Foreign Exchange Rate Determination in BRICS Nations: Hypothesis Testing of Monetary Approach

Professor Neera Verma
Professor in Economics, Department of Economics, Kurukshetra University, Kurukshetra (Haryana)

Amandeep Kaur
Research Scholar in Economics, Department Of Economics, Kurukshetra University, Kurukshetra(Haryana)

Abstract

Exchange rate is an important element of the country's economic health. The exchange rate is a key financial variable that effects decisions made by foreign exchange investors, exporters, importer, bankers, financial institutions, policy makers. Exchange rate fluctuations affect the value of international investment portfolios, Competitiveness of exports and imports, value of international reserves, currency value and balance of payment. In the past few decades, some large economies such as Brazil, Russia, India, China, and South Africa (BRICS) have acquired a vital role in the world economy as producers of goods and services, receivers of capital, and as potential consumer markets. The BRICS economies have been identified as some of the fastest growing countries and the engines of the global recovery process, which underscores the changed role of these economies. The purpose of this study is to examine the foreign exchange rate determination in BRICS nations. In recent years various models of foreign exchange rate determination have been formulated, one of which is the flexible-price monetarist exchange rate model. The purpose of this work is to explain briefly the theory behind the model, and to assess its adequacy and reliability in explaining movement of BRICS exchange rate. Prices, interest rates, and money supply in the domestic and foreign country are found important variables of monetary model. Based on the theoretical foundations, the study applies the simple Ordinary Least Square (OLS) method and multiple regression method to describe the behavior of the bilateral exchange rate between BRICS nations and U.S.A over the time period 1990-2015. This paper examines the determinants of exchange rate in BRICS nations within the framework of monetary approach with econometric analysis and the effects of economic variable on foreign exchange rate. The study revealed that Dornbusch's sticky price model and flexible price monetary model is not be validated in the analysis of Brazil, Russia, India and South Africa currency. Only China is one of the country which sticky price model are applicable for foreign exchange rate determination.

Keywords: Exchange Rate, Money Supply, Interest Rate, Gross Domestic Product, Consumer Price Index

INTRODUCTION: In today's era of globalization and financial liberalization, exchange rate play an important role in international trade and finance. Exchange Rate is the single most, vital relative price in the financial world. In a more open economy, monetary transmission operates through exchange rate effects on

net exports and interest rates that affect the financial portfolio. An exchange rate can be defined as a price of one country's currency in terms of another country's currency. A country's exchange rate is an important determinant of the growth of its cross-border trading and it serves as a measure of its international competitiveness (Bah and Amusa, 2003: 2; Walters and De Beer, 1999).The exchange rate is a key financial variable that effects decisions made by foreign exchange investors, exporters, bankers, financial institutions, policy makers. Exchange rate fluctuations affect the value of international investment portfolios, competitiveness of exports and imports, value of international reserves, currency value of debt payments, and the cost to tourists in terms of the value of their currency (Surendra and Mathur,2014). Exchange rate regimes can be classified into three categories: fixed (pegged), flexible (floating) and intermediate regimes. The advantages of fixed exchange rate is that it provides stability in the foreign exchange market. The stability of exchange rate encourages international trade and investment. The fixed exchange rate system creates conditions for smooth flow of international capital, and eliminates the possibility of speculative activities in the foreign exchange market. This system reduces the possibility of competitive depreciation of currencies as it happened during 1930s. Also deviations from fixed rate are easily adjustable. But fixed exchange rate create the problem of international liquidity and unexpected disturbances in the economy.

Flexible exchange rate is self-adjusting and therefore depend the government is not required to maintain an adequate foreign exchange reserve. The flexible exchange rate is determined by market forces, and has the quality of predictability. This system serves as a barometer of the actual purchasing power and strength of a currency in the foreign exchange market. The system corrects the disequilibrium in the BOP and removes the problem of international liquidity. But this system can create the problem of exchange risks and adverse effect of speculation.There are a number of hybrids or intermediate exchange rate system(s) between the two extremes of rigidly fixed and freely floating (flexible) exchange rates. Under this system, the monetary authority (central bank) intervenes in the foreign exchange market to smooth out short- run fluctuations in exchange rates. If the short-run demand for foreign exchange in the market is more than its supply, the monetary authority supplies the foreign exchange reserves in the market thereby moderating devaluation of its currency and vice-versa. Exchange rate regime refers to the system through which this price is determined and it is one of the most important policy instruments of governments. The choice of exchange rate regime has considerable impact on trade in goods and services, capital flows, inflation, balance of payments and other macroeconomic variables. For this reason, the choice of an appropriate exchange rate regime is a principal component of economic management in maintaining growth and stability. Prior to 1970's, most economies operated under fixed exchange rate regime known as the Bretton-Woods system. Under this system, countries fixed their exchange rates against US dollar and the dollar was worth a fixed amount of gold. All participating currencies were implicitly pegged to the gold. The system broke down after 25 years (1946-1971) but the system of fixed exchange rate remained the preferred regime in many countries. The basic motivation for keeping exchange rates fixed is the belief that a stable exchange rate can facilitate trade and investment flows

between countries by reducing fluctuations in relative prices and by reducing uncertainty. However since 1971, economies have been moving towards flexible exchange rate regimes, where the value of the currency is determined by the market. In this setting, the domestic currency, all else equal, depreciates when demand for the foreign currency increases or supply of the foreign currency decreases and appreciates when demand for the foreign currency decreases or supply of the foreign currency increases.

Exchange rate regimes have been considered as one of the factors leading to crisis in many emerging market economies. Such as the Financial and currency crisis in Russia (1998) and Brazil (1999). Hence effective exchange rate is crucial not only for trade but also economic growth. Since exchange rate directly affects trade and growth of an economy it will have its impact on the rest of the world (ROW) also. It is significant to analyses and understand the experience of different countries with different kinds of exchange rate regimes and relate it to their international trade and economic growth. Also it is important to identify the relative importance of various factors determining exchange rate in an economy. The present study is an attempt in this direction in case of BRICS countries. BRICS countries consisting of Brazil, Russia, India, China and South Africa have been chosen.

This paper examines the linkages between macro variable and exchange rates in the BRICS (Brazil, Russia, India, China and South Africa), a particularly interesting set of countries to consider given their increasingly important role in the world economy as a result of their rapidly growing share in global trade in the last two decades. BRIC firstly in the early 2000s Brazil, Russia, India and China that have common characters like wide area, big population and rapid economic growth are accepted as the fastest growing "emerging market" in world economy (O'Neill, 2001:1-16). South Africa into the BRIC group in 2010. As of 2010, the group's five members are Brazil, Russia, India, China and South Africa Total area of these countries contains more than 25% of the world area and total population of them contains more than 40% of the world population. It is argued that BRIC group would take G7 group's place and get the leadership of the world economy when the economic indicators are considered (Frank and Frank, 2010:46-54). Goldman Sachs who has studies about BRIC countries estimates that in 2050 China will be the greatest economy in the world, India will be the third, Brazil will be the fourth and Russia will be the sixth biggest economy. If one compares the GDP in PPP terms, four economies figure among the top ten, with China, India, Russia, Brazil, and South Africa in 2nd, 4th, 6th, 8th, and 26th places, respectively.

Table: 1.1 Currency and Current Exchange Rate System of BRICS Nations

Country	Currency	Current Exchange Rate System
Brazil	Real	Floating Exchange Rate
Russia	Ruble	Managed Floating Exchange Rate
India	Rupee	Managed Floating Exchange Rate
China	Yuan	Managed Floating Exchange Rate
South-Africa	Rand	Floating Exchange Rate

Source: IMF report (2015)

Table: 1.2 KEY EVENTS OF EXCHANGE RATE IN BRICS NATIONS:

FXR IN BRAZIL
▪ 1967-1990-The brazil exchange system with its currencies "crawling pegged" to the U.S. dollar was adopted
▪ The currencies that had been adopted since 1967 include: Cruzeiro (1967-1986), Cruzado (1986-1989), and Novo Cruzado (1989-1990),Cruzeiro (1990-1993), Cruzeiro Real (1993-1994), Real (1994-).
▪ 1990- A floating exchange rate regime has been adopted.
▪ 1999- Brazil was involved in a currency crisis,
FXR IN RUSSIA
▪ July 1992, when the ruble first could be legally exchanged for United States dollars
▪ August 1998 –Russia crisis
▪ The global financial crisis that started in 2008 deeply affected Russia's economy and financial markets
FXR IN INDIA
▪ 1947-1971-Par value system of Exchange of Rate. Rupee's external par value was fixed in terms of gold.
▪ 1990-1991-Balance of Payment crisis
▪ 1991-Economic reforms
▪ 1992 – RBI announced a new system of dual exchange rate known as liberalized exchange rate Management system
▪ 1994:-Rupee fully convertible on current account from August 20th.
▪ 1998:-Foreign Exchange Management Act- FEMA bill 1998, which was placed in the parliament to replace FERA. Modification of FERA in light of the ongoing economic liberalization and improving foreign exchange Reserve position.
▪ 1999-At Present Time Implication of FEMA start. The FEMA, which come into effect from January 1, 2000 extends to the whole of India and also applies to all branches, offices, and Agencies outside Indian owned or controlled by a person resident in India
FXR IN CHINA
▪ Before 1978 Mostly determined by the nation's strategic interests
▪ 1978 -Reform and opening-up economy policy
▪ Jan 1981 to Jan 1985 -Dual exchange rate system
▪ Jul 1986 to Jan 1994- Official rate and foreign swap market rate coexisted
▪ On Jan 1, 1994 -Unification of exchange rate regime
▪ 1997 -De facto pegged to U.S dollar exchange rate regime
▪ On July 21, 2005-AT PRESENT -Managed floating exchange rate regime
FXR IN SOUTH AFRICA
▪ The movements of the real effective exchange rate during the 1970s,
▪ 1979- greater flexibility was introduced into the foreign exchange market with a dual currency exchange rate system,
▪ some evidence to suggest that from1979 to 1988 exchange rate intervention was directed at maintaining profitability and stability in the gold mining industry by smoothing the real 5 It was only after December 1988
▪ The real effective exchange rate index appreciated gradually from 96.00 at the end of 1988, to 104.02, by the end of 1992

