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Predictive Analysis on Foreign Exchange Rates

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Abstract:

The foreign exchange market is a global currency exchange and trading market that is vital to the global economy. The currency market has existed since ancient times when coins were used for money transfers. The Bretton Woods system and the European Common Float are major changes in the currency market. The Foreign Exchange Regulation Act, 1973 empowered the Reserve Bank of India and the central government to monitor and regulate foreign exchange payments made outside India. The value of the Indian rupee against the US dollar is driven by supply and demand, and its value can be affected by disruptions such as the Russian-Ukrainian war, global economic problems, inflation and high oil prices. As a result, it is necessary to predict the exchange rate of the Indian rupee. The purpose of this study is to identify the variables affecting the exchange rate of the rupee, quantify their impact and forecast the exchange rate of the rupee in the future. The research material includes secondary data collected from reliable sources and periodicals and exchange rates of rupee from April 2004 to November 2022. Factors studied include the exchange rate of the rupee against the US dollar, inflation, foreign direct investment, trade balance, oil price and gold prices. The study uses regression analysis and machine learning techniques such as logistic regression to examine the data and predict the future exchange rate of the rupee. The findings of the study are relevant to policy makers, investors and companies involved in foreign exchanges in the rupee. In short, the Indian Rupee has fluctuated significantly over the past two decades, reaching a high of 82 and a low of 39 against the US dollar. Among all the variables in the study (inflation, interest rate, GDP, external liabilities and current accounts), inflation is the most influential for the Indian rupee with a correlation of 0.97.

Keywords: Foreign Exchange markets, Foreign Exchange, Indian Rupee, US Dollar, Gross Domestic Product, Consumer Price Index, National Debt, Interest Rates, Linear Regression, Logistic Regression

Introduction:

The currency market has been around for as long as people have been trading. Ancient civilizations used coins whose value was determined by their weight to exchange goods and

currency. Since then, the currency market has evolved.

The foreign exchange market is a contactless market that determines exchange rates worldwide. This currency market is also called foreign exchange market, Forex or FX. In these markets, the participants buy, sell, exchange and speculate on currencies. Banks, currency traders, trading companies, central banks, investment funds, hedge funds, foreign currency traders and investors participate in these currency markets.

The Bretton Woods system, the first major reorganisation of currency markets, took place at the end of World War II. The United States, Great Britain and France met at the United Nations Monetary and Financial Conference in Bretton Woods, New Hampshire, to build a new global economic system. An adjustable peg is an exchange rate policy in which one currency is pegged to another currency. In this case, foreign countries would "peg" their exchange rates to the US dollar. The US dollar was pegged to gold because the US had the largest gold reserves in the world at the time. So foreign countries trade in US dollars.

In 1972, the European community tried to get rid of its dependence on the American dollar. West Germany, France, Italy, the Netherlands, Belgium and Luxembourg formed the European Common Float. Both agreements made mistakes like the Bretton Woods agreement and collapsed in 1973. These mistakes led to the official transition to a free-floating system. US President Richard Nixon is credited with breaking the Bretton Woods Agreement and fixed exchange rates, leading to a free-floating currency system. The number of US central bank international operations was quite modest in 1961-62. Those involved in exchange rate management found the limits of the agreement unrealistic and ended it in March 1973, when none of the major currencies had the ability to convert into gold, with organizations relying instead on foreign reserves. Coins were free to peg to any currency they chose, or remain unpegged and let the supply and demand of the currency determine its value. The number of market transactions tripled between 1970 and 1973.

The currency market plays a decisive role in society and the world economy. They facilitate trade across borders, that includes investment, exchange of goods and services, and financial activities.

Currency has long been considered a limited commodity in India due to scarcity. In the early stages of the country's currency management, the focus was on managing exchange rates by limiting demand due to limited supply. On September 3, 1939, exchange control was temporarily imposed in India under the Defense of India Ordinances.

