Research Article

AN INSIGHT INTO THE DETERMINANTS ON THE CURRENCY VOLATILITY IN DEVELOPED VS DEVELOPING COUNTRIES- AN EMPIRICAL ANALYSIS

Dr. Suraj. E. S*
Associate Professor, Department of Management Studies,
Naipunnya Business School, Pongam, Kerala, India.
Parth Thakkar*
Research Scholar, Department of Management, Christ University,
Bangalore, Karnataka, India.
Nitha.K.P*
Research Scholar, Department of Computer Science and Engineering,
Avinashilingam Institute of Home Science & Higher Education for Women,
Coimbatore, Tamil Nadu, India.

Abstract: *The paper focused on the impact of macro-economic variables and its impact on various currencies by comparing the macro-economic variables of developing and developed countries. The developing countries used for analysis are India & Singapore, US and China as developed countries also. In developing Countries that is India and Singapore, the most impactful variable was Current Account Balance which was followed by foreign direct investment determining the volatility of exchange rate. China had successfully managed to manage the exchange rate with a volatility of just 3.03 over last 20 years due to the strength in the merchandise exports. In India, inflation had also shown substantial significance in the volatility in exchange rate. Developing countries should focus much more on bringing FDI into the country and also focus on other factors to ensure the economic growth of the country. It was concluded that macro economic variables were successful in explaining the volatility movements in the exchange rate at significance level.*
Keywords: Current account balance, Exchange rate volatiliy, Foreign Direct Investment

Introduction

In the present era of globalization, volatility in exchange rate has a considerable influence on the operations and profitability of MNCs, and also affects the small and medium enterprises. Hence the exchange rate is an important parameter for determining international competitiveness and also indicates the global position of the economy. This study considered four macro-economic variables influenced on the exchange rate volatility in developed vs developing economies. The major macroeconomic variables used in the paper to analyse the changes in exchange rate are: Inflation rate, Real Interest rate, Current Account Balance and Foreign Direct Investment. Hence, the economies that have been taken for analysis are: India, United States, China and Singapore. In India since liberalization, foreign exchange markets have experienced a tremendous growth. Over the years India has witnessed episodes of

excessive volatility leading to changes in the value of Indian Rupee. Due to such volatility, international trade and investment becomes much more difficult due to an increase in the exchange rate risk. Since the interwar period, US Dollar have dominated many financial markets and also has major holdings of all market operations in the foreign exchange market. Chinese Yuan is also considered as one of the world's major reserve currency. The addition of the Chinese Yuan in the Special Drawing Rights (SDR) in 2016 makes Yuan as one of the world's major currencies. The Yuan is also the first emerging market currency to be included in the IMF's special drawing rights. The substantial rise of Singapore has also strengthened the Singapore Dollar over the years. This paper focuses on the reasons for the depreciation or appreciation of Indian Rupee, Chinese Yuan, US Dollar and Singapore Dollar in the context of economic variables. The main purpose of the paper is to identify the most influential economic variable which affects the volatility of Indian Rupee, US Dollar, Chinese Yuan and for the Singapore Dollar.

Review of Literature

This section focused on establishing the relationship between macroeconomic variables and exchange rate on the developing vs developed economies. **Broll & Eckwert (1999)** discussed the implications of a dynamic business ' volatility within exchange rates. This paper analysed to determine the theoretical basis as a positive correlation between the exchange rate and international trade. **Bergin & Sheffrin (2000),** developed a testable intertemporal model of the current account that allows for variable interest rates and exchange rates. This model showcases the volatility of current account data and explains the historical episodes of current account imbalance. Australia, UK and Canada were the three open economies used for research by the author. The main analysis and the model focused on how current account had an impact to the exchange rate of Australia, UK and Canada. The statistical test in all three countries rejected the benchmark model, which ignored changes in the interest rate and exchange rate.

Akinlo (2003) adopted cointegration approach to examine whether Nigeria's Naira depreciation had resulted in currency substitution in the country. The paper investigated whether currency depreciation had resulted in currency substitution in Nigeria or not. The paper had shown that currency depreciation could have adverse effects on the debt- service costs of domestic countries' private sectors and cause the residents to hedge external liabilities.

Bergvall (2005) studied importance of exchange rate stabilization in Sweden had a floating exchange rate system. The results demonstrate economic stability in determining the exchange rate system. Eventually, under the imaginary floating exchange-rate system, the real exchange rate had a stabilizing effect on demand, with a stabilizing effect on supply by the central bank. The findings indicate that the option of the exchange rate system has an effect on macroeconomic stability. More precisely, the actual exchange system's variability of supply is nearly equivalent to the hypothetical floating exchange rate system, but its performance under the hypothetical fixed exchange rate structure is considerably more unpredictable.

Campa & Goldberg (2005) analysed the presented cross-country, time lines and industry-specific proof that exchange rates are being passed on into import prices across a large range of local currencies, which represents 46% of exchange-rate volatility in the short term and almost 65% over the long-term. The quantitative significance of these macroeconomic impacts in the OECD had low statistical correlations. The evidence suggests that the emphasis of the interconnection may not depend on whether foreign products rates are laid down in the producers ' currencies or the importers ' local currencies.

Bhanumurthy (2006) examined the relative importance in determination of short-term exchange rates of macro (interest rates, inflation, etc.) and micro variables (order flows, information). **Kandil (2008)** analysed interactions between exchange rate fluctuations and the macro economy in a sample of developing and developed countries. The trade balance also improves as currency depreciation boosts export competitiveness in many developing countries. In contrast, the reduction in exports with respect to currency appreciation may be matched by a reduction in the domestic value of imports in many industrial countries.