This paper draws its focus on determination of exchange rate in the floating exchange regime. The forces that guide the determination of exchange rates have for years drawn serious concerns from many researcher all around the global. One of the famous area studied using models is international economics where exchange rate forms an important part. Many models have been developed to give insights on how exchange rates are derived, determined, and if possible forecasted. This paper reviews the monetary approach to exchange rate determination. This approaches play important role in international economics, the monetary approach creates even a clearer picture for demand and supply of rival currencies in the foreign currencies markets

The research paper has been divided into five Sections. The first Section discuss the Survey of literature for foreign Exchange Rate determination and section-II discuss the econometric modelling approach. Section - III analyze the objective, data sources, methodology, Econometric Analysis and hypothesis. Section-IV explain the Empirical estimation of foreign exchange rate determination with monetary approach from 1991-2015 and Section-V deals with the Main conclusion and policy implication of this study.

SECTION-I

REVIEW OF LITERATURE

The Monetary Approach states that the supply and demand for currency stocks, as well as the expected growth rates of currency stocks, will determine the price level or the inflation rate and thus explain changes of the exchange rate according to PPP. The main class of asset market models for exchange rate determination have been proposed the monetary approach. The flexible price, monetary approach to exchange rate determination was born in the 1970s to defend the superiority of a floating exchange rate regime over the just abandoned fixed exchange rate regime of Bretton Woods (Frenkel 1976; Mussa 1976). Combining continuous PPP and the quantity theory of money, the exchange rate is specified as the relative price of domestic and foreign money, determined by their respective demand and supply. The dominant model was the flexible-price monetary model that has been analyzed in many early studies.

There are several studies conducted to empirically test the validity of various versions of monetary models of exchange rate determination “Early studies during the late 1970s and the early 1980s employed traditional regression analysis and found mixed evidence” for the validity of monetary model in explaining the exchange rate movements. These studies include Frankel (1976); Bilson (1978a, 1978b); Dornbusch (1979); Dornbusch (1980); Rasula and Wilford (1980); Haynes and Stone (1981); Meese and Rogoff (1983); Frankel (1984), Backus (1984); and Boughton (1988) support the performance of the flexible price monetary model in modelling and forecasting exchange rates. An analysis of these studies by classifying them on the basis of methodology used shows that the empirical evidence for the monetary model is mostly depend on the type of model used (Islam and Hasan, 2006). As noted by Islam and Hasan (2006),

The use of earlier version of the co-integration method, Engle and Granger (1987); two-step cointegration methodology provides no evidence for the validity of monetary models. These studies are mostly done in the eighties and early nineties, which includes Meese (1986); Baillie and Selover (1987); Boothe and Glassman (1987); Kearney and MacDonald (1990); McNown and Wallace (1989). In the nineties most of the studies have used the Johanson (1988), Johansen and Juselius (1990) cointegration methodology. MacDonald and Taylor (1991, 1992, 1993, 1994a, 1994b) have used this methodology to test the validity of the monetary model for the sterling/dollar, the Deutschemark/dollar, the yen/dollar and the French franc/dollar exchange rates and got results in favor of monetary model. Moosa (1994) has analyzed the exchange rate of US dollar with UK pound, German Mark and Japanese Yen for the period January 1975 to December 1986 and found evidence for the validity of the monetary models. Menzie D. Chinn(1999) examined the behavior of the South African rand is modeled using a monetary model of the exchange rate. The assumptions underlying the monetary approach are discussed in the context of the conditions prevailing in the South African economy. A cointegrating relationship involving the exchange rate, money stocks, industrial production and inflation rates is identified for the 1980M01-1998M11 period. In a later sub-period spanning 1988M01-1997M12, a sticky-price monetary model appears to fit the data better. The model also explains movements in the Rand during a sample encompassing the Russian financial crisis, as long as a dummy variable is included in the regression.

The Flexible Price Monetary Model (FPMM) was very representative in the 1970s when industrialized economies adopted the floating exchange rates after the collapse of Bretton Woods system in 1973. According to Sarno and Taylor (2002), this model became the dominant exchange rate model during the 1970s, for earlier studies on this see Frenkell (1976) and Mussa (1976, 1979). As Rosenberg (1996) noted, there are many versions of monetary models of exchange rate determination all of which are outgrowths and extensions of the basic flexible-price model of Frenkel (1976) and Bilson (1978) as well as Dornbusch's (1976) sticky-price model, Frankel's (1979) real interest rate-differential model, and the Hooper-Morton (1982) equilibrium real exchange-rate model. According to Wong and Khan, (2006), Islam and Hassan (2006) and Nwafor (2006) the flexible-price Monetary Model (FPMM) attempts to demonstrate how changes in the supply of and demand for money both directly and indirectly affect exchange rates. The flexible price monetary model defines the exchange rate as the relative prices of economies (rupee, rand, ruble, Yuan, real and US Dollar) and is determined by the interaction of market forces of the monies under study. Furthermore, relative prices in each country and exchange rates are related by the law of purchasing power parity, PPP which holds continuously. The equilibrium is achieved when the supply and demand for money in each country are equalized.

The sticky price or overshooting model by Dornbusch(1976) is also tested amongst others by Alquist and Chinn (2008) and Zita and Gupta (2007).Frankel (1979) argued that a drawback of the Dornbusch formulation of the sticky-price monetary model was that it did not allow a role for differences in secular rates of inflation. The innovation is that it combines the assumption of sticky prices with that of flexible prices with

the assumption that there are secular rates of inflation. This yields the real interest differential model. Hooper and Morton (1982) extend the sticky price formulation by incorporating changes in the long-run real exchange rate. 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 (depreciation) of the exchange rate.Studies by Driskill and sheffrin (1981) failed to support the flexible price monetary model and real interest differential model in modelling exchange rate.

Recently, the empirical results in favor of the model remain mixed at best (Hassan & Simione, 2011),Kumar (2010). Earlier studies by Aron, Elbadawi and Kahn (1997), Casteleijn (1999), Jonsson (1999), Moll (1999; 2000), as detailed in Nell (2003), and the more recent study by Ziramba (2007) tend to find no long-run relationship between nominal exchange rates, money supply and income, which is the essence of the simple monetary model. The models are estimated using the Johansen (1995) cointegration framework. We obtain robust results showing the existence of a long-run relation between the rand per US dollar exchange rates, money, income and interest rate differentials between the two countries. The results further show that the rising current account balance as a ratio of gross domestic product as well as commodity prices depreciate the rand per US dollar exchange rate. Rapach and Wohar (2002) present favorable results for the monetary model using a century of data and corroborate these findings with results based on panel data. K.Sham Bhat And R. Rajendran (2003);Their study investigated the empirical validity of the monetary model of exchange rate determination for Indian rupee, pound sterling and yen in terms of U.S dollar. The necessary monthly information were collected from the international financial statistics for the year 1975:10 to 1998:05. The model proves that the exchange rate are not determined by purely monetary factors. The study provides scope for developing a comprehensive structural model by incorporating other fundamental variables like trade balance, reserve position, government's fiscal deficit as percentage to GDP, public debt position etc. to judge the value and direction of exchange rate movements. L. Raputsoane, K R Todani(2008) This paper estimates four versions of the monetary model of rand per United States dollar exchange rates using South African and United States (US) quarterly data for the period 1986Q1to 2005Q4. Liew, Baharumshah, and Puah (2009) examined the validity of the flexible price monetary model for the case of Thailand using the Johansen multivariate cointegration testing framework. The Japanese Yen was chosen as base currency. The study was conducted using monthly data from January 1977 through March 2006 taking real GDP as real income, M2 for money stock, CPI for inflation and money market rate for interest rate. The study shows that there exist co-integrating relationship in the estimated VAR model, indicating the presence of long-run relationship among exchange rate and the monetary variables. As shown by Shiller and Perron (1985), Hakkio and Rush (1991) and Otero and Smith (2000) in Rapach and Wohar (2004), the span of the data, not the frequency, determines the power of the unit root and co-integration tests, which concludes the existence of a long-run relationship between exchange rates and a set of monetary fundamentals. R.N. Aggarwal (2000); In his study

has been done 1971-1972 to 1996-1997 time period. The variable is used in their study is prices, interest rates, and money supply in the home and foreign country are found to explain the behaviour of the bilateral exchange rate. Other significant variable found are balance of payment and foreign exchange reserves. This study is based on the behavior of the nominal bilateral exchange rate between India and U.S.A. The result show that the model can be used for forecasting the exchange rate in the short run.