The Foreign Exchange Regulation Act of 1947 (FERA) created a statutory foreign exchange regulatory authority, which was later replaced by the more comprehensive Foreign Exchange Regulation Act of 1973. This act empowered the Reserve Bank and in some cases the central government to exercise supervision. And regulates, inter alia, transactions involving foreign

currency payments outside India, export and import of currency notes and orks, transfer of securities between domestic and foreign countries, acquisition of foreign securities and acquisition of immovable property in India and outside India. Things There are several types of currency markets:

Spot Market

Currency pair transactions happen quickly in this market. Transactions in such markets require immediate payment at the current exchange rate, ie the spot rate. Spot traders are generally not affected by the uncertainty of the FOREX market, which raises or lowers the price between the trade and the contract.

Futures Exchange:

Transactions in the futures market, as the name suggests, require future payment and delivery at a pre-agreed rate, also known as the forward rate. These agreements and transactions are formal, which ensures that the terms of the agreement or transaction remain unchanged. Trading in the futures market is preferred by traders who make large FOREX trades and need a constant return on their holdings.

Futures Market:

Futures Market is the same as futures market transactions. The main difference is that the parties to the futures market negotiate the terms. The provisions of the contract can be adjusted and adjusted according to the needs of the parties. The futures market offers flexibility.

According to an article on Instarem.com, interest rates and inflation, current account deficit, government debt, terms of trade, economic activity, recession, speculation are factors that affect the exchange rates of the Indian rupee.

Review of Literature:

- Singhal, Shelly. (2023) studied "Analytical Study of Depreciation of Indian Currency Rupee Against US Dollar and Its Economic Impact" and found that the rupee lost more than 10 percent of its value this year, making it one of the lowest currencies. In Asia. This article discusses the likely reasons for the rupee's depreciation and its outlook. It is also considering policy options to prevent the rupee from weakening.
- Prof. Jeelan Basha.V (2021) examined empirical research on the determinants of exchange rates against the Indian rupee and the US dollar and concluded that the fluctuations in the exchange rate of the Indian rupee are influenced by various factors such as gross domestic product (GDP) growth rates), average inflation (WPI), balance of payments, loan interest rates, foreign exchange reserves, foreign investments, etc.
- Arushi Gupta (2021) studied the forecast of the daily exchange rate of the rupee against major currencies and argued that the fundamentality of exchange rates as one of the key indicators of the macro economy implies the need for these forecasts. However, their inherently noisy and

chaotic behavior makes reliable prediction difficult. Advanced forecasting techniques that use neural networks and ensemble forecasts can be used. There is evidence to support the superiority of neural predictive models due to their ability to capture non-linear and interactive effects.

- SashikantaKhuntia and J.K. Pattanayak (2019) investigated the topic "Evolving Efficiency of Exchange Movement: Evidence from the Indian Foreign Exchange Market" and concluded that empirical studies suggest time-varying dynamics of market efficiency in the Indian foreign exchange market. Rolling window analysis reveals pockets of efficiency and inefficiency associated with significant economic, non-economic events and changes in market microstructure. Thus, market efficiency is time dependent and the AMH framework provides a better and deeper understanding of the nuances of efficiency in an emerging currency market like India.
- Sheetal Maurya (2017) studied the topic "Factors affecting exchange rate and its impact on Indian economy" and found that exchange rate is not the only determinant of economic growth in a country but many other macroeconomic factors affect economic growth. are: inflation rate, interest rate, consumer confidence, public spending, political environment, technological development, human capital, etc.

Need for the study:

Like any currency, the Indian rupee reflects the underlying strength of the Indian economy. The value of the Indian rupee against the US dollar is based on supply and demand. When there is more demand for the US dollar, the Indian rupee depreciates and vice versa. When a country imports more than it exports, the demand for the dollar exceeds the supply, and the domestic currency, such as the Indian rupee, depreciates against the dollar.

The value of the rupee is affected by disturbances caused by, for example, the war between Russia and Ukraine, global economic problems, inflation and high oil prices.

Since India is largely dependent on imports including petroleum, metals, electronics etc., the country makes payments in US dollars. Now that the rupee is weak, one has to pay more for the same amount of goods. In such cases, raw material and production costs rise, which is passed on to consumers. Therefore, it is necessary to anticipate the exchange rate of the rupee.