Kandil (2009) measured export growth in developing countries and given their high dependency on imports, the current account balance deteriorates with respect to currency depreciation. The analysis of this paper had focused on the effects of exchange rate fluctuations affected very much on the major components of the balance of payments in a sample of industrial and developing countries. This study found that, in the short-run (one year according to data frequency), elasticity of imports and exports determines the effects of exchange rate fluctuations on the trade balance.

Mirchandani (2013) investigated various macroeconomic variables leading to acute variations in the exchange rate of a currency. On the basis of his analysis, it can be said that Indian Rupee has shown high volatility over the years. India was receiving capital inflows even amidst continued global uncertainty in 2009-11 as its domestic outlook was positive.

Oil, prices of other imported commodities like metals, gold etc. had also increased overall inflation. Even if the prices of global oil and commodities declined, the Indian consumers were not benefited as depreciation had negated the impact.

Jaratin Lily, Mori, Sang, & Asid (2014) stated that the inflows of foreign direct investment (FDI) are important for a country's economic development, but the world market for FDI has become more competitive. They analysed the exchange rate movements and foreign direct investment (FDI) relationship using annual data on ASEAN economies of: Malaysia, Philippines, Thailand, and Singapore. The results showed that existence of significant long-run cointegration between exchange rate and FDI in the case of Singapore, Malaysia, and Philippines with all countries recording negative coefficient implying that the appreciation of Singapore dollar, Malaysian ringgit, and the Philippine peso has a positive impact on FDI inflows.

Ramasamy & Abar (2015) conducted a study on seeing whether the exchange rates play a significant role in international trade not only in fixing the prices but also in determining the nature of hedging to be arranged to avoid exchange rate risks. They used three countries yearly exchange rates with their macroeconomic variables such as relative interest rates etc to study the impact they had on exchange rates. Interestingly many variables showed the opposite relationships. For instance, interest rate, BOP and inflation rates should influence the exchange rate positively as per theory but the results show the opposite.

Akhter & Faruqui (2015) analysed the currency of Bangladesh with different exchange rate regime, comparing the performance of previous and current exchange rate regime with selected south Asian countries. The results showed that macroeconomic variables significantly influenced the exchange rate.

Monfared & Akın (2017) analysed the relationship between Exchange rate and inflation based on time series data, using Hendry General to Specific Modelling method and Vector Autoregression (VAR) model. As a result of the Hendry model, it was obtained that there is a direct relationship between Exchange rate and inflation. An increase in foreign exchange rates makes the inflation goes up. Ozcelebi (2018), has used the Panel Vector Autoregression (PVAR) model which is used to determine the impacts of exchange rate volatility on industrial production growth rate, consumer price inflation, short-term interest rates and stock returns for 10 OECD countries. The variance decompositions (VDCs) found that exchange rate volatility can be a secondary factor for the variations in immediate interest rates.

Objectives of the study

1. To know the relation between economic variables and volatility of exchange rates of developed vs developing countries.

2. To find the most influential macroeconomic variable in the developed country compared to developing country.

3. To suggest ways to stabilize the exchange rate volatility in developed vs developing economies.

Research Methodology

Sources of data

Exchange rate data retrieved from investing.com and the data of macro-economic variables taken from the world bank data site, to ensure standardization of data and to make the study more accurate. The data is taken yearly of each macro-economic variable and exchange rate of each economies. The yearly data ensures long term volatility and tries to show the long-term impact of macro-economic variables to the exchange rate. The data is taken from January 1 1999 till December 31st 2018.

Statistical Tools used for the study

Stationarity Test

Unit Root Test has been used for checking stationarity in time series data. Unit Root measure the shift in distribution shaped due to variation in series of time. If time series under study has any kind of non- stationarity then the data have unit root. This study test to unit root is carried out with Augmented Dickey-Fuller.

Hypothesis

H0: Data has unit root (Non-Stationary)

H1: Data does not have unit root (Stationary).

Null hypothesis is tested with t-statistics and p-value where p-value <0.05 reject the null hypothesis at 5 per cent significance level. If results will not be determined at level then test will be done at 1st difference.

Correlation Test

The test of correlation is used to measure the degree of interdependence or level of association between the multiple quantitative variables. The result of correlation is shown in a pair wise matrix where each result is described by the correlation coefficient (r). The "r" value ranges from -1 to +1. To interpret the results the significance of value is determined by

checking the value closeness to -1 and +1. Where (-) sign determines negative correlation and (+) sign determines positive correlation. Correlation is also tested with the help of scatter diagram where the scattering in the diagram reflects the relationship between the variables.

Granger Causality Test

The Granger-causality test is a univariate model which is used to find out whether one time series helps in estimating the other. In this study, the Granger causality study is undertaken to assess whether there is any potential predictability power of one macroeconomic variable for the other.

$$\Delta J_t = \alpha_1 + \beta_{11}\Delta J_{t-1} + \beta_{12}\Delta J_{t-2} + \beta_{1n}\Delta J_{t-n} + \gamma_{11}\Delta N_{t-1} + \gamma_{12}\Delta N_{t-2} + \ldots + \gamma_{1n}\Delta N_{t-n} + u_1,$$

Where, ΔJ_t is the first difference at time 't', where the series is non-stationary, 'α' is the constant, 'n' is a positive integer, β_j and y_j are parameters, N and u_t are error terms. The cause and effect relationship is determined by making a pair wise granger cause study on the variables under the study.

Hypothesis:

H0: Variable x does not granger cause Variable y H1: Variable x granger causes variable y

Multiple Regression Test

Regression is a statistical method used in finance, investing, and other disciplines that attempts to determine the strength and character of the relationship between one dependent variable (usually denoted by Y) and a series of other variables (known as independent variables).