Theoretically, there are a large number of macroeconomic variables to be hypothesized as determinants but as per the convention of econometric analysis, five key macroeconomic variables would be selected for the study. Depending on the availability of data, the variables selected for five countries are FXR, income, inflation, rate of interest, money supply and price. The reason for selecting these variables are availability of data, these have been used by the previous researchers identifying determinants and other plausible arguments specifically given while discussing the variable. Finally, the flexible price monetary model is chosen here for investigation. This paper investigates the BRICS exchange rates under Flexible Price Monetary Model (FPMM) and sticky price monetary model during time series of 1991-2015.

SECTION-II

ECONOMETRIC MODELLING APPROACH

- **SPECIFICATION OF THE MODELS**

The monetary approach happens to be one of the oldest approaches to determine the exchange rate. The monetary model assumes a simple demand for money curve. The purchasing power parity or the law of one price holds true. The monetary model also assumes a vertical aggregate supply curve. A vertical aggregate supply curve does not imply constancy in the output but a flexible price.

Now let us begin with the model:

According to the absolute purchasing power parity the exchange rate is obtained by dividing the price level of the home country with that of the foreign country .i.e.

$$P = e P^* \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$e = \frac{P}{P^*} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

P stands for the domestic price level and P* the foreign price level. e is the exchange rate.

The demand for money equation is given by

Md = f (y)

Md = kPy …….. (3)

Where k is constant and y is the real income level

In equilibrium,

Md =Ms …… (4)

Md- demand for money

Ms- the supply of money

Hence at the point of intersection of the aggregate demand and the aggregate supply curve, put the value of Md in equation (4)

kPy=Ms ……. (5)

or, P = Ms / ky ……(6)

or eP* = P = Ms / ky ……..(7)

or, e = Ms / P*ky ……(8)

At this point external equilibrium is obtained in the economy. It is also clear from the above equation that an increase in the money supply within an economy would lead to appreciation of the domestic currency. Conversely, international price level as well as the output level related inversely with the exchange rate.Let us consider a situation where keeping all parameters fixed money supply rises in the domestic economy. Since prices are kept constant, excess money supply injects higher demand for goods and services within the economy. In the face of a fixed output, prices are pushed up. This will be accompanied by depreciation in the nominal exchange rate. In the above discussion we have explained the determination of exchange rates under a flexible regime. In a fixed regime the economy takes a somewhat different course. Let us say that the foreign price level has increased, ceteris paribus. There is also excess demand for goods that are produced in the home market. This in turn causes a balance of payment surplus. Foreign exchange reserves will rise along with an increase in the money supply. The rise in the supply of money would lead to a rise in the domestic price level and competitiveness in the economy will be as before.

Theoretical View of Monetary Approach as Used in Exchange Rate Determination

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. In the monetary models, it is the money supply in relation to money demand in both home and foreign country, which

determine the exchange rate. The prominent monetary models include the flexible and sticky-price monetary models of exchange rates as well as the real interest differential model. The Flexible-Price Monetary Model (Frenkel, 1976) assumes that prices are perfectly flexible. Consequently, changes in the nominal interest rate reflect changes in the expected inflation rate. A relative increase in the domestic interest rate compared to the foreign interest rate implies that the domestic currency is expected to depreciate through the effect of inflation which causes the demand for the domestic currency to fall relative to the foreign currency. In addition to flexible prices, the model also assumes uncovered interest parity, continuous purchasing power parity and the existence of stable money demand functions for the domestic and foreign economies. The model further implies that an increase in the domestic money supply relative to the foreign money supply would lead to a rise in domestic prices and depreciation of the domestic currency to maintain PPP. Further, an increase in domestic output would lead to an appreciation of the domestic currency since an increase in real income creates an excess demand for domestic money supply. This, in turn, causes a reduction in aggregate demand as agents try to increase their real money balances leading to a fall in prices until money market equilibrium is restored. In the Sticky-Price 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.

1. Macroeconomic variable

Monetary theory states that exchange rate can be influenced by money supply, gross domestic product, interest rate and consumer price index of domestic and foreign country.

FXR = F (M, M*, P, P*, Y, Y*, R, R*, Π, Π*)

LFXR = F (LM, LM*, LP, LP*, LY, LY*, LR, LR*, LΠ, LΠ*)

er = f(m, m* , p, p* , y, y*, r, r*,π,π*)

Where----

Er - log value of foreign exchange rate

m- log value of money supply of domestic country

m*- log value of money supply of foreign country

p - log value of Price in domestic country

p* - log value of Price in foreign country

y - log value of income in domestic country

y*- log value of income in foreign country

r - log value of rate of interest in domestic country

r*- log value of rate of interest in foreign country

π - Log value of rate of inflation in domestic country

π*- log value of rate of inflation in foreign country

Model-I

Monetary model can be expressed as follows:

$$er = \beta 0 + \beta 1m + \beta 2y + \beta 3r + \beta 4p + \beta 5\pi + \beta 6\, m^* + \beta 7y^* + \beta 8r^* + \beta 9p^* + \beta 10\pi^* + ut$$

Where m is Money Supply, y refers to GDP, r is real interest rate and p denotes the consumer price index, π is inflation rate and ut is random term (Shahrestani, Anaraki, & Ghaffari, 2009).

Most of the large industrialized economies floated their exchange rate in early 1973, after the demise of the post-war Bretton Woods system of fixed exchange rates. But long before the dismissal of the Bretton woods exchange system, researcher have had tried to develop models that are useful in determination and forecast of exchange rate. Such efforts resulted into a number of good models in exchange rates. The prominent models suggested that, the Flexible Price Monetary Model (FPMM) and The sticky price monetary model influences the exchange rate pattern.

Model-II

2. The Flexible Price Monetary Model (FPMM) and Sticky Price Monetary Model

The Flexible Price Monetary Model (FPMM): The FPMM is to assume that, in each country, the equalization of currency supply and demand determines the price level in each country. Furthermore, relative prices in each country and exchange rates are related by the purchasing power parity relationship. The solution of the FPMM leads to an exchange rate equation where the exchange rate is determined by relative money supplies, output levels and interest rates. The flexible-price monetary model (FPMM) attempts to demonstrate how changes in the supply of money and demand for money both directly and indirectly affect exchange rates. In line with Rosenberg, assume the following: a two-country global economy -- a domestic countries (BRICS) and a foreign country (USA); money supplies (m) in the two countries are exogenously determined by the respective central banks; real demand for money (m-p) is determined by the level of income (y) and the level of interest rate (i) and that their respective elasticities are the same in both countries. Following Sarno and Taylor in discrete time and utilizing time subscripts for emphasis, and asterisks to denote foreign variables and parameters, monetary equilibrium is achieved when the supply of money and demand for money in each

country are equalized. More specifically, in econometric terms, the equilibrium equation to be estimated can be presented by:

$mt = pt + \beta yt - \theta it$……. (1)

$m^*t = p^*t + \beta y^*t - \theta i^*t$…… (2)

Further, it is assumed that the domestic interest rate is predetermined in the world markets because of the implicit assumption of perfect capital mobility. In addition, assume that purchasing power parity (PPP) holds continuously:

$et = pt - p^*t$……(purchasing power parity relationship) (3)

Equating (1) and (2) would suggest the quantity theory of money which postulates that a country's price level is determined by the supply of money relative to the demand for money. Thus, if the Substituting equations (1) and (2) in equation (3) yields nominal exchange rate of the FPMM version:

FPMM version:

$et = \alpha (m - m^*)t - \beta(y - y^*)t + \theta(i - i^*)t$ ……..(4)

where, α, β, θ are parameters.

In econometric parlance, the FPMM to be estimated could be presented below

$et = \beta o + \alpha (m - m^*)t - \beta(y - y^*)t + \theta(i - i^*)t + ut$ ……..(5a)

$et = \beta o + \alpha m - \alpha m^* - \beta y + \beta y^* + \theta i - \theta i^* + ut$…….(5b)

Equations (5a, 5b) is the fundamental equation of monetary model with flexible prices (Taylor, 1995, p.21).

- A relative increase in the domestic money supply leads to a proportional increase in the price level (the quantity theory of money). This increase in the price level then results in a nominal depreciation (PPP)
- An exogenous rise in domestic income results in greater demand for money. As agents build their money balances, expenditures decline. This lowers the price level, and via PPP, causes an appreciation of the currency.
- Unlike in the Mundell-Fleming model, an increase in the domestic interest rate coincides, with a nominal depreciation. Why? Because, with output fixed, the increase in the interest rate reduces demand for money balances. The price level rises as a result.

