. Therefore,

$$F_t = E(s_{t+1}) \tag{1.9}$$

Now $E(s_{t+1})$ represents the conditional expectation of (s_{t+1})such that

$$F_t = s^e_{t+1} = E\,[s_{t+1}/\,\Omega)] \tag{1.10}$$

$$\text{where } \Omega = \{\, s_{t+1};\ i = 1,\ldots.\}$$

Consequently, $$(s_{t+1}) = F_t + \varepsilon_{t+1} \tag{1.11}$$

where ε_{t+1} has a mean value of zero from the respective of time period t in $(t + 1)$

$$\text{Here } \varepsilon_{t+1} = s_{t+1} - F_t \tag{1.12}$$

Therefore, ε_{t+1} is forecast error.

F_t is the unbiased estimator of s_{t+1} iff

$$\varepsilon_{t+1} \sim \text{iid } N\,(0,\sigma^2_\varepsilon\,) \tag{1.13}$$

Now if F_t is the 'Minimum Mean Square Error' estimate of s_{t+1} such that

$$\varepsilon_{t+1} = 0$$

$$\text{then} \quad F_t = s^e_{t+1} \tag{1.14}$$

$$\text{Again} \quad f_t = \dot{s}^e_t$$

$$\text{or,} \quad \frac{F_t - s_{t+1}}{s_t} = \frac{s^e_{t+1} - s_{t+1}}{s_t}$$

$$\text{or, } F_t - s_{t+1} = s^e_{t+1} - s_{t+1}$$

$$\text{or, } F_t = s^e_{t+1}$$

$$\text{Or, } F_t = E(s_{t+1}) \tag{1.15}$$

Equation (1.15) indicates that the forward rate F_t is the unbiased predictor of the future spot exchange rate. This indicates that the CIRAP Doctrine is essentially developed on the idea that the forward rate is the unbiased predictor of '*Future Spot Exchange Rate'*.

1.5 Role of forecasting in UIRP:

The speculators i.e., those who demand for and supply of the foreign exchange, hope to make an immediate profit on the delivery day owing to the difference between the contracted forward rate and the current (spot) market rate on that day. If a speculator expects that the actual future spot rate will be higher than the current forward rate, the speculator will purchase foreign currency forward and take a *'long position'* in foreign exchange market. If the expectation is realized, forward foreign exchange is acquired on the delivery date at the contracted price and then is immediately resold at the spot price at that time for a profit. If, on the other hand, it is expected that the actual future spot rate will be lower than the current forward rate, the speculator will enter into a contract to sell foreign exchange forward or take a '*short position*' in the foreign exchange market.

Thus, expectations play an important role in this market, particularly on the part of those holding an uncovered position. The opportunity cost of hedging in this market consists of the difference between the contracted exchange rate and the rate actually existing on the contracted delivery day.

1.6 Random walk property of Exchange Rate and 'Foreign Exchange Market Efficiency Hypothesis' (FEMH):

Foreign Exchange Market is assumed to be efficient in international finance literature. As a matter of fact, this hypothesis is an integral part of the theories of exchange rates developed so far. This hypothesis is based on the assumption that spot exchange rate follows a 'random walk' process such that

$$s_t = s_{t-1} + \varepsilon_t$$

$$\text{where } \varepsilon_t \sim \text{ iid } N(0, \alpha_\varepsilon^2)$$

$$\text{Therefore,} \quad E(s_t/\Omega_t) = s_{t-1} + E(\varepsilon_t/\Omega_t)$$

$$\text{Or,} \, s_t^e = s_{t-1} \tag{1.16}$$

$$\text{Therefore,} \, s_{t+1}^e = s_t \tag{1.16a}$$

$$[\text{Here } \Omega = \text{set of information available at time t}]$$

Thus the Efficient Market Hypothesis (EMH) for exchange rate indicates that the predicted exchange rate for any period $(t+1)$ i.e. s_{t+1}^{e} is nothing but the past period exchange rate s_t. If EMH holds, then from (1.15) we have

$$F_t = s_{t+1}^{e} = s_t \tag{1.17}$$

Again if (1.17) holds, then there arises no question of looking for minimizing investment risk by taking resort to F_t. In that case, the investor, while making investment abroad, would cost only s_t for converting the foreign currency to home currency. Consequently, the entire exercise of hedging becomes meaningless under CIRAP; given that exchange rate series defines a Random Walk by nature.

1.7 Direction of Causality: What causes what?

In UIRP we have

$$i_h = i_f + \dot{s}_t^{e} \tag{1.6}$$

Here we have three variables like i_h , i_f and $\dot{s}_t^{e}$ while the number of equation is one only. However, equation (1.6) can be written as

$$(i_f - i_h) = - \dot{s}_t^{e} \tag{1.6a}$$

Here $(i_f - i_h)$ or interest rate differential may be taken as a variable. Consequently, equation (1.6a) contains two variables, viz, $(i_f - i_h)$ and $\dot{s}_t^{e}$. The equation cannot be solved for the values of $(i_f - i_h)$ and $\dot{s}_t^{e}$ simultaneously. The equation can be solved if value of any one of the variables is given. In that case the value of the other variable can be obtained.