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + ... + b_tX_t + u$$

Where:

- Y = the variable that you are trying to predict (dependent variable)

- X = the variable that you are using to predict Y (independent variable).

- a = the intercept.

- b = the slope.

- u = the regression residual.

Regression takes a group of random variables, thought to be predicting Y, and tries to find a

mathematical relationship between them.

Variables and Equations

There is basic equation framed in the study which are followed throughout for running the test and interpreting the results thereof. These equations are:

Table 1.1 Variable used in the analysis.

Types of countries	Country	Exchange Rate	Macroeconomic Variable
Developing Countries	India	USD to INR SGD to INR CNY to INR	Inflation Rate (India)
			Real Interest Rate (India)
			Current Account (India)
			FDI (India)
	Singapore	SGD to INR SGD to CNY SGD to USD	Inflation Rate (Singapore)
			Real Interest Rate(Singapore)
			Current Account(Singapore)
			FDI(Singapore)
Developed Countries	United States	USD to INR USD to SGD USD to CNY	Inflation Rate (Unites states)
			Real Interest Rate(United states)
			Current Account(Unites states)
			FDI(Unites states)
	China	INR to CNY SGD to CNY USD to CNY	Inflation Rate (China)
			Real Interest Rate(China)
			Current Account(China)
			FDI(China)

Here study selected two developing countries such as India, Singapore and Developed country as United States and China respectively. Four macro economic indicators of each country used for the analysis purpose.

Stationarity Test

Unit Root Test (Augmented Dickey-Fuller) has been used to test the stationarity of data in India & Singapore(Developing economies).

Table 1.2 Stationarity of the data used for India, Singapore (Developing Countries)

Augmented Dickey-Fuller (ADF) test – Intercept- INDIA				Augmented Dickey-Fuller (ADF) test – Intercept-Singapore			
Data Series	At Level		At 1st order difference	Data Series	At Level		At 1st order difference
	t- value	Prob.	t-value	Prob.		t value	Prob	t-value	Prob
CNY to INR**	-0.210	0.9217	-4.822	0.0014	SGD to INR**	-0.657	0.8421	-4.399	0.0018
USD to INR**	-0.609	0.8465	-4.602	0.0022	SGD to USD**	-1.550	0.4943	-4.314	0.0022

SGD to INR**	0.176	0.9632	-3.297	0.0305	SGD to CNY*	-4.106	0.0035	-5.439 0.0003
Inflation Rate**	-2.51	0.1313	-3.947	0.0083	Inflation Rate*	-3.270	0.0259	-7.029 0.0000
Real Interest Rate**	-2.264	0.1924	-5.593	0.0003	Real Interest Rate*	-4.785	0.0006	-9.680 0.0000
Current Account**	-1.185	0.6579	3.486	0.0211	Current Account**	-0.0256	0.9480	-6.715 0.0000
FDI**	-1.150	0.6727	-4.578	0.0023	FDI**	1.485	0.9988	-7.624 0.0000

*Indicates that the data is Stationary at only Level
**Indicates that the data is Stationary at only 1st order difference level.
***Indicates that the data is not Stationary at Level and 1st order difference level.

Unit root test was carried in addition to time series graphical representation to forecast real nature of data. Augmented Dickey-Fuller (ADF) is done to confirm the stationarity in time series data. The test is tested at 5 per cent significance level where all data series are non-stationary at level and turn into stationary at first difference. The analysis clearly shows us that the exchange rate between Singapore and China (SGD to CNY) the data is stationary at level, and other macro-economic variables like Inflation Rate and Real Interest Rate is also stationary at level. While all the other data taken for analysis is stationary at 1st order difference level. In a stationary data or time mean, variance and autocorrelation are all constant over time. When the data is non-stationary it can cause high instability in the test such as high t-test ratio, high r-square and so on. So Unit root test has been conducted before the correlation and regression analysis.

Table1.3. Correlation Matrix between macro econonomic variables and Exchane rate of Developing Economies

Correlation between Macro economic variables of India vs Exchange rate				Correlation between Macro economic variables of Singapore Vs Exchange rate			
Macro Economic Variable	USD to INR	CNY to INR	SGD to INR	Macro Economic Variable	SGD to INR	SGD to USD	SGD to CNY
Inflation Rate (in %)	-0.1874	0.0881	0.1165	**Inflation Rate (in %)**	-0.1413	0.4253	0.6943
Real Interest Rate (in %)	0.1575	-0.0309	-0.0824	**Real Interest Rate (in %)**	-0.1537	-0.0999	-0.0767
Current Account	-0.2521	-0.4826	-0.5427	**Current Account**	0.8049	0.8576	0.1893
FDI	0.6030	0.7513	0.7698	**FDI**	0.9188	0.7610	0.0134

If the inflation in India increase, the Indian currency value will depreciate with

respect to CNY and SGD. Current Account is negatively correlated across all the three countries currencies which prove that if the current account surplus increase, then the value of the Indian rupee will appreciate as the CNY, SGD and USD will depreciate.By considering the maco economic vaiables in Singapore, current account is positively correlated for SGD/INR, SGD/USD, SGD/CNY states that value of INR, USD, CNY will appreciate and SGD will depreciate as per the increase in current account surplus in Singapore which is a contradictory phenomena.This states that current account surplus is not the significant factor determining the currency value of Singapore dollar.