Model-III

Dornbusch's Sticky Price Monetary Model: The sticky price monetary model was initially explained in 1976 by Dornbusch which introduced the concept of exchange rate overshooting and provided an explanation for both exchange rate volatility and misalignment from the purchasing power parity (Datta & Mukhopadhyay, n.d). Dornbusch's sticky price monetary theory states that exchange rate can be influenced by money supply, gross domestic product, interest rate and inflation. The SPMM sticky price monetary model, captures price stickiness in both economies by the following equilibrium equation:

Accordingly fundamental equation for the sticky price monetary model is

$et = \alpha (m - m^*)t - \beta(y - y^*)t - \theta(i - i^*)t$ ……..(6a)

$et = \beta o + \alpha m - \alpha m^* - \beta y + \beta y^* - \theta i + \theta i^* + ut$ …….(6b)

In econometric parlance, the SPMM to be estimated could be presented below

More Specified Flexible-Price Monetary Model (FPMM)

Expectations could be introduced in equation (4) since the nominal interest rate consists of real interest rate and the expected inflation rate:

$et = \alpha (m - m^*)t - \beta(y - y^*)t + \theta(i - i^*)t + \infty(\pi t - \pi^*)t$ ……..(7)

$it = rt + \pi t$…….. (8)

$i^*t = rt^* + \pi^*t$ …… (9)

The relationship that captures this is called the Fisher equation, which states: Nominal interest rate = real interest rate + rate of inflation. Where rt and rt* are the domestic and foreign real interest rate and πt and π*t are the domestic and foreign inflation rate, respectively. Supposing that real interest rates are equalized in both domestic and foreign country USA, then

$it - i^*t = \pi t - \pi^*t$ ……. (9)

Thus, substituting equation (9) in equation (4) provides a more specified flexible-price monetary model (FPMM) of exchange rate determination in the form of (i-i*)t:

$et = \kappa + \alpha (m - m^*)t - \beta(y - y^*)t + \theta(\pi t - \pi^*)t + ut$ ……. (10)

In econometric parlance, the FPMM to be estimated

Where κ is an arbitrary constant and ut is a stochastic term. Consider πt and as logarithms of the inflation rates in BRICS countries and in the United States respectively. Equation (10) implies that an increase

in the domestic money supply relative to the foreign money stock induces a depreciation of the domestic currency relative to the foreign currency (a rise in et). Also, ceteris paribus. An increase in domestic real income, produces an excess domestic money demand. In order to increase their real money balances, spending by domestic residents decreases and prices fall until the market clears. Given the PPP, the fall in domestic prices assuming foreign prices constant, suggests an appreciation of the domestic currency relative to the foreign currency. Lastly, according to equation (10), a relative rise in domestic interest rates which reflects an increase in domestic inflationary expectations, will lead to a depreciation of the domestic currency

The fundamental equation depicts that the relative money supply, relative output levels and expected inflation differentials in the bilateral exchange relation have an impact on the spot exchange rates.

SECTION-III

- **OBJECTIVIES OF THE STUDY:**

After reviewing the existing literature of foreign exchange rate determination it is observed that the results of FXR determination differ from one country to another. The main objective of this study is to analyses the monetary model for the determination of exchange rate in emerging economies like Brazil, Russia, India, China and South-Africa with respect to US dollar.

SUB-OBJECTIVE OF THE STUDY:

1. To investigate the impact of macroeconomic determinants (variables) on foreign exchange rate(s) in BRICS countries.
2. To testing the Sticky Price Monetary Model of foreign exchange rate(s) in BRICS countries
3. To testing the Flexible Price Monetary Model of foreign exchange rate determination in BRICS countries.

- **RESEARCH METHODOLOGY:-**

Data and Variables: The analysis is based on panel data for BRICS nation (N= 1... 5), namely Brazil, Russia, India, China and South Africa for the time period 1991 to 2015 to analyses the monetary model of foreign exchange rate determination. The study used (FXR) foreign exchange rate as dependent variable and money supply, income, rate of interest, inflation of domestic countries and foreign country (USA) referred as the independent variable. For carrying out the estimations in the study, the data-set are converted into their log forms.

Source of Data: The data and other relevant information required for the study have been collected from the various national and International sources. The main source of Data have been IMF'S "International financial statistics", world bank , "world development indicator", "Economic survey of India", R.B. I. bulletin and

Report(s) on currency and finance, Indian foreign Trade Review and Indian Economic Journal (Various Issues).

Research Methodology depicts the research framework which highlights the main aim of the research which is to find out if Money Supply, Interest rate, Gross Domestic Product and Consumer Price Index could have an impact on the dependent variable of the study; the study applies the simple Ordinary Least Square (OLS) method and multiple regression method to describe the behavior of the bilateral exchange rate between BRICS nations and U.S.A over the time period 1990-2015.Exchange rate Correlation and Regression analysis will be performed to identify the relationship between variables.

Model Specification

Model -1

$er = \beta 0 + \beta 1m + \beta 2y + \beta 3r + \beta 4p + \beta 5\pi + \beta 6\ m^* + \beta 7y^* + \beta 8r^* + \beta 9p^* + \beta 10\pi^* + ut$

HYPOTHESIS SETTING AND VARIABLES

H0: There is no statistically significant impact of macroeconomic variables on foreign exchange rate (BRICS Nations).

H1: There is statistically significant impact of macroeconomic variables on foreign exchange rate (BRICS Nations).

Null and Alternative hypothesis has been generated for the ten independent variables. Hypothesis null (Ho) indicates that the variances to the independent macro variable can affect the exchange rate value. Hypothesis alternative (H1) indicates vice versa. The results of the tests have been compared against the null hypothesis to identify the determinants of exchange rate.

Model -2

HYPOTHESIS:

H0: Neither the basic nor the modified (flexible or sticky price) monetary model explains the exchange rate determination in BRICS nations.

H1: Either the basic or the modified (flexible or sticky price) monetary model explains the exchange rate determination in BRICS nations.

In econometric parlance, the **FPMM** to be estimated could be presented below

$et = \beta o + \alpha\ (m - m^*)t - \beta(y - y^*)t + \theta(i - i^*)t + ut$

$et = \beta o + \alpha m - \alpha m^* - \beta y + \beta y^* + \theta i - \theta i^* + ut$

- The model illustrates that a given increase in domestic money supply inflates domestic price (FXR) which by virtue of PPP depreciate domestic currency proportion.

  Ms ↑ =FXR ↑ ------DEPRICIATE DOMESTIC CURRENCY

- A higher level of domestic real income reduce the domestic price level which under ppp result in appreciation of domestic currency

  Y ↑ = FXR ↓ ------- APPRECIATION OF DOMESTIC CURRENCY

- An increase in domestic interest rate reduce the demand for domestic goods causing increase the domestic price level (FXR) which under ppp result in depreciate of domestic currency

  R ↑ = FXR ↑ ---------- DEPRICIATE DOMESTIC CURRENCY

More Specified Flexible-Price Monetary Model (FPMM)

$et = \kappa + \alpha (m - m^*)t - \beta(y - y^*)t + \theta(\pi t - \pi^*)t + ut$

- High expected domestic inflation rate leads to depreciate of domestic country.

  π ↑ = FXR ↑ ---------- DEPRICIATE DOMESTIC CURRENCY

Model -3

The sticky price monetary model can be expressed as follows:

$et = \beta o + \alpha (m - m^*)t - \beta(y - y^*)t - \theta(i - i^*)t + ut$

$et = \beta o + \alpha m - \alpha m^* - \beta y + \beta y^* - \theta i + \theta i^* + ut$

- A rise in domestic interest rate indicates a relative shortage of liquidity in domestic money market which gives rise to capital inflow and result in appreciation of domestic currency.

  R ↑ = FXR ↓

Table 2. Variables of basic and modified model and their expected signs.

Variables		Expected signs	
Denotation	Meaning	Model 2: FPMM model	Model 3: SPMM model
Log(FXR)	Log of the exchange rate	N/A (dependant variable)	N/A (dependant variable)
Log(M)	Log of domestic money supply	+	+
Log(M USA)	Log of the foreign money supply	–	–
Log(GDP)	Log of the real income	–	–
Log(GDP USA)	Log of the foreign real income	+	+
Log (R)	interest rate (domestic)	+	–
Log (R USA)	(foreign interest rate)	–	+

+ =positive relationship with FXR, - = negative relationship with FXR

SECTION-IV

EMPIRICAL RESULTS

Empirical Estimation of foreign Exchange Rate Determination with annual data 1991-2015. In this section we have analyzed the impact of monetary variable on exchange Rate. The analysis has been made by applying the OLS linear regression equation Model and multiple regression equation Model. The main two models apply this study - flexible price monetary model and sticky price monetary model of foreign exchange rate determination. Foreign exchange rate is function of monetary variable like money supply, GDP, rate of Interest, price and inflation of domestic and foreign country (USA).