Objectives of the study:

- To identify the various factors influencing the exchange rate of Rupee
- To measure the impact of the identified factors on the exchange rate of rupee.
- To forecast the future exchange rate of rupee

Research Methodology:

The data required for the study is mostly secondary data. Secondary data was collected from

sources like trusted websites and journals. The data consists of the exchange rates of rupee from January 2004 to November 2022. The variables under study are the exchange rate of rupee to dollar as the dependent variable, and inflation rate, interest rate, gross domestic product and government debt as the independent variables. The data collected is analysed through descriptive statistics, exploratory analysis and predictive analysis using Software tools like ‘MS Excel’ and ‘Python’. The predictive model used to forecast the future exchange rates of Indian Rupee include multiple linear regression, Logistic Regression and the other predictive analysis models.

Data Sources:

Exchange rate data: <https://fred.stlouisfed.org>

Inflation data: www.macrotrends.net, <https://fred.stlouisfed.org>

External debt data: www.macrotrends.net, <https://fred.stlouisfed.org>

GDP data: <https://data.worldbank.org>, <https://fred.stlouisfed.org>

Interest rate data: <https://data.worldbank.org>, <https://fred.stlouisfed.org>

Current account deficit data: <https://data.worldbank.org>, <https://fred.stlouisfed.org>

Analysis:

Each row in the exchange rate data set represents a monthly observation and has 224 rows and 7 columns. The first column contains the observation date, which specifies when the exchange rate was measured. The dependent variable in this data set is the Indian Rupee to US Dollar Spot Exchange Rate, which is shown in the second column. The following six columns are the independent factors that were utilised to forecast the exchange rate. GDP, inflation rate (%), interest rate, external debt, and current account deficits are examples (CAD). The data collection contains information on numerous economic factors that may influence the Indian Rupee's exchange rate with the US Dollar.

Exploratory Data Analysis:

Fig.1

Table showing different measures of the data

	Indian Rupees to U.S. Dollar Spot Exchange Rate	GDP	Inflation Rate (%)	Interest rate	External Debt	CAD
count	224.000000	224.000000	224.000000	224.000000	2.240000e+02	2.240000e+02
mean	57.651681	99.976417	87.395343	6.469420	-9.089683e+05	-5.994701e+05
std	12.214106	2.076368	31.379046	1.416966	6.665607e+05	6.637340e+05
min	39.267600	83.558113	41.789953	4.250000	-2.984100e+06	-2.671975e+06
25%	45.523175	99.350944	56.614600	6.000000	-1.275200e+06	-9.630750e+05
50%	59.510500	100.138624	90.277335	6.000000	-7.842500e+05	-4.721250e+05
75%	67.793800	101.069843	110.168951	6.812500	-4.134250e+05	-1.013000e+05
max	82.291500	102.029920	145.983203	10.250000	6.190000e+04	3.740250e+05

The above table shows a clear summary of the data collected and used for analysis. The

summary statistics provide a quick snapshot of the distribution of exchange rates in the dataset, allowing us to understand the central tendency, variability, and range of the data.

The dataset consists of 224 observations i.e. the monthly data from April 2004 to November 2022.

Indian Rupees to US Dollar Spot Exchange Rate:

The average exchange rate is 57.6251, with a standard deviation of 12.214, which means that the exchange rate values vary by approximately 12.214 around the mean. This value gives us an idea of the dispersion of the exchange rate values in the dataset. The minimum exchange rate is 39.267, while the maximum is 82.29

Gross Domestic Product:

Gross Domestic Product (GDP) is a measure of the total value of goods and services produced within a country's borders during a specific time period, usually a year. GDP is often used as a key indicator of a country's economic performance, as it provides a broad view of the overall size and growth of the economy. The average GDP for the period of study is 99.97 billion with a standard deviation of 2.07 billion. A maximum GDP of 102.02 billion while a minimum of 83.55 billion were recorded during the time period.

Inflation Rate:

The inflation rate varied between 41.78 and 141.98 with an average of 87.39

As a part of the Exploratory Data Analysis, the relationships between the dependent and independent variables were measured.

Interest Rate:

An average rate of 6.47 ranging between 4.25 and 10.25 prevailed during the period of study. The interest rate varied about 1.41% around the mean.

External Debt:

An average rate of -908963 ranging between -2984100 and 61900 prevailed during the period of study. The interest rate varied about 666560 around the mean.