Granger Causality Test

Granger causality test is used to determine the pair-wise short run relations in between currency value. The Granger Causality test also provides information whether the past information of volatility is useful to improve the prediction of exchange rate compared to the macro-economic variables. This study relies on the conventional F-statistics for joint exclusion restrictions. This implies that the results show whether the exchange rate and macroeconomic variables have cause and effect relationship within them or not. The observations test the cause and effect relationship between the exchange rate and macroeconomic variables through Granger causality test

Table 1.4. Cause and Effect Relationship between macroeconomic variables and exchange rate of INDIA & SIGAPORE

Granger Causality Tests (INDIA)					Granger Causality Tests (Singapore)				
CNY to INR	CURRENT ACCOUNT	8.581	0.009	Rejected	SGD To INR	CURRENT ACCOUNT	1.719	0.208	Not Rejected
	FDI	3.089	0.097	Not Rejected		FDI	0.060	0.808	Not Rejected
	INFLATION RATE	3.681	0.073	Not Rejected		INFLATION RATE	18.66	0.000	Rejected
	REAL INTERST	2.090	0.167	Not Rejected		REAL INTERST	1.329	0.265	Not Rejected
SGD to INR	CURRENT ACCOUNT	19.72	0.000	Rejected	SGD To USD	CURRENT ACCOUNT	11.10	0.004	Rejected
	FOREIGN DIRECT INVESTMENT	1.730	0.206	Not Rejected		FDI	2.446	0.137	Not Rejected
	INFLATION RATE	12.89	0.002	Rejected		INFLATION RATE	0.001	0.965	Not Rejected
	REAL INTERST	9.678	0.006	Rejected		REAL INTERST	3.927	0.065	Not Rejected
	CURRENT	3.283	0.088	Not		CURRENT	0.752	0.392	Not

USD to INR	ACCOUNT			Rejected	SGD To CNY	ACCOUNT			Rejected
	FOREIGN DIRECT INVESTMENT	2.748	0.116	Not Rejected		FDI	0.073	0.782	Not Rejected
	INFLATION RATE	2.519	0.132	Not Rejected		INFLATION RATE	0.748	0.392	Not Rejected
	REAL INTERST	0.186	0.671	Not Rejected		REAL INTERST	2.956	0.104	Not Rejected

The test results in India highlight that null hypothesis is not rejected in most of the cases. Causation effect has been seen for CNY to INR with the current account in India. In the case of SGD to INR, Current Account, Inflation Rate and Real Interest Rate also shows the cause and effect relation in India. Hence it is inferred that the current account in India can be used to forecast the exchange rate of CNY/INR, SGD/INR. The test results in Sigapore highlight that null hypothesis is not rejected in most of the cases. Usually the cause and effect relationship are rejected in all cases except the cause and effect of current account to the USD/SGD and the inflation rate to the INR/SGD in Singapore. So current Account is not a strong variable that determining the value of Singapore Dollar.

Multiple Regression

Multiple regression allows you to determine the overall fit (variance explained) of the model and the relative contribution of each of the predictors to the total variance explained.

Table 1.5. Multiple regression analysis of Macro economic Indicators with exchange Rate in India

Currency Exchange	R-Square	Significance F	Significance
CNY to INR	0.720033351	0.000456556	Significant
Particulars	Coefficients	P-Value	Significance
Inflation Rate (in %)	-0.143377	0.333764	Not Significant
Real Interest Rate (in %)	0.272305	0.094278	Not Significant
Current Account	-0.000031	0.057003	Not Significant
Foreign Direct Investment (FDI)	0.000088	0.000716	Significant
. SGD to INR	0.7535243	0.0001825	Significant
Particulars	Coefficients	P-Value	Significance
Inflation Rate (in %)	-0.7819123	0.2400493	Not Significant
Real Interest Rate (in %)	1.1667690	0.1061426	Not Significant
Current Account	-0.0000017	0.0228218	Significant
Foreign Direct Investment (FDI)	0.0000004	0.0005411	Significant
Currency Exchange			
USD to INR	0.643404	0.0025507	Significant
Particulars	Coefficients	P-Value	Significance
Inflation Rate (in %)	-1.4407698	0.0675657	Not Significant
Real Interest Rate (in %)	1.0082033	0.2137810	Not Significant
Current Account	0.0000008	0.2058921	Not Significant
Foreign Direct Investment (FDI)	0.643404	0.0025507	Significant

The above multiple regression clearly states for each currency evaluation that the H1 is accepted whereas the p-value is lower than 0.05. And then moving on the most influential variables that are significant and have a probability less than 0.05 are foreign Direct Investment for each pair of currency. So this clearly states that there is relationship between foreign Direct Investment and currency exchange rate of India & the second most important variable showing the relationship would be current account surplus/deficit in India. This clearly states that FDI Inflows from countries are the major determinant of the Indian currency value. Along with that Merchandise exports, Service exports from India are the major components in the current account determing the value of Indian currency in the market with respect to other currencies.