Equation (1.6a) can be written in two different ways.

$$(i_f - i_h) = - \dot{s}_t^{e}$$

$$\text{or, } - \dot{s}_t^{e} = (i_f - i_h) \tag{1.6b}$$

In (1.6a) $(i_f - i_h)$ is the endogenous Variables and s_t^{e} is the exogenous variable.

The equation (1.6a) shows how $\dot{s}_t^{e}$ changes first leading to changes $(i_f - i_h)$. Hence that change occurs initially in $\dot{s}_t^{e}$ and this leads to the change interest rate differential. Thus variations in $\dot{s}_t^e$ Granger Cause variation in (i_h - i_f). Thus variations in ($i_h - i_f$) can be predicted on the basis of the variations in $\dot{s}_t^e$.

On the other hand in equation (1.6b) $\dot{s}_t^e$ is the endogenous variable while (i_h - i_f) is the exogenous variable. The equation (1.6b) shows that initial changes in (i_h - i_f) lead to changes in $\dot{s}_t^e$. Here change occurs initially in (i_h - i_f) and this leads to changes in $\dot{s}_t^e$. Thus variations in (i_h - i_f) Granger cause variations in $\dot{s}_t^e$. Consequently, variations in $\dot{s}_t^e$ can be predicted on the basis of the variations in (i_h - i_f).

There exists no theoretical justification for deciding a *priory* the direction of Granger Causality between interest rate differential and expected variations in spot exchange rate. An empirical study may, on the other hand, establish the direction of causality in any particular economy at any given period of time. The present study is an attempt in this direction.

1.8 Exchange Rate and Interest rate: Relations in Exchange Rate Theories.

Exchange rate theories exhibit relations between exchange rates and interest rates. Such relations are explicit in some theories while these are implicit in some others. In some theories exchange rates are related to nominal interest rates while in others exchange rates are related to real interest rates. Some exchange rate theories state that exchange rates are positively related to interest rate changes. Again some other exchange rate theories exhibit negative relation between exchange rate and interest rate. We consider some well-known exchange rate theories here and explain how exchange rates are related to interest rates in these theories. This gives us a scope for understanding the relevance and importance of UIRAP doctrine in international finance.

1.8.1 Purchasing Power Parity (PPP) Theory

Purchasing Power Parity theory [Balasa (1964), Dornbusch (1987), Frenkel(1981), Hakkio (1984), Katseli, L. and Papaefstratiou (1979), Officer (1976), Sarno and Taylor (2002)] basically deals with the determination of equilibrium exchange rate. It also explains the properties of equilibrium exchange rate of currencies concerned. Economists are of the view that Purchasing Power Parity Theory holds in the long-run and the theory fails to explain the determination of short-run exchange rates.

According to PPP theory, in equilibrium exchange rate equals the ratio of price indices of countries concerned such that

$$s_t = \frac{p_t}{p_t^*} \tag{1.18}$$

where s_t = exchange rate i.e. domestic currency price of a unit of foreign currency at time- t, p_t = domestic price index at t, p_t^* = foreign country price index at time t.

It, therefore, appears that absolute version of Purchasing Power Parity Theory does not relate exchange rate to nominal or real interest rates of the countries concerned. However, 'Relative Version of Purchasing Power Parity (PPP) Theory' hints at such relation. This is explained below.

Taking log on both sides of equation (1.18) we have

$$\log s_t = \log p_t - \log p_t^*$$

Now differentiating with respect to t, or we get

$$\frac{1}{s_t}\frac{ds_t}{dt} = \frac{1}{p_t}\frac{dp_t}{dt} - \frac{1}{p_t^*}\frac{dp_t^*}{dt}$$

$$\text{or,} \quad \dot{s}_t = \pi_t - \pi_t^* \tag{1.19}$$

$$\text{where, } \dot{s}_t = \text{rate of change of exchange rate } (s_t)$$

$$\pi_t = \text{domestic inflation rate at period t}$$

$$\pi_t^* = \text{foreign inflation rate at t}$$

Thus equation (1.19) relates $\dot{s}_t$, the rate of change of exchange rate, to inflation differential in trading countries concerned.

Let us now assume that 'Fishers Theory of Interest' holds good such that

Realized real interest rate = nominal interest rate – inflation rate.

Thus for the countries concerned we have

$$r_t = i_t - \pi_t \tag{1.20}$$

$$\text{and} \quad r_t^* = i_t^* - \pi_t^* \tag{1.21}$$

where r_t = realized real interest rate in the domestic economy

i_t = domestic nominal interest rate

r_t^* = realized real interest rate in the in the foreign economy concerned

i_t^*= foreign nominal interest rate

Then from equation (1.20) and (1.21) we get

$$\pi_t = i_t - r_t \tag{1.22}$$

and $$\pi_t^* = i_t^* - r_t^* \tag{1.23}$$

Substituting (1.22) and (1.23) in equation (1.19) we have

$$\dot{s}_t = i_t - r_t - i_t^* + r_t^* \tag{1.24}$$

Assuming that real interest rates become identical across countries under free trade and perfect capital mobility, we have $r_t = r_t^*$.

