The correlation between inflation and exchange rate in India

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Abstract
The economic variables are integrated with each other like a complex mesh affecting one another with an unknown complex algorithm. It is a very tedious process and requires large skills and experience to establish the relationships among the plethora of economic variables in order to interpret the picture of the economy comprehensively. All the economic variables interact jointly to form the basis of understanding the economic algorithm. In contemporary ages, there has been a special interest in the inter-relationship between the exchange rates and inflation in both the advanced as well as the developing countries. These variables play a vital role in predicting the quantum of the development in the nominal and real sides of the economy, including the behaviour of domestic inflation, real output, exports and imports. The primary objective of this study is to establish the strength of correlation between the exchange rates and inflation in India over a period of time.

Keywords: exchange rates, inflation, correlation, India

Introduction
The exchange rate regime plays a vital role in economic development of the country. Exchange rate represents the monetary competitiveness of a country at a global platform. Exchange rate of a country affects the exports and imports of that country directly. In case of currency appreciation, exports are negatively affected and in case of currency depreciation, imports become expensive. These changes in exchange rates impacts the inflation target of the central banks. There exist a very strong association between the exchange rate regime and the economic growth. Although, it is very difficult to establish the correlation between the exchange rate and inflation with respect to overall economic growth yet the exchange rate is correlated to growth and inflation directly as well as indirectly. The major impact on exchange rate is due the change in inflation yet there many other economic variables that affect the exchange rates.

Literature Survey
According ito I Mishkin, (2008) [28], the exchange rate of the currency in which a portfolio holds the bulk of its investments determines that portfolio's real return. A declining exchange rate obviously decreases the purchasing power of income and capital gains derived from any returns. Moreover, the exchange rate influences other income factors such as interest rates, inflation and even capital gains from domestic securities. While exchange rates are determined by numerous complex factors that often leave even the most experienced economists flummoxed, investors should still have some understanding of how currency values and exchange rates play an important role in the rate of return on their investments. Exchange rates are prices that are determined by supply and demand. For some countries the exchange rate is the single most important price in the economy because it determines the international balance of payments. (Levich, 2001) [23] There is no general theory of exchange rate determination, but Eiteman *et al* (2001) [13] divide the potential exchange rate determinants into five areas: parity conditions, infrastructure, speculation, cross-border foreign direct investment and portfolio investment, and political risks.

There are strong arguments to substantiate the theory that inflation may/can/does affect exchange rates. However, in reality there may be no direct relationship between the two. We know that exchange rates continually fluctuate, but the cost to the consumer is more stable, the supply chain and currency hedging absorbing much of the variations.

A study by Pattnaik and Mitra (2001) [36] indicates that interest rates, inflation rates and exchange rates are all highly correlated. The real exchange rate is the actual exchange rate adjusted for inflationary effects in the two countries of concern. Another study by Ndung'u (1997) [32] states that interest rate differential will widen with real exchange rate appreciation, and this will trigger capital inflows. A thesis by Kiptoo (2007) [22] found that the real exchange rate (rer) is obtained by adjusting the nominal exchange rate (ner) with inflation differential between the domestic economy, and foreign trading partner economies. A study by Sifunjo, (2011) [39] further found that the derivation of the rer therefore, requires that the data of the ner, domestic inflation and foreign inflation be obtained. Domestic inflation will rise with exchange rate depreciation, and the influence of foreign inflation will decrease with exchange rate appreciation. Nevertheless, no study has been carried to satisfactorily indicate how such in relation can affect the exchange rates either positively or negatively. This study therefore sought to cover the interrelation between inflation and exchange rate. The study sought to get such information by exploring the question; what is the relationship between inflation rate and the exchange rates in India?