Table 1.6. Multiple regression analysis of Macro economic Indicators with exchange Rate in Singapore

1. SGD to INR	0.868521	0.000001850501	Significant
Particulars	**Coefficients**	**P-Value**	**Significance**
Inflation Rate (in %)	-0.454550	0.429513	Not Significant
Real Interest Rate (in %)	0.569653	0.153582	Not Significant
Current Account	0.000044	0.747233	Not Significant
Foreign Direct Investment (FDI)	0.000307	0.003156	Significant
Currency Exchange	**R-Square**	**Significance F**	**Significance**
2. SGD to USD	0.859536	0.000003	Significant
Particulars	**Coefficients**	**P-Value**	**Significance**
Inflation Rate (in %)	0.016096	0.007915	Significant
Real Interest Rate (in %)	0.005508	0.142549	Not Significant
Current Account	0.000002	0.114985	Not Significant
Foreign Direct Investment (FDI)	0.000001	0.110026	Not Significant
Currency Exchange	**R-Square**	**Significance F**	**Significance**
3. SGD to CNY	0.498105	0.026914	Significant
Particulars	**Coefficients**	**P-Value**	**Significance**
Inflation Rate (in %)	0.070171	0.005967	Significant
Real Interest Rate (in %)	-0.008512	0.574908	Not Significant
Current Account	-0.000009	0.865286	Not Significant
Foreign Direct Investment (FDI)	0.000008	0.816562	Not Significant

The most influential variables that are significant and have a probability less than 0.05 are Inflation rate for SGD/USD, SGD/CNY of each pair of currency. So this clearly states that there is relationship between inflation rate and currency exchange rate of Singapore. While the FDI aslo proves to be other variable that shows the positive significance for SGD/INR value.

Standard Deviation

Standard deviation is a statistical term that measures the amount of variability or dispersion around an average. Standard deviation is also a measure of volatility. Basically, these used to see how much each currency has changed over the years, and to figure out the volatility, the standard deviation is used.

Table 1.7. Volatility Measurement of developing country currency

Particulars	Standard Deviation
India	19.584399
Singapore	16.176189

India shows a volatility of 19.58 which is considered very high, more over the Indian rupee has depreciated over the years with a volatility of 19.58. While the other country Singapore has shown a volatility of 16.17 which means that the Singapore Dollar has appreciated by 16.17 compared to other countries. So, the volatility of Singapore has been seen in an appreciating manner and the Indian rupee is seen in a depreciating manner

Analysis of Developed Countries

Stationary Test

Unit root rest is run to check the presence of stationarity in data sets selected for the analysis purpose.

Table 2.1. Stationarity of the data used for USA, CHINA (Developed Countries)

Augmented Dickey-Fuller (ADF) test – Intercept- USA					Augmented Dickey-Fuller (ADF) test – Intercept - China				
Data Series	At Level		At 1st order difference		Data Series	At Level		At 1st order difference	
	t value	Prob.	t-value	Prob.		t value	Prob	t value	Prob
USD to INR**	-1.4682	0.5351	-5.5319	0.0001	INR to CNY**	-1.2582	0.6349	-5.9133	0.0000
USD to CNY**	-2.8185	0.0681	-4.6491	0.0009	USD to CNY**	-2.8185	0.0681	-4.6491	0.0009
USD to SGD**	-1.8420	0.3537	-4.4527	0.0015	SGD to CNY*	-4.1067	0.0035	-5.4394	0.0003
Inflation Rate*	-3.4310	0.0179	-5.7604	0.0001	Inflation Rate**	-1.8522	0.3483	-3.9520	0.0057
Real Interest Rate**	-2.1858	0.2154	-3.5243	0.0147	Real Interest Rate**	-2.8615	0.0623	-4.5522	0.0013
Current Account**	-1.2540	0.6368	-4.3304	0.0021	Current Account**	-1.6398	0.4501	-4.6894	0.0008
USD to INR**	-1.4682	0.5351	-5.5319	0.0001	FDI**	-1.0095	0.7363	-5.3030	0.0002

*Indicates that the data is Stationary at only Level
**Indicates that the data is Stationary at only 1st order difference level.
***Indicates that the data is not Stationary at Level and 1st order difference level.

Unit root test carried in addition to time series graphical representation to forecast real nature of data. Augmented Dickey-Fuller (ADF) was done to confirm the stationarity in time series data. The test is tested at 5 per cent significance level where all data series are non-stationary at level except the Interest Rate, and rest of the time series turn into stationary at first difference. Since the above data sets are stationary which will reject the null hypothesis. This ensures that the data taken for analysis is stationary and the data that has been chosen for China including the macro-economic variables and exchange rate has shown stationary in the data.All the variable has shown stationary data at the 1st level order difference, and the exchange rate of SGD to CNY has also shown significance at the Level.

Correlation

Correlation is the study to inspect the co-movement between the exchange rate of India in respect to the macro-economic variables through correlation coefficient, which ranges from -1 to +1 and determines the relationship between the two variables. The exchange rate is compared to each variable and each currency to know which is the most influential variable among the economic variables.

Table 2.2. Correlation Matrix between macro econonomic variables and Exchane rate of Developed Economies

Correlation between Macro economic variables and exchange rate of USA				Correlation between Macro economic variables and exchange rate of China			
Macro Economic Variable	USD to INR	USD to CNY	USD to SGD	Macro Economic Variable	INR to CNY	USD to CNY	SGD to CNY
Inflation Rate (in %)	-0.5185	0.4879	0.2500	**Inflation Rate (in %)**	-0.0539	-0.2953	0.6735
Real Interest Rate (in %)	-0.4495	0.6531	0.6031	**Real Interest Rate (in %)**	-0.1201	0.0208	-0.5677
Current Account	0.3865	-0.3892	-0.2306	**Current Account**	-0.2487	-0.4650	0.2051
FDI	0.4411	-0.4324	-0.4458	**FDI**	-0.7298	-0.9144	0.2609

If the inflation in United States increase, the USD will appreciate with respect to CNY and SGD. Then the inflation rate also shows the positive correlation which is very unusual and completely opposite to the purchasing power parity. The negative correlation of inflation in China shows the influence of inflation in the exchange rate volatility of China Likewise, if the interest rate in USA increases, USD will appreciate with respect to CNY and GSD. Current Account is negatively correlated across two countries currencies (CNY, GSD) which prove that if the current account surplus increase, then the value of the USD will appreciate as the

CNY, SGD and USD will depreciate. By considering the FDI in USA, current account is negatively correlated for USD/CNY, USD/SGD, states that value of USD will appreciate with respect to CNY, SGD. Both the principles of purchasing power parity and international Fischer were seen in China. The negative correlation of FDI and Current Account also proves that if the current account or FDI. increases of China then the exchange rate among these countries will decrease, which will result in an appreciation of Chinese Yuan.