Then from (1.24) we have

$$\dot{s}_t = i_t - i_t^* \tag{1.25}$$

Equation (1.25) indicates that rate of change of exchange rate ($\dot{s}_t$) equals the differential of interest rates prevailing in the trading countries concerned.

Now given the foreign interest rate (i_t^*) unchanged, change in ($\dot{s}_t$) is positively related to change in i_t i.e. di_t. In that case acceleration of exchange rate equals the change in domestic interest rate series such that

$$\frac{d\dot{s}_t}{dt} = \frac{di_t}{dt} \tag{1.26}$$

$$\frac{d^2}{dt^2}(\log s_t) = \frac{di_t}{dt} \tag{1.26a}$$

The equation (1.26a) does not explicitly show that exchange rate is positively related to nominal interest rate. Besides, the relation (1.26) is obtained with a few restrictive assumptions like

(i) real interest rates become equal across all trading nations under free trade and perfect capital mobility

(ii) Fisher's Interest Equation holds good, and

(iii) foreign nominal interest rate remains constant over time.

1.8.2 Monetary Theory of Exchange Rate (MTER)

Monetary Theory of Exchange Rate [Bilson, J. F. O. (1978, 1979), Frenkel (1976)] has been derived on the basis of market clearing condition

$$\frac{M_t^d}{P_t} = \frac{M_t^s}{P_t} = \frac{M_t}{P_t} \tag{1.27}$$

where $\frac{M_t^d}{P_t} =$ Real demand for money in the domestic economy

$\frac{M_t^s}{P_t} =$ Real supply of money in the domestic economy

Similarly, for the foreign economy the relevant condition is

$$\frac{M_t^{*d}}{P_t^*} = \frac{M_t^{*s}}{P_t^*} = \frac{M_t^*}{P_t^*} \tag{1.28}$$

where * stands for foreign countries

The demand for money equations are given by

$$\frac{M^d}{P_t} = Y_t e^{-i_t} \tag{1.29}$$

$$\text{and} \quad \frac{M^{*d}}{P_t^*} = Y_t^* e^{-i_t^*} \tag{1.30}$$

where Y_t and Y_t^* represent income level in the domestic and foreign countries respectively. Again i_t and i_t^* represent nominal interest rates in the domestic and foreign countries respectively.

Therefore in equilibrium

$$M_t = P_t Y_t e^{-i_t} \tag{1.31a}$$

$$\text{and} \quad M_t^* = P_t^* Y_t^* e^{-i_t^*} \tag{1.31b}$$

Thus we have

$$\frac{M_t}{M_t^*} = \frac{P_t}{P_t^*} \frac{e^{-i_t}}{e^{-i_t^*}} \cdot \frac{Y_t}{Y_t^*} \tag{1.32}$$

$$\text{or} \quad \frac{M_t}{M_t^*} = s_t \, \frac{e^{-i_t}}{e^{-i_t^*}} \cdot \frac{Y_t}{Y_t^*} \quad [\because s_t = \frac{P_t}{P_t^*}]$$

$$\text{or} \quad s_t = \frac{M_t e^{-i_t^*}}{M_t^* e^{-i_t}} . \frac{Y_t^*}{Y_t} = \frac{M_t}{M_t^*} \, e^{-i_t^* + i_t} . \frac{Y_t^*}{Y_t} \tag{1.33}$$

Taking log on both sides we have

$$\log s_t = \log M_t - \log M_t^* - i_t^* + i_t + \log Y_t^* - \log Y^t \tag{1.34}$$

Now differentiating with respect to t,

$$\frac{1}{s_t} \frac{ds_t}{dt} = \frac{di_t}{dt}$$

$$\text{or} \quad \dot{s}_t = \frac{di_t}{dt} \tag{1.35}$$

where money supplies and output levels in both countries remain unchanged with a constant foreign interest rate. The equation (1.35) states that the rate of change in exchange rate ($\dot{s}_t$) equals the change in domestic interest rate. However, this equation does not establish any direct and explicit linkage between exchange rate (s_t) and domestic interest rate (i_t).

1.8.3 MUNDELL – FLEMING MODEL:

The Mundell – Fleming model [Mundell (1962, 1968), Fleming (1962)] is an open economy version of the IS-LM model with the usual inherent assumption that price level is fixed. Consequently, inflation rate is zero and nominal interest rate equals real interest rate. The structure of the Mundell- Fleming model is as follows:

$$Y_t = C(Y_t - T_t) + I_t(i_t) + G_t + NX_t . (e_t) \tag{1.36a, IS}$$

$$\frac{M_t}{P_t} = L(i_t, Y_t) \tag{1.36b, LM}$$

$$i_t = i_t^* \tag{1.36c}$$

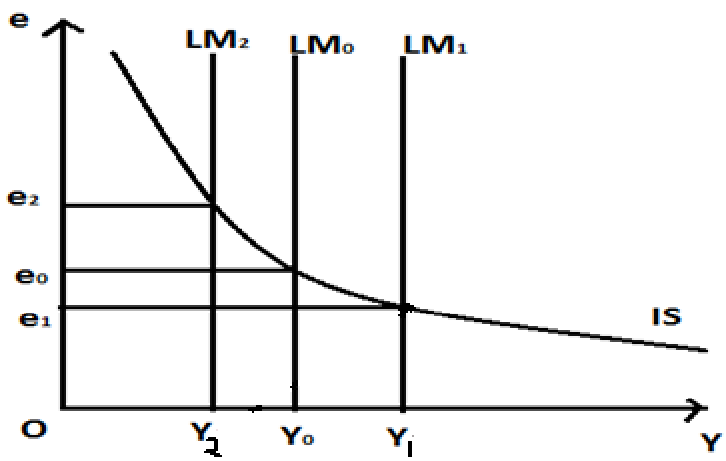
Equation (1.36a) describes the goods market equilibrium where Y_t is a function i_t, y_t, s_t, T_t and G_t. Here e_t represents the foreign currency price of a unit of domestic currency such that $e_t = \frac{1}{s_t}$. Equation (1.36b) represents the money market equilibrium. Since the economy is a small one which cannot affect the world interest rate, domestic interest rate (i_t) cannot deviate from world interest rate i_t^*. Thus $i_t = i_t^*$ represents the economic compulsion and feature of a small economy. Since $i_t = i_t^*$ and $Y_t = \overline{Y}$ while net export (NX) is a negative function of exchange rate, IS is a negative function of exchange rate. LM curve is a function of interest rate and not of exchange rate, Thus LM curve is a vertical line since exchange rate does not enter into the LM equation.

Let us consider effects of a change in interest rate following changes in monetary policy on exchange rate.

Case 1: Expansionary Monetary Policy and Exchange Rate:

Let us consider an easy money policy followed by the Central Bank of the country concerned such that money supply increases, given that, price level remains fixed. So real money balances increase and LM curve shifts to the right from LM_0 to LM_1.

Exchange rate ($e_t = \frac{1}{S_t}$)



Income Level

As a result, exchange rate falls from Oe_0 to Oe_1 , while income level rises from OY_0 to OY_1 . In the domestic economy an increase in money supply lowers the interest rate. In a small economy interest rate cannot deviate from the world interest rate for a long period. So a downward pressure on domestic interest encourages domestic capital to flow to other countries where it can earn a higher return. Capital outflow raises the supply of domestic currency in the foreign exchange market and, thus lower the exchange rate. Domestic currency, as a result, depreciates i.e, e_o falls to oe_1 such that the domestic price of a unit of foreign currency (s_t) rises. Thus in the Mundell-Fleming model s_t rises following a fall in interest rate such that $s_t \infty \frac{1}{i_t}$

Case 2: Contractionary Monetary Policy in Mundell-Fleming Model and Exchange rate.

Let us assume that money supply declines following a contractionary monetary policy followed by the Central Bank of the country concerned. Price level remaining fixed, real money balances decline and LM curve shifts left from LM_0 to LM_2 in the above figure. As a result, exchange rate rises from Oe_0 to Oe_2 and income level falls from OY_0 to OY_2.

In the domestic economy decline in money supply raises domestic interest rate. Upward pressure on interest rate triggers inflow of foreign capital. Capital inflow raises the demand for domestic currency resulting in appreciation of domestic currency such that exchange rate (e_t) rises and (s_t) falls. Thus in case of contractionary monetary policy also (s_t) is found to be inversely related to interest rate such that $s_t \infty \frac{1}{i_t}$.

1.8.4 UNCOVERED INTEREST RATE ARBITRAGE PARITY DOCTRINE:

Relation Between Interest Rate and Exchange Rate.

Interest Arbitrage Parity doctrine [Aliber (1973), Frenkel and Levich (1975), Taylor (1987)] is based on some important assumptions like

(a) perfect capital mobility exists among trading partners,

(b) expectations are formed rationally and

(c) the equilibrium occurs in financial market when interest rate differential equals the rate of expected depreciation of domestic currency as given in equation (1.5a) such that

$$i_h = i_f + \frac{s_{t+1}^e - s_t}{s_t} \qquad (1.5a)$$

$$\text{or, } i_h = i_f + \frac{s_{t+1}^e}{s_t} - 1 \qquad (1.5b)$$

Here i_h and i_f are the domestic and foreign interest rate respectively where s_{t+1}^e the expected future exchange rate and s_t represents the domestic currency price of a unit of foreign currency concerned.

If $i_h = i_f$, then $i_h - i_f = 0$ and $i_h - i_f = \frac{s_{t+1}^e}{s_t} - 1 = 0$

$$\text{or, } s_{t+1}^e = s_t \; ; \tag{1.37}$$

Thus in equilibrium the expected future exchange rate equals the spot exchange rate. It means that the present spot exchange prevails even in future. As a result, speculators restrain themselves from taking either the '*long*' or '*short*' position in the foreign exchange market. The market is in equilibrium.