Research Methodology
The factors like research design, sampling design, target

populations, data collection instrument and data analysis technique are crucial for empirical studies. The descriptive research design was used in this study. The descriptive research design is suitable for the need to describe the interrelationship and impact of inflation on exchange rates in India. Its purpose was to portray the state of affairs as it is. A research design helps researchers to lay out the research questions, methodologies, implementation procedures, and data collection and analysis for the conduct of a research work. Generally, there are three types of research design: quantitative design, qualitative design, and mixed methods design Mugenda and Mugenda (2003). In this study, the researcher used the quantitative research design which includes the descriptive research design. The study described the impact of inflation associated with exchange rates in India.

The study basically used the World Bank, International Monetary Fund and the Reserve Bank of India as sources of information in the pursuit to establish the effects of inflation on exchange rates in India. Data used was in the form of secondary data and in particular, the following data was used: Monthly data from 1992 to 2017 and Annual data from 1952 to 2017. The secondary data was collected from the World Bank, International Monetary Fund, the Reserve Bank of India and few other online sources. The data collected helped answer the research problem. Data was analysed using quantitative method like linear regression model and R-programming to get the correlation between inflation and exchange rates.

The formula given below was used to calculate the linear regression.

Y= a + bX + E
Y= Dependent Variable
X= Independent Variable
a= Intercept
b= Slope
E= Error Term

$$b = \frac{n \sum xy - (\sum x)(\sum y)}{n(\sum x^2) - (\sum x)^2}$$

$$a = \frac{\sum y - b \sum x}{n}$$

In this study inflation is independent variable whereas exchange rate is dependent variable.

Spearman's Correlation Coefficient
R= [NΣxy - (Σx) (Σy)]/ {[NΣx² – (Σx)²] [NΣy² –(Σy)²]}^{1/2}
N= Number of pair of scores
Σxy= sum of the products of paired score
Σx= sum of x scores
Σy= sum of y scores
Σx²= sum of squared x scores
Σy²= sum of squared y scores

Data Analysis
For the purpose of this study, monthly data was collected for twenty-six years

(1992-2017) and annual data was collected for fifty-seven years (1960-2016) from World Bank, International Monetary Fund and Reserve Bank of India and few other online sources to establish the effects of inflation on exchange rates in India. The data used was of two types

1. Annualized: INR/USD Annualized Average Exchange Rates (Forex), and Annual Average Economic Inflation Rates (in %) to determine the effects of inflation rate on exchange rates in India
2. Monthly: INR/USD Monthly Average Exchange Rates (Forex), and Monthly Average Economic Inflation Rates (in %) to determine the effects of inflation on exchange rates in India

▪ **Regression Analysis**
The intention is to establish the relationship between the INR and USD exchange rates (Forex) and inflation rates. Secondary data was used for regression analysis. Regression analysis was done using Microsoft Excel.

Analysis of Monthly Data

Table 1: Regression Statistics for Monthly Data (1992-2017)

Slope	-0.71564
Intercept	46.6224
Correlation	-0.05525

Regression Equation for monthly data will be as follows:
Y= 46.6224 + (-0.71546) X

Table 2: Summary Statistics for Monthly Data

Variable	Observations	Minimum	Maximum	Mean	Std. deviation
Exchange Rate (RBI)	310	29.455	68.238	46.208	10.325
Inflation	310	-2.100	3.230	0.580	0.797

Table 3: Goodness of fit statistics (Exchange Rate (RBI)) for Monthly Data

Observations	310.000
Sum of weights	310.000
DF	308.000
R²	0.003
Adjusted R²	0.000
MSE	106.633
RMSE	10.326
MAPE	17.736
DW	0.010

Table 4: Analysis of variance (Exchange Rate (RBI)) for Monthly Data

Source	DF	Sum of squares	Mean squares	F	Pr > F
Model	1	100.603	100.603	0.943	0.332
Error	308	32843.057	106.633		
Corrected Total	309	32943.660			

Computed against model Y=Mean(Y)

**Table 5:** Model parameters (Exchange Rate (RBI)) for Monthly Data

Source	Value	Standard error	t	Pr > |t|	Lower bound (95%)	Upper bound (95%)
Intercept	46.622	0.725	64.267	**< 0.0001**	45.195	48.050
Inflation	-0.716	0.737	-0.971	0.332	-2.165	0.734