Granger Causality Test

Granger causality test is used here to determine the pair-wise short run relations in between Macro economic factors in the market. The Granger Causality test also provides information whether the past information of volatility is useful to improve the prediction of exchange rate compared to the macro-economic variables. This study relies on the conventional F-statistics for joint exclusion restrictions. This implies that the results show whether the exchange rate and macroeconomic variables have cause and effect relationship within them or not.

Table 2.3. Cause and Effect Relationship between macroeconomic variables and exchange rate of USA & CHINA

Granger Causality Tests (USA)					Granger Causality Tests (CHINA)				
USD to INR	CURRENT ACCOUNT	0.916	0.352	Not Rejected	INR TO CNY	CURRENT ACCOUNT	2.401	0.140	Not Rejected
	FDI	2.930	0.106	Not Rejected		FDI	7.623	0.013	Rejected
	INFLATION RATE	0.035	0.853	Not Rejected		INFLATION RATE	4.431	0.051	Not Rejected
	REAL INTERST	0.668	0.425	Not Rejected		REAL INTERST	1.791	0.199	Not Rejected
USD to CNY	CURRENT ACCOUNT	4.578	0.048	Rejected	USD to CNY	CURRENT ACCOUNT	4.107	0.059	Not Rejected
	FDI	0.038	0.847	Not Rejected		FDI	5.616	0.030	Rejected
	INFLATION RATE	06.19	0.024	Rejected		INFLATION RATE	6.456	0.021	Rejected
	REAL INTERST	0.018	0.892	Not Rejected		REAL INTERST	9.849	0.006	Rejected
USD to S	CURRENT ACCOUNT	0.942	0.346	Not Rejected	SGD to CNY	CURRENT ACCOUNT	0.077	0.784	Not Rejected
	FOREIGN DIRECT INVESTMENT	0.520	0.481	Not Rejected		FDI	0.013	0.909	Not Rejected

G D	INFLATION RATE	0.916	0.352	Not Rejected		INFLATION RATE	0.001	0.972	Not Rejected
	REAL INTERST	2.930	0.1063	Not Rejected		REAL INTERST	0.601	0.449	Not Rejected

The above observations test the cause and effect relationship between the exchange rate and macroeconomic variables through Granger causality test. The test results highlight that null hypothesis is not rejected in most of the cases. Where the macro-economic variables show a cause and effect relationship with exchange rates are:. The cause and effect of macro-economic variables such as Foreign Direct Investment, Inflation rate and Real Interest to the exchange rate is clearly seen in USA.

Multiple Regression

Multiple regression is an extension of simple linear regression. It is used when we want to predict the value of a variable based on the value of two or more other variables. The variable we want to predict is called the dependent. The variables we are using to predict the value of the dependent variable are called the independent variables. Multiple regression also allows you to determine the overall fit (variance explained) of the model and the relative contribution of each of the predictors to the total variance explained.

Table 2.4. Multiple regression analysis of Macro economic Indicators with exchange Rate in United States

Currency Exchange	R-Square	Significance F	Significance
1. USD to INR	0.549575	0.012930	Significant
Particulars	**Coefficients**	**P-Value**	**Significance**
Inflation Rate (in %)	-1.676289	0.401113	Not Significant
Real Interest Rate (in %)	-2.089647	0.054931	Not Significant
Current Account	0.0000001	0.389055	Not Significant
Foreign Direct Investment (FDI)	0.0000003	0.026059	Significant
Currency Exchange	**R-Square**	**Significance F**	**Significance**
2. USD to CNY	0.750976	0.000197	Significant
Particulars	**Coefficients**	**P-Value**	**Significance**
Inflation Rate (in %)	0.022699	0.876018	Not Significant
Real Interest Rate (in %)	0.344578	0.000311	Significant
Current Account	-0.000001	0.122230	Not Significant
Foreign Direct Investment (FDI)	-0.000003	0.002682	Significant
Currency Exchange	**R-Square**	**Significance F**	**Significance**
3. USD to SGD	0.663175	0.001705	Significant
Particulars	**Coefficients**	**P-Value**	**Significance**
Inflation Rate (in %)	-0.039708	0.285227	Not Significant

Real Interest Rate (in %)	0.079898	0.000621	Significant
Current Account	-0.000003	0.218205	Not Significant
Foreign Direct Investment (FDI)	-0.000009	0.003625	Significant

The model shows us a significant approach towards each currency used, where the significance level is less than .05 for each currency. It shows that the most influential variable that influence the exchange rate is the foreign direct investment and the real interest rate. Real interest rate in USA has shown a positive correlation across Singapore Dollar and also to the Chinese Yuan. This proves the international Fischer effect is relevant and valid in United States. The below regression model of China shows us that all the data used is significant and also inflation rate is showing positive coefficient across all the exchange rates. This validate purchasing power parity principle in China. Foreign Direct Investment is also seen to be significant across all the levels.