Now let us assume that i_h rises, given i_f remain unchanged. Then

$$i_h > i_f + \left(\frac{s_{t+1}^e}{s_t} - 1\right) \tag{1.38}$$

In order to ensure equilibrium in the foreign exchange market, given i_f unchanged, s_{t+1}^emust increase. Now $i_h > i_f$ indicates that $i_h - i_f > 0$ and

$$i_h - i_f = \frac{s_{t+1}^e}{s_t} - 1 > 0 \tag{1.39}$$

$$\text{Therefore, } \quad \frac{s_{t+1}^e}{s_t} > 1$$

$$\text{and } \quad s_{t+1}^e > s_t \tag{1.40}$$

This shows that, as i_h rises, the expected future spot rate s_{t+1}^e must exceed s_t. In other words, domestic currency is expected to depreciate vis-à-vis foreign currency. Speculators will take *'long'* position on foreign currency at the spot and '*short*' position on domestic currency. As a result, spot demand for foreign currency rises and, consequently, spot rate for foreign currency rises such that s_t also rises until s_t equals s_{t+1}^e.

It, therefore, appears that, following a rise in domestic interest rate i_h , domestic currency depreciates such that spot price of domestic currency s_t rises. Thus $s_t \infty i_h$ in '*Interest Arbitrage Parity Doctrine*'.

On the other hand, if i_h declines, given i_f unchanged, $i_h - i_f < 0$ and

$$\frac{s_{t+1}^e}{s_t} - 1 < 0 \tag{1.41}$$

$$\text{Therefore,} \quad s_{t+1}^{e} < s_t \tag{1.42}$$

This indicates that the expected future price of a unit foreign currency in terms of domestic currency falls below the spot prices. This means that domestic currency is expected to depreciate and incites the speculators to take a *'long position'* on domestic currency and '*short position'* on foreign currency. As a result, the spot price of domestic currency rises such that s_t declines. It, therefore, follows that, following a decline in domestic interest rate, domestic currency appreciates such that s_t falls. Thus

$$s_t \infty i_h \tag{1.43}$$

under Interest Arbitrage Parity doctrine

1.8.5 DORNBUSCH MODEL OF EXCHANGE RATE OVERSHOOTING

Dornbusch Model of Exchange Rate [Dornbusch (1976a, 1976b)] 'Overshooting' is based on the following assumptions.

(i) the home country is a 'small' one implying that the country has no effect on 'world' interest rate.

(ii) there is perfect capital mobility such that domestic and foreign financial assets are perfect substitutes implying absence of risk premium in the financial market as given in equation (1.5a) such that

$$i_h = i_f + \frac{s_{t+1}^{e} - s_t}{s_t} \tag{1.5a}$$

$$\text{or,} \quad i_h = i_f + x_a \tag{1.5b}$$

$$\text{where } x_a = \frac{s_{t+1}^{e}}{s_t} - 1 = \dot{s}_{t+1} \tag{1.5c}$$

where i_h and i_f are domestic and foreign interest rates respectively

(iii) Asset market quickly adjusts itself and attains equilibrium through the equation (1.5a).

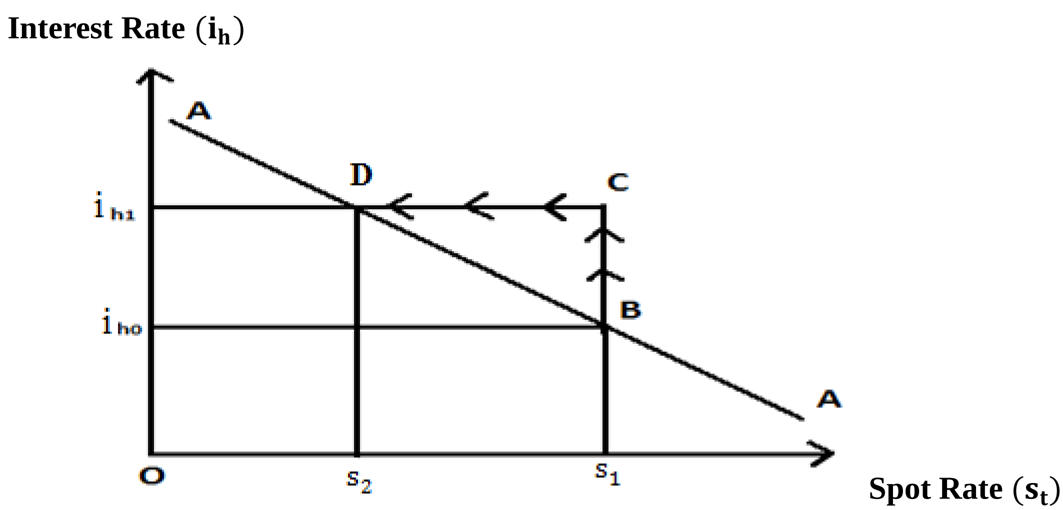
1.8.5 A Short Run Analysis

Let there be a rise in domestic interest rate i_h . Asset market equilibrium will be attained through change in x_a

$$\text{where } x_a = \frac{s_{t+1}^e}{s_t} - 1 \tag{1.5c}$$

such that x_a must rise to ensure equilibrium in the asset market. Rise in x_a may come through either a rise in s_{t+1}^e or a fall in s_t. However, s_{t+1}^e, as Dornbusch holds, remains unalteared in the short-run. Therefore, rise in x_a must come through a fall in s_t. Thus, following a rise in i_h, spot rate s_t must decline indicating an appreciation of domestic currency. It, therefore, follows that spot rate is negatively related to interest rate in short run under Dornbusch model.

This negative relation is represented by the AA schedule below:



The AA schedule shows various combinations of interest rate i_h and exchange rate s_t which satisfy the asset market equilibrium condition that $i_h = i_f + x_a$.