- **Descriptive Statistics Analysis:**

In Annexure **Table 3** illustrates the descriptive statistics for all the macroeconomic variables analyzed in this study. Each variable has 25 sets of data. Exchange rate mean indicates that the value of Brazil's real on an average was 1.73 per US dollar. Likewise, the average money supplied by the government sums up to 1.67e+12. The average GDP totals to USD 1.19e+12, whereas the average interest rate equals to 44.97. While the minimum interest rate is 18.63, the maximum interest rate charged is 77.61. The mean of CPI is 67.8, which indicate the average consumer price of Brazil for the past 25 years. The standard deviations of all the

variables show that the data sets are very precise rather than widely spread. When standard deviation of each variable is compared to the mean it shows that the values are far from the average which is an indication that the data sets of each macroeconomic variable have been tightly grouped. The coefficient of standard deviation are less in foreign exchange rate and money supply which indicates greater stability in this variable. The time series for FXR and price is negative skewed which indicate that large number of values below average value. In inflation have kurtosis value greater than 3 which implies the price series to be not normally distributed. **Table 4** analysis the value of Russian ruble on an average was 22.48 per US dollar and the average money supplied by the government sums up to 1.21E+13. The average of GDP and interest rate is 9.07E+11 and 15.98. The coefficient of standard deviation are high in all variable which indicates less stability in this variables. The time series are positive skewed which indicate that large number of values above the average value. In inflation have kurtosis value greater than 3 which implies the price series to be not normally distributed. **Table 5** explained the value of Indian rupee on an average was 43.35 per US dollar. Likewise, the average money supplied by the government sums up to 3.24E+13. The average GDP totals to 9.16E+11 and average interest rate equals to 5.899. The mean of CPI is 70.62. When standard deviation of each variable is compared to the mean it shows that that the values are far from the average which is an indication that the data sets of each macroeconomic variable have been tightly grouped. The coefficient of standard deviation are less in money supply, income and rate of interest which indicates greater stability in this variable. The time series for FXR is negative skewed which indicate that large number of values below average value. **Table 6** illustrates the value of china yuan on an average was 7.35 per US dollar and average money supplied by the government sums up to 3.96E+13. The average GDP totals to 3.43E+12, whereas the average interest rate equals to 1.92. The mean of CPI is 84.67, the coefficient of standard deviation are less in foreign exchange rate and price which indicates greater stability in this variable. The time series for FXR, rate of interest and CPI is negative skewed which indicate that large number of values below average value. In inflation have kurtosis value greater than 3 which implies the price series to be not normally distributed. **Table 7** analysis the value of South Africa rand on an average was 6.78 per US dollar. Likewise, the average money supplied by the government sums up to1.16E+12. The average GDP totals to 2.27E+11, whereas the average interest rate equals to 5.38 the mean of CPI is 71.29, the coefficient of standard deviation are less in foreign exchange rate and CPI which indicates greater stability in this variable. All variables have kurtosis value less than 3 which implies the price series to be normally distributed.

- **Correlation Matrix Analysis:**

Table 8 explained the relationship between the frequencies of dependent and independent variables, Person correlation was computed. The correlation test results indicate that there is a positive correlation between money supply, gross domestic product and consumer price index of Brazil and money supply, GDP and CPI of USA with exchange rate whereas interest rate and inflation of domestic and foreign country shows a

negative correlation with exchange rate according to the correlation results. Also, the correlation results indicate that consumer price index is the most highly correlated variable among the macroeconomic fundamentals tested. In **Table 9** indicate that there is a positive correlation between money supply, gross domestic product and consumer price index of Russia and money supply, GDP and CPI of USA with exchange rate whereas interest rate and inflation of domestic and foreign country shows a negative correlation with exchange rate according to the correlation results. **Table 10** indicate that in India there is a positive correlation between money supply, gross domestic product and consumer price index of India and money supply, GDP and CPI of USA with exchange rate whereas interest rate and inflation of domestic and foreign country shows a negative correlation with exchange rate according to the correlation results. **Table 11** show that there is a positive correlation between rate of interest, inflation of china and USA with exchange rate whereas money supply, gross domestic product and consumer price index of India and money supply, GDP and CPI of USA shows a negative correlation with exchange rate according to the correlation results. **Table 12** depict that there is a positive correlation between money supply, gross domestic product and consumer price index of South Africa and money supply, GDP and CPI of USA with exchange rate whereas interest rate and inflation of domestic and foreign country shows a negative correlation with exchange rate according to the correlation results.

- **Trend Analysis of Macroeconomic Variable**

Figure 1: Trend line of FXR in BRICS Nations

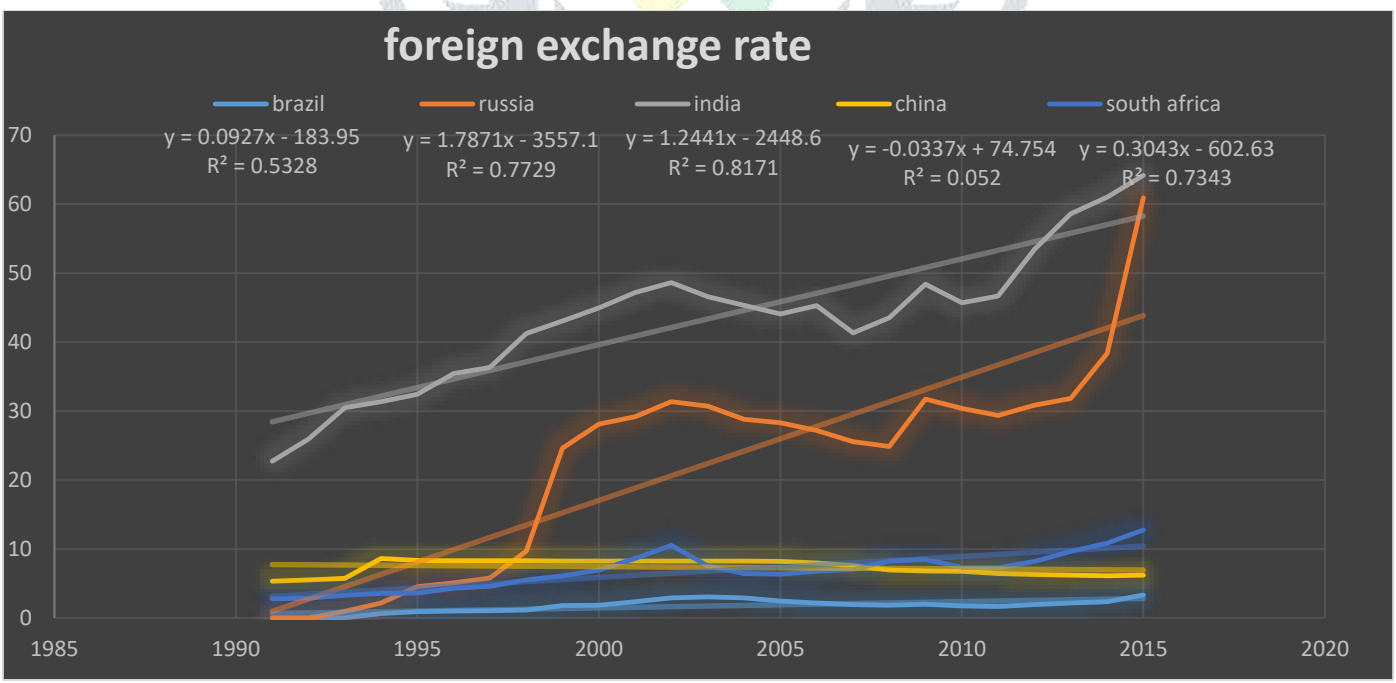

Figure 1 explain the trend line of foreign exchange rate in BRICS nations. The value of currency are continuous decline in Brazil, Russia, India and South Africa with respect to US Dollar but only China's currency appreciate during the whole time period 1991-2015.**Figure 2** explain the increasing trend of GDP in BRICS nations. **Figure 3** explain the decreasing trend of real interest rate in BRICS nations. Brazil and Russia has drastically change in their interest rate. **Figure 4** explain the increasing trend of CPI in BRICS nations. **Figure 5** explain the increasing trend of Money supply in % of GDP in BRICS nations. **Figure 6** explain the increasing trend of Money supply in BRICS nations but after 2010 china has overlap USA in money supply.

- **Hypothesis testing by regression analysis**

Model -1

Table 13: Hypotheses testing results in Brazil

	BRAZIL		
Independent variables	***Coefficients***	***P-value***	**Hypothesis**
Intercept	-5.93999	0.76212	
LM	-0.13679*	0.058658	Reject the null hypothesis
LY	-0.75934	6.14E-08	Accept the null hypothesis
LR	-0.18826*	0.033679	Reject the null hypothesis
LP	1.139716	8.33E-11	Accept the null hypothesis
LI	-0.01525	0.215814	Accept the null hypothesis
LM*	0.994253*	0.038818	Reject the null hypothesis
LY*	0.252242	0.719563	Accept the null hypothesis
LR*	-0.08128*	0.03414	Reject the null hypothesis
LP*	-2.20068	0.376034	Accept the null hypothesis
LI*	-0.03956*	0.017892	Reject the null hypothesis
Multiple R	0.999914		
R Square	0.999828		
Adjusted R Square	0.999705		
Standard Error	0.040724		
Observations	25		

Source: Author Calculation, * Represents the significance of parameter at 5 % level of significance