Table 2.5. Multiple regression analysis of Macro economic Indicators with Exchange Rate in China

Currency Exchange	R-Square	Significance F	Significance
1. INR to CYN	0.696571	0.000812	Significant
Particulars	**Coefficients**	**P-Value**	**Significance**
Inflation Rate (in %)	0.013010	0.401113	Not Significant
Real Interest Rate (in %)	0.003420	0.054931	Not Significant
Current Account	0.000000	0.389055	Not Significant
Foreign Direct Investment (FDI)	-0.000004	0.026059	Significant
Currency Exchange	R-Square	Significance F	Significance
2. USD to CNY	0.886822	0.000001	Significant
Particulars	**Coefficients**	**P-Value**	**Significance**
Inflation Rate (in %)	0.125251	0.256323	Not Significant
Real Interest Rate (in %)	-0.000798	0.990807	Not Significant
Current Account	-0.000004	0.590269	Not Significant
Foreign Direct Investment (FDI)	0.000000	0.000001	Significant
3. SGD to CNY	0.504932	0.024550	Significant
Particulars	**Coefficients**	**P-Value**	**Significance**
Inflation Rate (in %)	0.103934	0.043654	Significant
Real Interest Rate (in %)	0.018703	0.545865	Not Significant
Current Account	-0.000004	0.354319	Not Significant
Foreign Direct Investment (FDI)	-0.000003	0.618853	Not Significant

Standard Deviation

Standard deviation is a statistical term that measures the amount of variability or dispersion around an average. Standard deviation is also a measure of volatility. Basically, these used to

see how much each currency has changed over the years, and to figure out the volatility, the standard deviation is used.

Table 2.6. Volatility Measurement of developed country currency

Particulars	Standard Deviation
US	22.493101
China	3.0327339

The volatility of the US and China is measured through standard deviation. The US Dollar has appreciated over the years with a volatility in the data of 22.49 while the Chinese Yuan has been stable with just a volatility of 3.03, which is due to the exchange rate regime followed by China.

It was Inferred that the most influential macroeconomic variable to the Indian exchange rate was Inflation and foreign direct investment, and current account which was also proved significant in the regression and Granger Analysis. Purchasing power parity theory proved in India which shows that if inflation increases then Indian rupee will depreciate its value and vice- versa. It proves that the 1st most influential variable to the exchange rate of Indian Rupee is the inflation rate.Foreign Direct investment showed positive correlation in Granger and Regression tests indicates that the increase in FDI will create demand of the Indian Rupee and the value of Indian rupee will appreciate .Singapore Dollar showed a volatility of 16.17, where over the years it has successfully appreciated. China has perfectly managed the exchange rate with just volatility of 3.03 over the last 20 years. They have successfully managed to keep the exchange rate low, so the exports could be cheaper which creates demand for chinese yuan. Real Interest rate is again a very important variable which has shown cause and effect relationship even in the granger test which means that the INR-CNY will definitely increase if the real interest rate decreases and vice-versa.

The most impactful macroeconomic variable to the Singapore exchange rate was Inflation, foreign direct investment, and current account which was also proved significant in the regression and Granger Analysis. Inflation was a surprising variable which was seen having a cause and effect with the Singapore Dollar. Mostly as inflation increases every year and the Singapore dollar has also appreciated over the years it is stating a cause and effect relationship.Current Account is positively correlated with Singapore Dollar which means if the balance of Current Account increases in Singapore, then the Singapore dollar will appreciate and vice-versa.

The United States exchange rate has appreciated tremendously over the years, and has also maintained consistency in the appreciation. Over the years the US Dollar has a volatility of 22.49, which is extremely high, but as the currency has appreciated most of the times, it is considered to be really good.The most influential variable in the United States is Real Interest Rate, which also proves the Fischer Effect true. The interest rate is considered a major variable which shows significance in the regression analysis. The second most influential variable in United States would be inflation which also shows cause and effect relationship in the granger test This proves the Purchasing power parity theory in USA. United States opts for the floating exchange rate regime, while India, China and Singapore opt for Fixed Exchange Rate Regime.The Chinese economy has wonderfully managed the exchange rate, by keeping it low and also ensuring less volatility, to increase the inflow of foreign direct investment and also to increase the trade balances over the years. The Chines economy was completely correlated with the exchange rate principles. The granger causality test also shows us the cause and effect relationship of various exchange rates and macro-economic variables which can be used by investors to hedge the risk of financial markets.

Conclusion

This paper focused on the impact of macro-economic variables and its impact on developing and developed countries currency value. This study used statistical tools for analysis were: Unit Root Test, Correlation, Granger Causality Test, Multi-Regression and Standard Deviation to know the relation between macro economic indicators and exchange rate. Standard deviation clearly showed the volatility of the exchange rates very high in developing countries as compared to developed countries. China had successfully managed to manage the exchange rate with a volatility of just 3.03 over last 20 years. Most influential variable in Indis determining the Rupee value was Current Account Balance which was followed by foreign direct investment. The developing countries focus much more on bringing FDI into the country and also focus on other factors to ensure the economic growth of the country. In India inflation had also shown substantial significance in the volatility in exchange rate. The Singapore government is continuously managing the Singapore Dollar to ensure stability and appreciation. The Singapore monetary authority has also allowed the interest rate to flow freely which is again a main reason for reduced inflation, and increased interest rate which results in the appreciation of Singapore Dollar over the years. In developed countries like China and United States the interest rate is seen as a major variable and also the International Fischer effect is also visible in both of these countries. Moreover, there is

dynamic linkage and co-movement within the exchange rate of economies to a certain extent even when the macro- economic variables are integrated together. Hence, the macro economic variables of countries were successful in explaining the volatility movements in the exchange rate at some level of significance.

References

1.   Akhter, F., & Faruqui, N. (2015). Effects of Macroeconomic Variables on Exchange Rates in Bangladesh. *International Journal of Scientific & Engineering Research*, 8.