At the initial position B, the asset market is in equilibrium with interest rate i_{ho} and spot exchange rate s_t. Now suddenly domestic interest rate rises to i_{h1} with spot exchange rate s_1. The position is represented by the point C which lies outside the AA schedule. Consequently, the asset market is in disequilibrium. The spot exchange rate is not in conformity with domestic interest rate i_{h1}. i_{h1} being already established, the adjustment must come through the changes in spot exchange rate.

Such change in spot rate (s_t) comes through a fall in it. This is shown by arrows from C to D. The new spot rate is s_2 such that $s_2 < s_1$. s_2 is in conformity with i_{h1} price level. The ordered pair (i_{h1}, s_2) lies on the AA schedule. Consequently domestic currency appreciates i.e, s_t falls following a rise in domestic interest rate. (s_t) falls means fewer domestic currency will be offered for a unit of foreign currency indicating an appreciation of domestic currency. This is the short run adjustment in the asset market where in equilibrium spot rate depicts a negative relationship with domestic interest rate such that $s_t \infty.\frac{1}{i_h}$ This further means that domestic currency appreciates following rise in domestic interest rate and it depreciates with fall in domestic interest rate.

1.8.5 Long-Run Adjustment

Asset market equilibrium requires that, following rise in i_h, $X_a = (\frac{s^e_{t+1}}{s_t}$ -1) must rise. In the short run s^e_{t+1} is fixed and so s_t falls to raise x_a . In the long-run s^e_{t+1} is not fixed and s^e_{t+1} rises to raise x_a . Rise in s^e_{t+1} implies expected depreciation of home currency which discourages inflow of foreign capital. Thus capital accounts, after initial improvement, suffer a decline resulting in depreciation of domestic currency just after its appreciation in the short run. However, such depreciation modifies the short-run appreciation but fails to neutralize it. Thus finally, in the long-run, domestic currency still remains appreciated, even after some depreciation, following a rise in domestic interest rate. This is the Dornbusch "*Over-shooting*" phenomenon in Dornbusch Model. Thus even in the long-run equilibrium s_t is negatively related to domestic interest rate i_h such that $s_t \infty \frac{1}{i_h}$.

1.9 RESOLUTIONS FROM THE ANALYSIS

The relations between spot rate (s_t) and domestic interest rate (i_h) has been examined above under different exchange rate theories. Resolutions from the study are given below.

(i) Under Purchasing Power Parity Theory, rate of change of spot rate $\dot{s_t}$ is positively related to change in domestic interest rate such that

$$\frac{d\dot{s_t}}{dt} = \frac{di_h}{dt}$$

$$\text{or,} \qquad \frac{d^2}{dt^2}(\log s_t) = \frac{di_h}{dt} \tag{1.43}$$

It further means that the acceleration of (s_t) (i.e, domestic currency price of a unit of foreign currency) equals the change in domestic interest rate.

(ii) Under Monetary Theory of Exchange (MTER), the rate of change in exchange rate is found to be positively related to the change in domestic interest rate such that

$$\dot{s_t} = \frac{di_t}{dt}.$$

(iii) Under Mundell-Fleming Model, spot rate (s_t) found to be negatively related to domestic interest (i_{ht}) such that $s_t \infty \frac{1}{i_h}$

(iv) Under *'Uncovered Interest Rate Arbitrage Parity Theory'*, spot rate (s_t) is found to be positively related to domestic interest rate such that

$$s_t \infty i_h$$

It indicates depreciation of domestic currency following rise in domestic interest rate. Similarly, according to this theory, domestic currency appreciates with fall in domestic interest.

(v) Under *'Dornbusch Model of exchange rate overshooting'*, spot rate s_t is found to be negatively related to domestic interest rate such that

$$s_t \infty \frac{1}{i_h}$$

However, the short run appreciation of domestic currency exceeds in the long-run, following a rise in domestic interest. The extent of short-run appreciation of domestic currency is modified by subsequent depreciation, to some extent, in the long run. However, even in the long-run spot rate is found to maintain a negative relation with domestic currency.

It, therefore, appears that *'Uncovered Interest Rate Arbitrage Parity'* doctrine is the *singular* theory of exchange rate which stresses upon the positive relation between spot rate s_t (i.e, the domestic currency price of a unit of foreign currency) and the domestic interest rate. No other theory of exchange rate indicates such explicit positive relation between spot exchange rate s_t and domestic interest rate.

1.10 Relation between spot exchange rate (s_t) and domestic interest rate in Indian economy over the period (22nd September 2011 to 7th August 2012): Relevance of the Present Study.

The Reserve Bank of India adopted contractionary Monetary policy since 2011**.** Domestic rate of interest was raised from 7 to 7.75 percent on 7th August, 2012.