($p = 0.000 < \alpha = 0.05$) reject the null hypothesis

($p = 0.100 > \alpha = 0.05$) accept the null hypothesis

FXR ↑ --------- DEPRICIATE OF CURRENCY

FXR ⇩---------- APPRECIATE OF CURRENCY

Table 14: Hypotheses testing results of Russia

	Russia		
Independent variables	***Coefficients***	***P-value***	**Hypothesis**
Intercept	-106.340818	0.077619534	
LM	-0.010502597	0.958029269	Accept the null hypothesis
LY	-0.835026743*	0.002372415	Reject the null hypothesis
LR	-0.018147021	0.590416122	Accept the null hypothesis
LP	0.257395282*	0.026963373	Reject the null hypothesis
LI	-0.02431081	0.7095418	Accept the null hypothesis
LM*	2.366022354	0.145391627	Accept the null hypothesis
LY*	2.790970424	0.140653225	Accept the null hypothesis
LR*	-0.071116795	0.523417179	Accept the null hypothesis
LP*	-5.145765606	0.392454425	Accept the null hypothesis
LI*	0.059953595	0.388540259	Accept the null hypothesis
Multiple R	0.996152739		
R Square	0.99232028		
Adjusted R Square	0.986834766		
Standard Error	0.150732347		
Observations	25		

Source: Author Calculation, * Represents the significance of parameter at 5 % level of significance

($p = 0.000 < \alpha = 0.05$) reject the null hypothesis

($p = 0.100 > \alpha = 0.05$) accept the null hypothesis

Table 15: Hypotheses testing results of India

	India		
Independent variables	***Coefficients***	***P-value***	**Hypothesis**
Intercept	6.882472831	0.188765175	

LM	0.716954353*	0.002801945	Reject the null hypothesis
LY	-0.759720936*	1.00233E-08	Reject the null hypothesis
LR	0.026524301*	0.021474469	Reject the null hypothesis
LP	0.554974253*	0.000474393	Reject the null hypothesis
LI	-0.003792783	0.851346541	Accept the null hypothesis
LM*	-0.622381427*	0.000415893	Reject the null hypothesis
LY*	0.59849638*	0.026310153	Reject the null hypothesis
LR*	0.008484481	0.561491277	Accept the null hypothesis
LP*	-1.379181294	0.124880401	Accept the null hypothesis
LI*	0.014062728	0.192191219	Accept the null hypothesis
Multiple R	0.998441902		
R Square	0.996886232		
Adjusted R Square	0.994662113		
Standard Error	0.018305685		
Observations	25		

Source: Author Calculation, * Represents the significance of parameter at 5 % level of significance

($p = 0.000 < \alpha = 0.05$) reject the null hypothesis

($p = 0.100 > \alpha = 0.05$) accept the null hypothesis

Table 16: Hypotheses testing results of china

	China		
Independent variables	***Coefficients***	***P-value***	**Hypothesis**
Intercept	-25.20531918	0.182983011	
LM	-0.453972581	0.157411174	Accept the null hypothesis
LY	-0.419118803*	0.027189976	Reject the null hypothesis
LR	-0.011760011	0.522926432	Accept the null hypothesis
LP	1.834279198*	0.000564917	reject the null hypothesis
LI	-0.009941509	0.642323067	Accept the null hypothesis

LM*	0.531545888	0.39524708	Accept the null hypothesis
LY*	1.00175904	0.186344981	Accept the null hypothesis
LR*	-0.061763263	0.192388396	Accept the null hypothesis
LP*	-0.205017332	0.93806775	Accept the null hypothesis
LI*	-0.007848427	0.735127899	Accept the null hypothesis
Multiple R	0.969502458		
R Square	0.939935016		
Adjusted R Square	0.897031456		
Standard Error	0.04973528		
Observations	25		

Source: Author Calculation, * Represents the significance of parameter at 5 % level of significance

($p = 0.000 < \alpha = 0.05$) reject the null hypothesis

($p = 0.100 > \alpha = 0.05$) accept the null hypothesis

Table 17: Hypotheses testing results of South Africa

	South Africa		
Independent variables	*Coefficients*	*P-value*	Hypothesis
Intercept	11.84293844	0.037417176	
LM	0.241196585*	0.005236941	Reject the null hypothesis
LY	-1.003523913	2.34951E-14	Accept the null hypothesis
LR	-0.010497205	0.060753243	Accept the null hypothesis
LP	0.499913884*	0.001719294	Reject the null hypothesis
LI	-0.009289	0.483638196	Accept the null hypothesis
LM*	-0.218099672*	0.049376395	Reject the null hypothesis
LY*	0.165210279	0.452781321	Accept the null hypothesis
LR*	-0.01370826	0.240600752	Accept the null hypothesis
LP*	2.031327046*	0.008152418	Reject the null hypothesis
LI*	-0.007486157	0.23405938	Accept the null hypothesis

Multiple R	0.999701753		
R Square	0.999403595		
Adjusted R Square	0.998977592		
Standard Error	0.013547092		
Observations	25		

Source: Author Calculation, * Represents the significance of parameter at 5 % level of significance

($p = 0.000 < \alpha = 0.05$) reject the null hypothesis

($p = 0.100 > \alpha = 0.05$) accept the null hypothesis

Table 13, 14, 15, 16 and 17 summarizes the interpretations of hypothesis generated for BRICS Nations. In Brazil the null Hypothesis accepted it is indicating no relationship between exchange rate and income, price, inflation of domestic country and income and price of foreign country (USA), while the remaining macro fundamentals could be used to explain the changes in Brazil real. Price of domestic country, money supply and income of foreign country has positive impact on foreign exchange rate but the rest of the variables in the model has negative impact on foreign exchange rate. In Russia has only two variables income and price are statistical significant variable for foreign exchange rate determination. CPI of foreign country has been found as the macro fundamental that would influence exchange rate most. Price of domestic country, money supply, income and inflation of foreign country has positive impact on foreign exchange rate but the rest of the variables in the model has negative impact on foreign exchange rate. In India's money supply, income, rate of interest, price of India, money supply and income of USA are statistically significant variables for foreign exchange rate determination. CPI of foreign country has been found as the macro fundamental that would influence exchange rate most. Income and inflation of domestic country and money supply and price of foreign country has negative impact on foreign exchange rate but the rest of the variables in the model has positive impact on foreign exchange rate. In china has also only two variables price and income are statistically significant variable for foreign exchange rate determination. CPI of domestic country has been found as the macro fundamental that would influence exchange rate most. Price of domestic country, money supply and income of foreign country has positive impact on foreign exchange rate but the rest of the variables in the model has negative impact on foreign exchange rate. But South Africa money supply and price of South Africa and USA both are statistically significant variable for FXR determination. CPI of foreign country has been found important variable to influence exchange rate. Money supply, Price of domestic country and money supply, income of foreign country has positive impact on foreign exchange rate but the rest of the variables in the model has negative impact on foreign exchange rate.

Table 18. Variables of Basic and Modified Model and Their Expected Signs in Brazil.

Variables		Expected signs		
Denotation	Meaning	Model 2: FPMM model	Model 3: SPMM model	BRAZIL
Log(FXR)	Log of the exchange rate	N/A (dependant	N/A (dependant	FPMM/SPMM MODEL
Log(M)	Log of domestic money supply	+	+	0.917504541
Log(M USA)	Log of the foreign money supply	–	–	-1.548609456
Log(GDP)	Log of the real income	–	–	-0.74088752*
Log(GDP USA)	Log of the foreign real income	+	+	1.911494016
Log (R)	interest rate (domestic)	+	–	0.425510417
Log (R USA)	(foreign interest rate)	–	+	0.126789081

Source: Author Calculation, * Represents the significance of parameter at 5 % level of significance

+ =positive relationship with FXR, - = negative relationship with FXR

Table 20: Variables of Basic and Modified Model and Their Expected Signs in Russia.

Variables		Expected signs		
Denotation	Meaning	Model 2: FPMM model	Model 3: SPMM model	RUSSIA
Log(FXR)	Log of the exchange rate	N/A (dependant variable)	N/A (dependant variable)	FPMM/SPMM MODEL
Log(M)	Log of domestic money supply	+	+	-0.230866454
Log(M USA)	Log of the foreign money supply	–	–	0.844927964
Log(GDP)	Log of the real income	–	–	-1.08329293
Log(GDP USA)	Log of the foreign real income	+	+	5.417239154*
Log (R)	interest rate (domestic)	+	–	-0.049406721

Log (R USA)	(foreign interest rate)	–	+	-0.021406378

Source: Author Calculation, * Represents the significance of parameter at 5 % level of significance

Table 21. Variables of Basic and Modified Model and Their Expected Signs in India.

Variables		Expected signs		
Denotation	Meaning	Model 2: FPMM model	Model 3: SPMM mod	INDIA
Log(FXR)	Log of the exchange rate	N/A (dependant	N/A (dependant	FPMM/SPMM MODEL
Log(M)	Log of domestic money supply	+	+	1.191367894
Log(M USA)	Log of the foreign money supply	–	–	-0.987472797
Log(GDP)	Log of the real income	–	–	-0.958315646
Log(GDP USA)	Log of the foreign real income	+	+	-0.005171912
Log (R)	interest rate (domestic)	+	–	0.040015037*
Log (R USA)	(foreign interest rate)	–	+	0.025783743

Source: Author Calculation, * Represents the significance of parameter at 5 % level of significance

Table 22. Variables of Basic and Modified Model and Their Expected Signs in China.