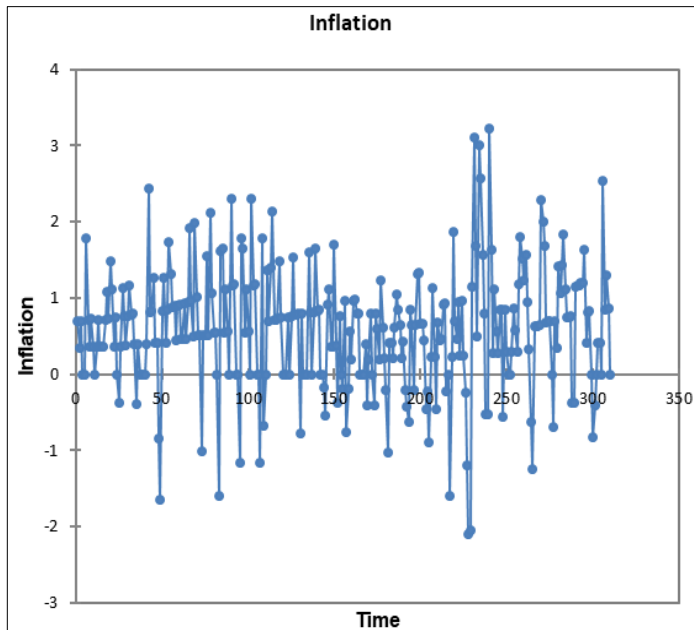**Table 6:** Standardized coefficients (Exchange Rate (RBI)) for Monthly Data

Source	Value	Standard error	t	Pr > |t|	Lower bound (95%)	Upper bound (95%)
Inflation	-0.055	0.057	-0.971	0.332	-0.167	0.057

Table 7: Correlation matrix (Pearson) for Monthly Data

Variables	Inflation	Exchange Rate (RBI)
Inflation	1	-0.055
Exchange Rate (RBI)	-0.055	1
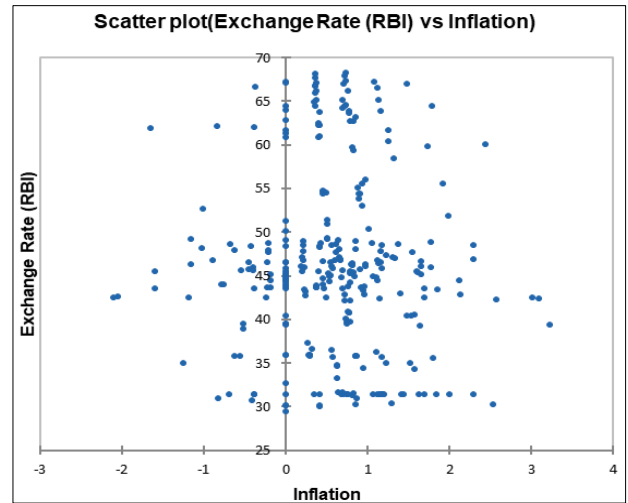
Fig 1: Scatter plot for Monthly Data

Fig 2: Time series (Inflation) for Monthly Data
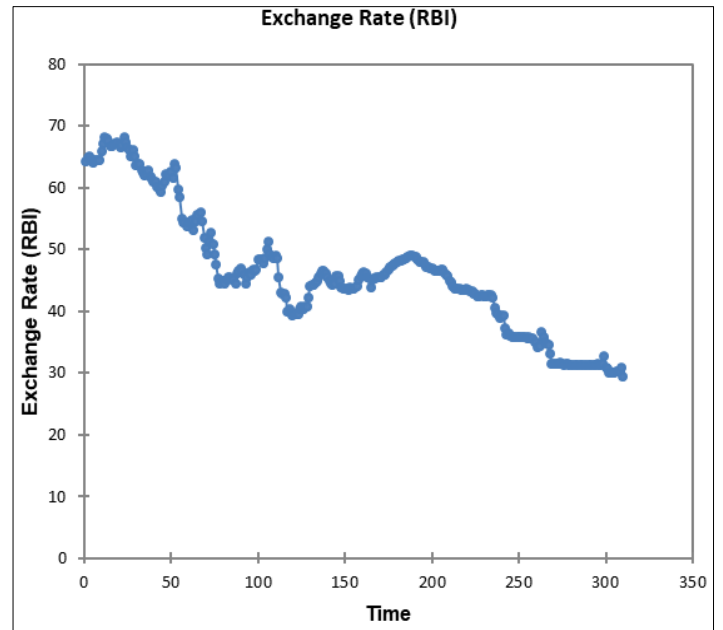
Fig 3: Time series (Exchange Rate (RBI)) for Monthly Data