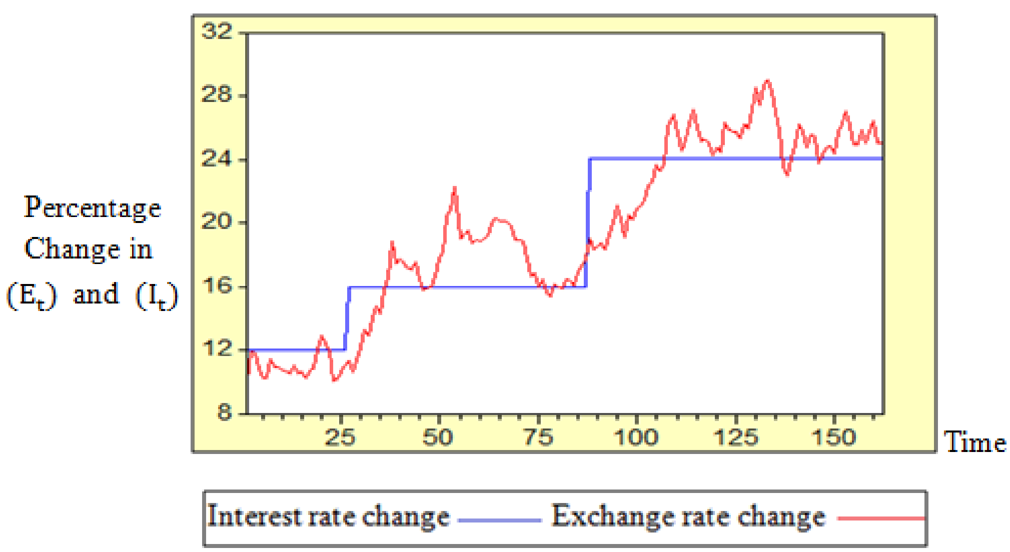
The main purpose of such rise in interest rate and contractionary monetary policy was to contain raising inflation in the economy. Such rise in interest rate was maintained for a considerable period of time even in the face of insistence from the fiscal authorities for reduction in interest rate. Such high interest rate structure was also considered to be hindering industrial investment.

Consequent upon the rise in domestic interest rate, rupee suffered depreciation and it slided continuously from Rs. 42/$ as to break the magic figure of Rs 50/$ and approached to the lowest limit of almost Rs. 70/$. Thus spot rate s_t, the domestic currency price of a unit of dollar) was found to maintain a positive relation with the domestic interest rate.

The movement of both the spot rate (s_t) and domestic interest rate (i_h) over the period is being presented through the figure-1.1 below. The figure presents the time plots of the percentage change in (s_t) vis-à-vis the percentage change in interest rate (i_h).

Figure: 1.1

Time Plots of the Percentage Change in Exchange Rate (E_t) and Percentage Change in Domestic Term Deposit Interest Rate (I_t) .



It may be noted that, $s_t \infty i_h$ means $s_t = ki_h$ where k is a constant.

$$\text{Therefore, } \log s_t = \log k + \log i_h \tag{1.44}$$

Differentiating with respect to t we have

$$\frac{1}{s_t}\frac{ds_t}{dt} = \frac{1}{i_{ht}}\frac{di_h}{dt}$$

Therefore, percentage change in spot rate (s_t) equals (or tends to be equal to) the percentage change in interest rate. 12th May 2011 is the base period for the measure of such percentage changes.

The figure shows that, following rise in interest rate, spot rate rises. Given a rise in interest rate, it was maintained at the same level for some time. Then further it was raised again. Thus the interest rate rise was discrete and the interest rate curve displays some step like features.

Spot rate (s_t) curve also exhibits a rising trend with some fluctuations in response to fluctuations in market expectations for future exchange rate s_t^e. The rising pattern of exchange rate changes has been triggered by its attempt for establishing the market equilibrium as given by the UIRAP equation (1.5a).

Time plots of the series (s_t and i_h) indicates that both the series share common trends and, therefore, may be cointegrated. In the event of these series being cointegrated over the period of study, the UIRAP theory appears to be operative behind the movement of spot exchange rate (s_t) over the period of study. This demands that a thorough study of the two series be undertaken in this respect in order to examine how far the relation between spot rate (s_t) and the domestic interest (i_h) is in conformity with the UIRAP doctrine. The present study has been devoted to address this issue.

1.11 Some Relevant Issues

The study of the relation between the spot rate (s_t) and the domestic interest rate (i_h) in Indian economy over the period (22nd September 2011 to 7th August 2012) entails several important issues for consideration.

First, the graphical presentation of the two series (s_t and i_h) as in figure 1.1 hints at the possibility of cointegration between these series. However, an enquiry into such possibility requires that the nature of stationarity and integrability of the series concerned be established first. Then the cointegrability of the series can be examined.

Second, the equilibrium condition in the foreign exchange market under UIRAP is

$$i_h = i_f + \frac{s_{t+1}^e}{s_t} - 1 \tag{1.5a}$$

Following a rise in i_h, given i_f , the asset market equilibrium is attained through rise in s_{t+1}^e. This means that market participants, following a rise in domestic interest rate (i_h), expects depreciation of foreign currency in future. Such expectation affects the current spot rate s_t and currency depreciates immediately. This a very familiar feature of the asset market and this occurs if and only if such expectations are *'rational'* This leads us to consider if market expectations in Indian financial market were really formed *'rationally'*. These constitute an important issue of consideration in this present study.