CAD:

An average rate of -599470 ranging between -2671975 and 374025 prevailed during the period of study. The interest rate varied about 663734 around the mean.

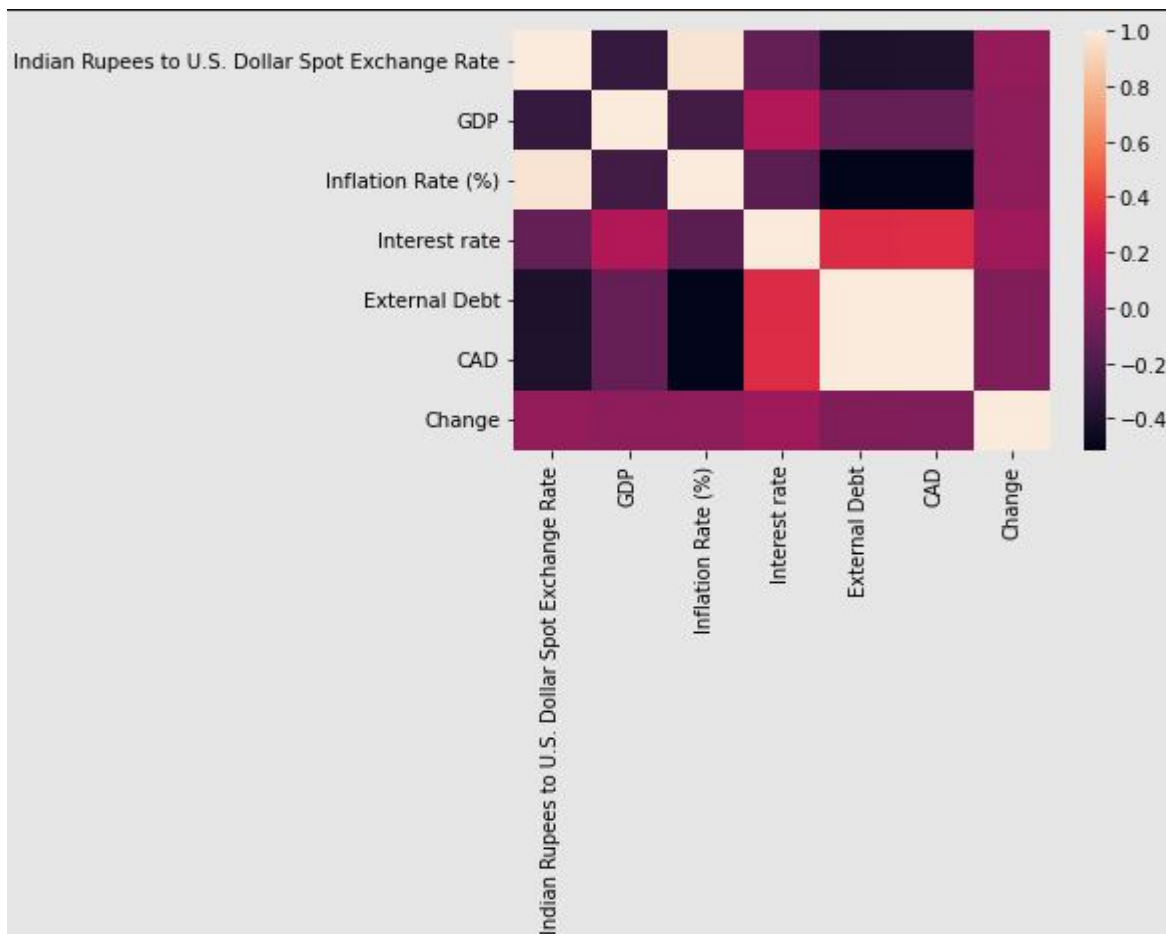
The dependent variable was the Indian Rupees to U.S. Dollar Spot Exchange Rate and the independent variables were Inflation Rate, External Debt, GDP, Interest rate and Current Account

Debits:

The heat map in Fig 2 shows the correlation between Indian Rupees to U.S. Dollar Spot Exchange Rate and other independent variables. It can be identified that the correlation is highest between exchange rate and inflation rate.