Analysis of Annual Data

Table 8: Regression Statistics for Annual Data (1960-2016)

Slope	**-0.17312**
Intercept	26.2686
Correlation	-0.04491

Regression Equation for annual data will be as follows:
Y= 26.2686 + (-0.17312) X

Table 9: Summary Statistics for Annual Data

Variable	Observations	Minimum	Maximum	Mean	Std. deviation
Exchange Rate	57	4.762	67.195	24.955	19.448
Inflation	57	-7.634	28.602	7.591	5.045

Table 10: Goodness of fit statistics (Exchange Rate) for Annual Data

Observations	**57.000**
Sum of weights	57.000
DF	55.000
R²	0.002
Adjusted R²	-0.016
Mean Squared Error (MSE)	384.319
Root Mean Squared Error (RMSE)	19.604
Mean Absolute Percentage Error (MAPE)	140.519
Durbin Watson (DW)	0.016

Table 11: Analysis of variance (Exchange Rate) for Annual Data

Source	DF	Sum of squares	Mean squares	F	Pr > F
Model	1	42.720	42.720	0.111	0.740
Error	55	21137.531	384.319		
Corrected Total	56	21180.251			

Computed against model Y=Mean(Y)

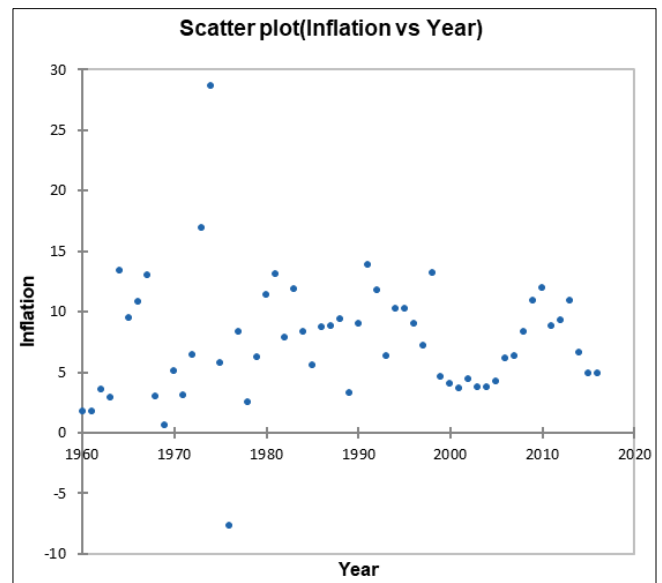**Table 12:** Model parameters (Exchange Rate) for Annual Data

Source	Value	Standard error	t	Pr > |t|	Lower bound (95%)	Upper bound (95%)
Intercept	26.269	4.720	5.565	< 0.0001	16.810	35.728
Inflation	-0.173	0.519	-0.333	0.740	-1.214	0.867