Variables		Expected signs		
Denotation	Meaning	Model 2: FPMM	Model 3: SPMM	CHINA
Log(FXR)	Log of the exchange rate	(dependent variable)	(dependent variable)	SPMM MODEL APPLY
Log(M)	Log of domestic money supply	+	+	0.470341398*
Log(M USA)	Log of the foreign money supply	–	–	-1.026300546*
Log(GDP)	Log of the real income	–	–	-0.472125211*
Log(GDP USA)	Log of the foreign real income	+	+	1.19084602
Log (R)	interest rate (domestic)	+	–	-0.002833906

Log (R USA)	(foreign interest rate)	–	+	0.071520676

Source: Author Calculation, * Represents the significance of parameter at 5 % level of significance

Table 23. Variables of Basic and Modified Model and Their Expected Signs in South Africa.

Variables		Expected signs		
Denotation	Meaning	Model 2: FPMM model	Model 3: SPMM model	SOUTH AFRICA
Log(FXR)	Log of the exchange rate	N/A (dependent variable)	N/A (dependant variable)	FPMM/SPMM MODEL INVALID
Log(M)	Log of domestic money supply	+	+	0.472173011
Log(M USA)	Log of the foreign money supply	–	–	-0.170282678
Log(GDP)	Log of the real income	–	–	-1.00400524
Log(GDP USA)	Log of the foreign real income	+	+	1.157871908*
Log (R)	interest rate (domestic)	+	–	-0.006608745
Log (R USA)	(foreign interest rate)	–	+	-0.062576774

Source: Author Calculation, * Represents the significance of parameter at 5 % level of significance

This study has explored the philosophy of the Dornbusch's Sticky price model and flexible price monetary model of exchange rate determination for BRICS Nations currencies. The study revealed that Dornbusch's sticky price model and flexible price monetary model is not be validated in the analysis of Brazil, Russia, India and South Africa's currency. Only China is one of the country which sticky price model are applicable for foreign exchange rate determination.

SECTION-V

CONCLUSIONS

- The trend line of foreign exchange rate in BRICS nations increases with respect to USA dollar except to china. The value of currency are continuous decline in Brazil, Russia, India and South Africa but only China's currency appreciate during the whole time period 1991-2015.

- Brazil's Price of domestic country, money supply and income of foreign country has positive impact on foreign exchange rate but the rest of the variables in the model has negative impact on foreign exchange rate. Russia has only two variables income and price are statistical significant variable for foreign exchange rate determination. In India's money supply, income, rate of interest, price of India, money supply and income of USA are statistically significant variables for foreign exchange rate determination. China has also only two variables price and income are statistically significant variable for foreign exchange rate determination. South Africa's money supply, price of South Africa and USA are statistically significant variable for FXR determination.
- The study revealed that Dornbusch's sticky price model and flexible price monetary model is not be validated in the analysis of Brazil, Russia, India and South Africa currency. Only China is one of the country which sticky price model are applicable for foreign exchange rate determination. It is also important to note the other factors that could impact exchange rate apart from the macroeconomic fundamentals highlighted in research. This includes political, social and many more other non-monetary factors that could pressure the value of exchange rate although the effect could be indirect and insignificant compared to the macro fundamentals focused on this study

Perhaps, this research could be a parameter for policy makers, especially the central bank of BRICS Nations to identify the main determinants of exchange rate

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ANNEXURE TABLES

Table 3: Summary Statistics for Macroeconomic Variable of Brazil

DISCRIPTIVE STATASTICS	*FXR*	*M*	*Y*	*R*	*P*	*I*
Mean	1.735734	1.67E+12	1.19E+12	44.97891	67.81412	223.7029
Standard Error	0.186948	3.44E+11	1.49E+11	2.884235	7.826687	114.5556
Median	1.833767	9.64E+11	8.64E+11	46.02272	69.83874	6.837831
Standard Deviation	0.934738	1.72E+12	7.46E+11	14.42117	39.13344	572.7782
Sample Variance	0.873735	2.96E+24	5.57E+23	207.9703	1531.426	328074.9
Kurtosis	-0.40148	-0.1232	-0.83012	-0.17249	-0.65553	6.795749
Skewness	-0.39792	1.033224	0.836529	0.281161	-0.13348	2.76957
Range	3.326728	5.62E+12	2.21E+12	58.98693	138.379	2072.689
Minimum	0.000176	21117945	4.01E+11	18.63033	0.004757	3.198592
Maximum	3.326904	5.62E+12	2.61E+12	77.61726	138.3837	2075.887
Sum	43.39335	4.17E+13	2.96E+13	1124.473	1695.353	5592.573
Count	25	25	25	25	25	25

Source: Author Calculation

Table 4: Summary Statistics for Macroeconomic Variable of Russia

DISCRIPTIVE STATASTICS	*FXR*	*M*	*Y*	*R*	*P*	*I*
Mean	22.4828	1.21E+13	9.07E+11	15.98586	55.59332	127.8025
Standard Error	2.973007	3.08E+12	1.37E+11	6.189318	9.364371	50.96792
Median	28.12917	3.96E+12	5.18E+11	1.217968	49.18108	14.76677
Standard Deviation	14.86503	1.54E+13	6.85E+11	30.94659	46.82185	254.8396
Sample Variance	220.9692	2.37E+26	4.69E+23	957.6915	2192.286	64943.23
Kurtosis	0.332939	0.563811	-0.8218	-0.56871	-0.99023	3.943174
Skewness	0.134604	1.274506	0.823433	1.057678	0.45243	2.267832
Range	60.18552	5.14E+13	2.04E+12	91.20696	151.465	869.5438
Minimum	0.752134	1.3E+11	1.96E+11	-18.9516	0.053597	5.078014
Maximum	60.93765	5.15E+13	2.23E+12	72.25533	151.5186	874.6218
Sum	562.0701	3.03E+14	2.27E+13	399.6466	1389.833	3195.063
Count	25	25	25	25	25	25

Source: Author Calculation

Table 5: Summary Statistics for Macroeconomic Variable of India

	FXR	*M*	*Y*	*R*	*P*	*I*
Mean	43.35731	3.24E+13	9.16E+11	5.899997	70.62693	7.817801
Standard Error	2.025938	6.49E+12	1.26E+11	0.508759	7.142925	0.640773
Median	44.94161	1.76E+13	6.18E+11	5.864178	60.85422	7.164254
Standard Deviation	10.12969	3.24E+13	6.3E+11	2.543797	35.71463	3.203864
Sample Variance	102.6106	1.05E+27	3.97E+23	6.470902	1275.535	10.26474
Kurtosis	0.105505	-0.0243	-1.01514	0.247539	-0.25264	-1.144
Skewness	-0.02514	1.098004	0.740909	-0.69156	0.85144	0.292259
Range	41.40951	1.05E+14	1.82E+12	9.788097	121.6102	10.18544
Minimum	22.74243	2.88E+12	2.75E+11	-0.59685	26.04675	3.684807
Maximum	64.15194	1.07E+14	2.1E+12	9.191247	147.657	13.87025

Sum	1083.933	8.1E+14	2.29E+13	147.4999	1765.673	195.445
Count	25	25	25	25	25	25

Source: Author Calculation

Table 6: Summary Statistics for Macroeconomic Variable of China

	FXR	***M***	***Y***	***R***	***P***	***I***
Mean	7.351351	3.96E+13	3.43E+12	1.929125	84.67762	4.413817
Standard Error	0.217161	8.31E+12	6.92E+11	0.741452	3.801936	1.205422
Median	7.973438	2.11E+13	1.66E+12	2.635888	81.55233	2.627119
Standard Deviation	1.085803	4.15E+13	3.46E+12	3.707259	19.00968	6.02711
Sample Variance	1.178969	1.72E+27	1.2E+25	13.74377	361.3679	36.32606
Kurtosis	-1.3657	0.214676	-0.09826	0.567141	0.273753	4.446991
Skewness	-0.50699	1.180652	1.129262	-0.72183	-0.47384	2.065317
Range	3.295351	1.37E+14	1.06E+13	15.32555	72.70761	25.64498
Minimum	5.323392	1.86E+12	3.83E+11	-7.97742	42.15072	-1.40789
Maximum	8.618743	1.39E+14	1.1E+13	7.348127	114.8583	24.23709
Sum	183.7838	9.9E+14	8.58E+13	48.22811	2116.941	110.3454
Count	25	25	25	25	25	25

Source: Author Calculation

Table 7: Summary Statistics for Macroeconomic Variable of South Africa

	FXR	***M***	***Y***	***R***	***P***	***I***
Mean	6.787533	1.16E+12	2.27E+11	5.385793	71.29019	7.085405
Standard Error	0.522625	1.85E+11	2.04E+10	0.63262	6.129525	0.631861
Median	6.939828	8.04E+11	1.75E+11	4.603671	68.32579	6.375259
Standard Deviation	2.613126	9.24E+11	1.02E+11	3.163098	30.64763	3.159305
Sample Variance	6.828426	8.53E+23	1.04E+22	10.00519	939.2771	9.981206
Kurtosis	-0.23719	-1.16362	-1.30257	0.506773	-0.92026	1.246208
Skewness	0.281054	0.589134	0.504652	0.900336	0.429292	0.979697
Range	9.997616	2.79E+12	3.01E+11	13.26142	102.7546	13.94939
Minimum	2.761315	1.83E+11	1.15E+11	-0.26886	27.39	1.385382
Maximum	12.75893	2.98E+12	4.16E+11	12.99255	130.1446	15.33477
Sum	169.6883	2.9E+13	5.67E+12	134.6448	1782.255	177.1351
Count	25	25	25	25	25	25