Third, rise in s_{t+1}^e i.e, the expectation of depreciation of rupee, following rise in domestic interest rate, makes rupee a risky asset for holding. In that case, foreign holders of rupee may require some *'premia'* per unit of rupee. These *'risk premia'* raise spot rate s_t i.e, the number of rupees per unit of dollar. Consequently, rupee depreciates, following rise in domestic interest rate. Thus the presence of '*risk premia*' may account for the positive relation between spot rate s_t and domestic interest rate i_h . It, therefore, becomes pertinent to enquire if *'risk premia'* did exist in the foreign exchange market for rupee over the period of study and how far such *'risk premia'* contributed to the positive relation between spot rate s_t and domestic interest rate i_h. This issue is being addressed properly in this study.

Fourth, *'risk-premia'* are the payment for bearing the '*uncovered*' risk. However, there are some risks which are 'coverable'. Market participants very offen cover the risk of fluctuations of currency by engaging in '*forward*' buying and/or selling of currencies concerned. In such case forward rates (F_t) replaces s_{t+1}^e in the UIRAP equilibrium condition. Consequently, the equilibrium condition for asset market under Covered Interest Arbitrage Parity becomes

$$i_h = i_f + \frac{F_t}{s_t} - 1 \qquad (1.8a)$$

In this case, as r_h rises, forward rate (F_t) rises and consequently, s_t the spot rate also rises. This is so because forward rate (F_t) is usually held as the '*Unbiased Predictor'* of spot rate. Covered Interest Arbitrage Parity provides a valid explanation for the positive relation between spot rate and domestic interest rate if and only if forward rates appear as the *'unbiased predictor'* of future spot rate. This feature of the relation between forward rate and spot rate also constitutes an issue of investigation in this present study.

Fifth, it is usually held that UIRAP becomes a valid phenomenon in the financial market which is *'efficient'*. '*Efficient'* market allows unhindered '*arbitrage*' activities resulting in market equilibrium as given by the equation (1.5a). It, therefore, becomes pertinent to consider if the foreign exchange market in India was '*efficient*' over the period of study and thus provided the favorable market environment for the holding of UIRAP. Thus the examination of level of *'efficiency'* of the foreign exchange market in India over the period concerned also constitutes an important issue of this present study.

1.12 Objective of Study

The present research study is an attempt to enquire into the tenets of the UIRAP Doctrine and the theoretical resolutions which follow from the UIRAP doctrine. More specifically, we seek to examine in the context of the economy of India and US:

(i) if an expected variation in spot exchange rate (Rupee/Dollar) were in long-run relation with the interest rate differentials.

(ii) if such long-run relationship, in the event of its existence, were stable.

(iii) if the forward exchange rate, as held by the CIRP doctrine, were the *unbiased predictor* of the future spot exchange rate.

(iv) if any *Minimum Mean Squared Error ARIMA (p, d, q)* forecast be generated for the future spot exchange rate. This exercise is an attempt to test the validity of the *Efficient Market Hypothesis (EMH)* for the foreign exchange market.

(v) the direction of Granger causal relation between expected depreciation of spot exchange rate and interest rate differentials.

(vi) if the expected future spot rate is in parity with the corresponding future spot rate.

(vii) if the officially quoted forward exchange rate is the unbiased predictor of the future spot rate.

(viii) if the ARIMA (p, d, q) forecast for future exchange rates is in conformity with the actual future spot rate.

(ix) if CIRAP holds for rupee-dollar exchange rates over the period of study.

(x) how spot rate and one-period lagged forward rate is related in the market.

(xi) which variable (spot rate or lagged forward rate) maintains an independent cointegrating relation with the other.

(xii) the nature of Granger causality in the relation between the rates.

(xiii) how spot and contemporaneous forward rates are related.

(xiv) if the usually observed high correlation between these two variables is apparent or real.

(xv) if risk premium exists in the market.

(xvi) how far the capital market is efficient.

1.13 Chapters of the study

Chapter 1 Introduction

Chapter 2 presents 'Review of Literature in which findings of some important and relevant studies on UIRAP and CIRAP have been reported.

Chapter 3 presents 'Data and Methodology'. Methodological issues relevant for the study have been explained in the chapter.

Chapter 4 presents the study on '*Stationarity*' and '*Integrability*' of time series data on macroeconomic variables under study.

Chapter 5 is devoted to the study on '*relationship*' between exchange rate (rupee/dollar) and interest rates in Indian economy. The study is designed for the verification of UIRAP doctrine in Indian economy.

Chapter 6 presents the study on 'Covered Interest Rate Arbitrage Parity (CIRAP) and '*Efficiency*' of foreign exchange (rupee/dollar) market in India. The study is carried on with Forward Rates and ARIMA Forecasts for future exchange rate on the basis of Weekly Exchange Rate Dataset.

Chapter 7 is devoted to the study on CIRAP and efficiency of foreign exchange (rupee/dollar) market in India with Monthly Exchange Rate Dataset.

Chapter 8 presents the study on CIRAP and the Long run Relation between spot and forward rates in the foreign exchange (rupee/dollar) market in India. The study is carried on Market Efficiency with ARIMA (p, d, q) forecasting.

Chapter 9 presents the '*Summary*' of findings and '*Conclusions'* of the study along with Public Policy Implications and Limitations of the study.