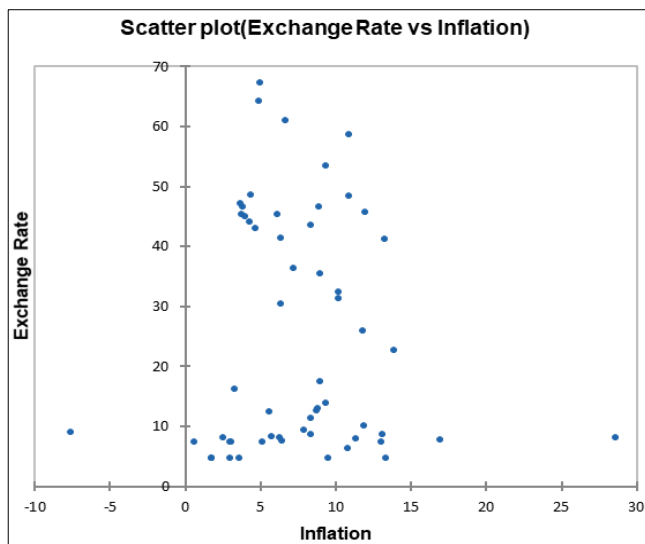**Table 13:** Standardized coefficients (Exchange Rate) for Annual Data

Source	Value	Standard error	t	Pr > |t|	Lower bound (95%)	Upper bound (95%)
Inflation	-0.045	0.135	-0.333	0.740	-0.315	0.225

Table 14: Correlation matrix for Annual Data

	Inflation	Exchange Rate
Inflation	1	-0.045
Exchange Rate	-0.045	1

Fig 4: Scatter plot for Annual Data
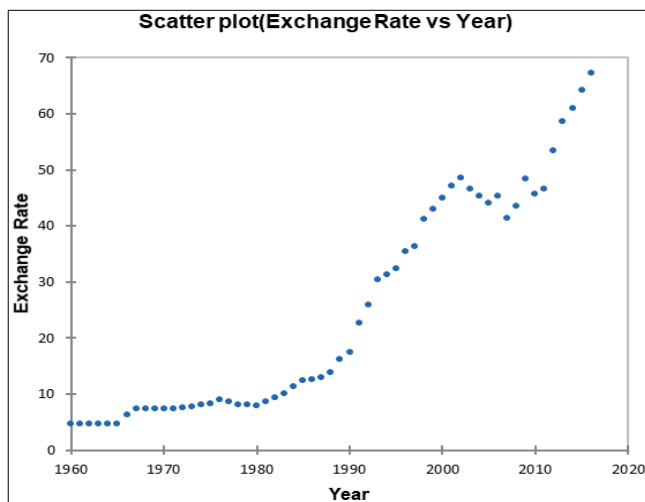
Fig 5: Time series (Exchange Rate) for Annual Data

Fig 6: Time series (Inflation) for Annual Data

▪ **Correlation using R-Programming**

We have calculated both Pearson and Spearman Correlation using R-programming.
For monthly basis:
Pearson Correlation = -0.06229955
For annual basis:
Pearson Correlation = -0.04491061

Result Discussion

The objective of the study was to analyse the relationship between the inflation rate and the exchange rates in India. Exchange rates (Forex) were established as the dependent variable while the independent variable was inflation rates. The study sought to understand the relationship between the independent variable (inflation) and dependent variable (exchange rate).

A weak and negative correlation between the exchange rate and inflation is established by the results. The correlation of monthly data is higher as compared to that of annual data. The value R^2 is very low suggesting that the variance of one variable (inflation) explains the variance of second variable (exchange rate) up to a very limited extent. The Mean Absolute Percentage Error (MAPE) for annual data is almost eight times as compared to monthly data. The Value of Durbin Watson Statistic (DW) is less than 2 for both the monthly as well as annual data suggesting a positive autocorrelation in the dataset.

Conclusion

The analysis investigated the impact of inflation rate on exchange rates in India with specific reference to INR/USD Annualized Average Exchange Rates (Forex), and Annual Average Economic Inflation Rates (in %) all information from the year 1960 to 2016 and INR/USD Monthly Average Exchange Rates (Forex), and Monthly Average Economic Inflation Rates (in %)

all information from the year 1992 to 2017. The study finally concluded that there is very weak negative correlation among the variables. This infirmity between the two variables is because inflation is just one variable among many others variables that collectively influences the exchange rate of the country.

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