Source: Author Calculation

- **Correlation Analysis**

Table 8: Correlation matrix among macro variables of Brazil

	FXR	*M*	*Y*	*R*	*P*	*I*	*M**	*Y**	*R**	*P**	*I**
FXR	1										
M	0.53570	1									
Y	0.29637	0.90278	1								
R	-0.4355	-0.8184	-0.7694	1							
P	0.76016	0.9181	0.83058	-0.73983	1						
I	-0.6144	-0.3675	-0.3666	0.20087	-0.5912	1					
M*	0.63930	0.96077	0.88642	-0.8523	0.9632	-0.4714	1				
Y*	0.71932	0.92869	0.84215	-0.8176	0.9828	-0.5208	0.98787	1			
R*	-0.4782	-0.7040	-0.6105	0.81436	-0.6277	0.0787	-0.7203	-0.6876	1		
P*	0.6915	0.9338	0.87215	-0.8258	0.9819	-0.5148	0.99113	0.99673	-0.7007	1	
I*	-0.4299	-0.5263	-0.3598	0.2232	-0.509	0.1935	-0.483	-0.451	0.305	-0.45	1

Source: Author Calculation

Table 9: Correlation among macro variables of Russia

	FXR	*M*	*Y*	*R*	*P*	*I*	*M**	*Y**	*R**	*P**	*I**
FXR	1										
M	0.74256	1									
Y	0.52679	0.87685	1								
R	-0.7695	-0.394	-0.3852	1							
P	0.8637	0.9469	0.8729	-0.6157	1						
I	-0.6541	-0.3681	-0.3278	0.73542	-0.5513	1					
M*	0.84043	0.9304	0.89186	-0.6308	0.99482	-0.5616	1				
Y*	0.873733	0.888837	0.846899	-0.70413	0.983872	-0.64462	0.98787	1			
R*	-0.58804	-0.6816	-0.70316	0.358041	-0.73862	0.137501	-0.72033	-0.68796	1		
P*	0.850274	0.892074	0.871097	-0.68724	0.984447	-0.64346	0.991138	0.996738	-0.70074	1	
I*	-0.52158	-0.52119	-0.25304	0.201185	-0.49999	0.351214	-0.48385	-0.45109	0.305595	-0.45822	1

Source: Author Calculation

Table 10: Correlation among macroeconomic variables of India

	FXR	*M*	*Y*	*R*	*P*	*I*	*M**	*Y**	*R**	*P**	*I**
FXR	1										
M	0.82	1									
Y	0.800	0.983	1								
R	-0.020	-0.295	-0.375	1							
P	0.895	0.98	0.978	-0.265	1						
I	-0.365	0.041	0.055	-0.517	-0.0491	1					
M*	0.860	0.952	0.973	-0.297	0.9689	-0.07	1				
Y*	0.888608	0.916352	0.944407	-0.26194	0.950398	-0.17596	0.98787	1			
R*	-0.56542	-0.70223	-0.71191	0.411672	-0.69053	0.0889	-0.72033	-0.68796	1		
P*	0.879668	0.922003	0.953642	-0.30335	0.953981	-0.13616	0.991138	0.996738	-0.70074	1	
I*	-0.6086	-0.52861	-0.47594	-0.06678	-0.54693	-0.0706	-0.48385	-0.45109	0.305595	-0.45822	1

Source: Author Calculation

Table 11: Correlation among macroeconomic variables of china

	FXR	*M*	*Y*	*R*	*P*	*I*	*M**	*Y**	*R**	*P**	*I**
FXR	1										
M	-0.4865	1									
Y	-0.5029	0.9976	1								
R	0.094193	0.17133	0.154434	1							
P	-0.03302	0.864039	0.862704	0.254077	1						
I	0.026464	-0.27849	-0.26118	-0.81029	-0.34559	1					
M*	-0.36772	0.943154	0.942332	0.161341	0.905538	-0.40115	1				
Y*	-0.24596	0.906639	0.902038	0.171349	0.927981	-0.42914	0.98787	1			
R*	0.501262	-0.69307	-0.69274	0.180645	-0.51261	0.156203	-0.72033	-0.68796	1		
P*	-0.26083	0.911709	0.91101	0.161075	0.935971	-0.41028	0.991138	0.996738	-0.70074	1	
I*	0.075841	-0.54089	-0.51266	-0.44594	-0.53235	0.294763	-0.48385	-0.45109	0.305595	-0.45822	1

Source: Author Calculation

Table 12: Correlation among Macro Variables of South Africa

	FXR	*M*	*Y*	*R*	*P*	*I*	*M**	*Y**	*R**	*P**	*I**
FXR	1										
M	0.78463	1									
Y	0.556146	0.930158	1								

R	-0.22486	-0.41651	-0.44756	1							
P	0.852578	0.984749	0.89756	-0.3542	1						
I	-0.482	-0.40993	-0.44151	-0.044	-0.516	1					
M*	0.8297	0.990841	0.9147	-0.403	0.9914	-0.469	1				
Y*	0.846855	0.966682	0.89654	-0.3502	0.9826	-0.565	0.987	1			
R*	-0.56036	-0.71527	-0.70798	0.6552	-0.715	0.2886	-0.720	-0.68796	1		
P*	0.834805	0.972264	0.91331	-0.356	0.9868	-0.5485	0.991	0.996738	-0.70074	1	
I*	-0.58794	-0.48293	-0.30559	-0.021	-0.534	0.3318	-0.483	-0.4510	0.3055	-0.458	1

Source: Author Calculation

ANNEXURE FIGURE

Figure 2: Trend of GDP in BRICS Nations

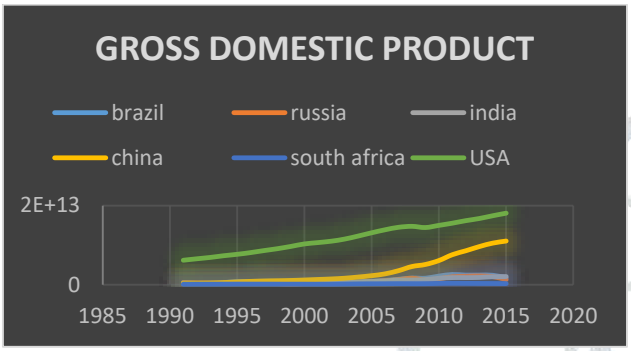

Figure 3: Trend of Real Interest Rate in BRICS Nations

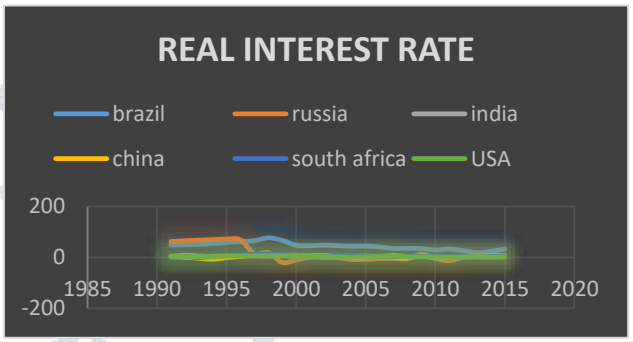

Figure 4: Trend of CPI in BRICS Nation

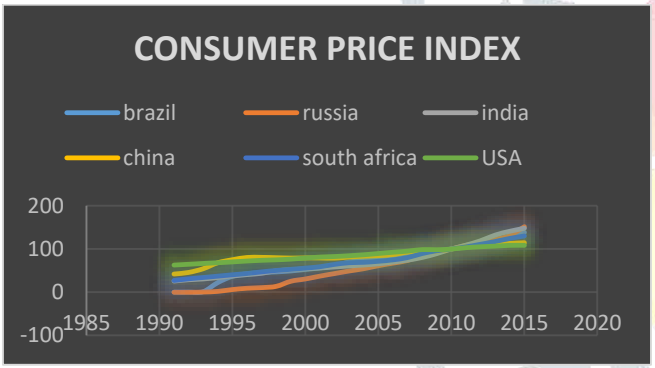

Figure 5: Trend of Money supply in % of GDP in BRICS Nations

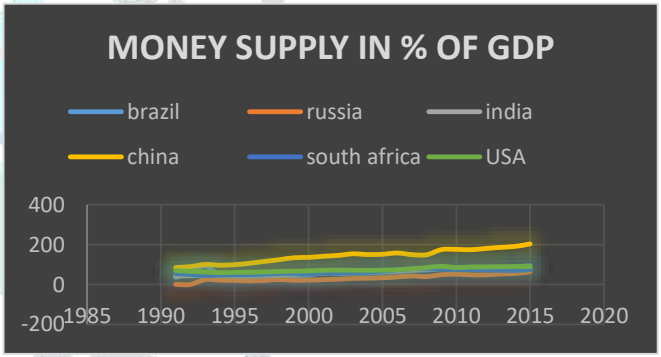

Figure 6: Trend of Money supply in US dollar in BRICS Nations