Fig.2

Heat Map showing the correlations between the variables



The table in Fig 3 shows the values of correlation, hence proving that exchange rate and inflation have a highest correlation of 0.97

Fig.3

Table showing the correlations between the variables

	Indian Rupees to U.S. Dollar Spot Exchange Rate	GDP	Inflation Rate (%)	Interest rate	External Debt	CAD
Indian Rupees to U.S. Dollar Spot Exchange Rate	1.000000	-0.295629	0.970177	-0.122773	-0.396123	-0.393559
GDP	-0.295629	1.000000	-0.243775	0.149559	-0.112186	-0.112087
Inflation Rate (%)	0.970177	-0.243775	1.000000	-0.158368	-0.513651	-0.510089
Interest rate	-0.122773	0.149559	-0.158368	1.000000	0.323470	0.326165
External Debt	-0.396123	-0.112186	-0.513651	0.323470	1.000000	0.999335
CAD	-0.393559	-0.112087	-0.510089	0.326165	0.999335	1.000000

Predictive Analysis:

Multiple Linear Regression and Logistics Regression were the 2 regression models used to predict the Exchange rate of Indian Rupee to US. Dollar.

1. Multiple Linear Regression:

Multiple regression is a statistical approach used to study the relationship between multiple

independent variables and a single dependent variable. It is often used for predictive analysis and modelling in many fields, including finance, economics and the social sciences.

Regression equation:

$$\text{Indian Rupees to U.S. Dollar Spot Exchange Rate} = (4.01864893e-01 * \text{GDP}) + (5.04504494e-02 * \text{Inflation Rate (\%)}) + (-1.78516269e-01 * \text{External Debt}) + (1.66726245e-05 * \text{Interest rate}) + (-1.43814615e-05 * \text{CAD})$$

The root mean square error of the regression model is 2.53 indicating an approximate 2.5 rupee difference between the actual and predicted exchange value of the Indian Rupee

2. Logistic Regression:

Logistic regression is a statistical approach for predicting binary outcomes where the dependent variable is either zero or one. It calculates the probability of a dependent variable based on one or more independent factors.

For this model a new binary independent variable called ‘Change’ was created to indicate increase or decrease in the exchange value of Indian rupee compared to the previous month. 0 indicates decrease or no change whereas 1 indicates an increase in the exchange value of Indian rupee.

Fig.5

Table showing the accuracy of various test-train splits

Logistic Regression	
Train-test split	Accuracy
80-20	0.711
75-25	0.714
70-30	0.721
65-35	0.722
60-40	0.724

From the table, we observe that the maximum accuracy is at 60-40 test train splits. However, the maximum accuracy is only 72.4%.

Findings:

- Between 2004 and 2022, the highest value of Indian rupee was 82 and the lowest value of Indian rupee was 39
- Scatter plot showing the change in the exchange value of Indian rupee to the US Dollar with time shows a positive trend
- The variable that influences the Indian rupee the most is Inflation rate(%) with a correlation of 0.97
- The root mean square error of the multiple linear regression model is 2.53

- The accuracy of the logistic regression model is 72.4%

Conclusion:

In conclusion, the Indian rupee has fluctuated significantly during the last two decades, reaching a peak of 82 and a low of 39 versus the US dollar. The scatter plot shows a positive trend, demonstrating that the Indian rupee has risen in value relative to the US dollar over time. As indicated by a significant correlation of 0.97, the inflation rate is the most influential factor impacting the Indian rupee. Additionally, the root mean square error of the multiple linear regression model is 2.53, showing that the model is dependable in forecasting the exchange value of the Indian rupee. The logistic regression model, on the other hand, has an accuracy of 72.4 %, indicating that additional improvements are needed to effectively anticipate exchange rate fluctuations. Ultimately, a thorough understanding of the Indian rupee's exchange rate fluctuations necessitates careful analysis of a variety of economic and political issues.

Limitations of the study:

- The present study is limited to the foreign exchange rate data of the Indian Rupee and the factors affecting it.
- Quarterly data from January 2004 to November 2022 has been considered for the study

Scope of further study:

The scope of the study can be expanded by exploring the exchange rate values of other currencies with respect to the US Dollar.

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