2.   Akinlo, A. E. (2003). EXCHANGE RATE DEPRECIATION AND CURRENCY SUBSTITUTION IN NIGERIA . *African Review of Money Finance and Banking*, 6.

3.   Allsopp, C., Kara, A., & Nelson, E. (2006). United Kingdom Inflation Targeting and the Exchange Rate. *The Economic Journal*, 14.

4.   Bergin, P., & Sheffrin, S. (2000). Interest Rates, Exchange Rates and Present Value Models of the Current Account. *The Economic Journal*, 25.

5.   Bergvall, A. (2005). Exchange Rate Regimes and Macroeconomic Stability: The Case of Sweden. *Oxford University Press*, 26.

6.   Bhanumurthy, N. R. (2006). Macroeconomic Fundamentals and Exchange Rate Dynamics in India: Some Survey Results. *Economic and Political Weekly*, 8.

7.   Broll, U., & Eckwert, B. (1999). Exchange Rate Volatility and International Trade. *Southern Economic Journal*, 9.Campa, J. M., & Goldberg, L. (2005). Exchange Rate Pass-through into Import Prices. *The Review of Economics and Statistics,*, 13.

8.   CHAPPELOW, J. (2019, October 1). *Investopedia*. Retrieved from https://www.investopedia.com/terms/d/dollarization.asp

9.   *Economics Online*. (2017, July 3). Retrieved from https://www.economicsonline.co.uk/Global_economics/Foreign_Direct_Investment.html

10.   Fast, P. (2015, Feb 5). *Inflation Calculator*. Retrieved from https://inflationcalculator.ca/how-does-inflation-affect-exchange-rates/

11.   GANTI, A. (2019, May 19). *Investopedia*. Retrieved from https://www.investopedia.com/terms/c/currencybasket.asp

12.   Gosh, A., & Ostry, J. (2009, December 26). *International Monetary Fund.* Retrieved from https://www.imf.org/external/pubs/ft/fandd/2009/12/ghosh.htm

13.   Hossain, M. (2010). Do Currency Regime and Developmental Stage Matter for Real Exchange Rate Volatility? A Cross-Country Analysis. *The Bangladesh Development*

Studies,, 23. Iyer, S. (2018, October 16). Instarem. Retrieved from https://www.instarem.com/blog/what-is-the-relationship-between-interest-   rates-exchange-rates/

14. Jaratin Lily, Mori, K., Sang, L. T., & Asid, R. (2014). Exchange Rate Movement and Foreign Direct Investment in Asean Economies. Hindawi Publishing Corporation Economics Research International, 11.

15. K.K.Ghai. (2016, March 19). Your Article Library. Retrieved from http://www.yourarticlelibrary.com/essay/foreign-trade-essay/exchange-rate- system-in-india-objectives-and-reforms/40406

16. Kandil, M. (2008). Exchange Rate Fluctuations and the Macro-Economy: Channels of Interaction in Developing and Developed Countries. Eastern Economic Journa, 24.

17. Kandil, M. (2009). Exchange Rate Fluctuations and the Balance of Payments: Channels of Interaction in Developing and Developed Countries. Journal of Economic Integration, 25.

18. Krugman, P. R. (1991). Target Zones and Exchange Rate Dynamics. The Quarterly Journal of Economics, 16.

19. MAJASKI, C. (2019, April 14). Investopedia. Retrieved from https://www.investopedia.com/terms/f/fixedexchangerate.asp

20. Mirchandani, A. (2013). Analysis of Macroeconomic Determinants of Exchange Rate Volatility in India. International Journal of Economics and Financial Issues, 8.

21. MITCHELL, C. (2019, June 25). Investopedia. Retrieved from https://www.investopedia.com/ask/answers/022415/how-does-inflation-affect-exchange-rate-between-two-nations.asp

22. Monfared, S. S., & Akın, F. (2017). The Relationship Between Exchage Rates and Inflation: The Case of Iran. European Journal of Sustainable Development ,

23. Pettinger, T. (2017, November 24). Economics Help. Retrieved from https://www.economicshelp.org/blog/2089/economics/exchange-rate-and-   current-account/

24. Pettinger, T. (2019, June 17). Economics Help. Retrieved from https://www.economicshelp.org/blog/1605/economics/higher-inflation-and- exchange-rates/

25. Policonomics. (2019, December 3). Retrieved from https://policonomics.com/lp-exchange-rate-regimes-exchange-rate-regime/

26. Ramasamy , R., & Abar , S. K. (2015). Influence of Macroeconomic Variables on Exchange Rates. Journal of Economics, Business and Management, 6.

27. Su, C.-W. (2012). The relationship between exchange rate and macroeconomic variables in China. SSRN, 24.

28. Venkatesan, T., & M. S. Ponnamma. (2018). An Analysis of Macroeconomic Factors Affecting Foreign Exchange Rate. SD Mind, Journal of mangement, 10.

29. Williams, B. (2019, November 23). Central Charts. Retrieved from https://www.centralcharts.com/en/gm/1-learn/9-economics/34-fundamental-analysis/605-the-impact-of-inflation-on-exchange-rates

30. Worstall, T. (2016, November 2). American Express. Retrieved from https://www.americanexpress.com/us/foreign-exchange/articles/inflation-and- foreign-exchange-rates/

31. Wu, Y. (1997). The Trend Behavior of Real Exchange Rates: Evidence from OECD Countries. Springer, 16.

32. Zakaria, M., & Ahmad, E. (2009). Productivity Shocks and Nominal Exchange Rate Variability: a Case Study of Pakistan. Journal of Economic Integration, 16.