Distribution Nature of Foreign Exchange (FOREX) Rates in Nepal

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ABSTRACT

1The economy of Nepal is based on the inflow of remittances sent by the Nepalese who have gone abroad for foreign employment. The trend started after the start of the Maoist insurgency and has been going on due to a lack of employment opportunities within the nation. Other than remittance, tourism and a certain amount of foreign aid have been the sources of foreign exchange earnings for Nepal. These sources of FOREX have been able to maintain the balance of payments in Nepal. One unique feature of FOREX rates in Nepal is that the Nepalese rupee (NPR) is pegged with the Indian rupee (INR), the currency of the neighboring nation, India. The central bank of Nepal, Nepal Rastra Bank, publishes FOREX rates for 21 different countries on a daily basis, though exchange rates for 16 currencies have been publishing buying and selling rates for the past decade. Hence, the paper analyzed the distribution nature of 16 countries FOREX buying and selling rates and found that INR FOREX rates have no randomness as they are pegged. The most concerned currencies, like USD, SAR, QAR, and AED, were fitted with beta distribution capabilities to reflect the future trend of the exchange rate. At the same time, the GBP buying rate, JPY, and KRW buying and selling rates were best-fitted in general extreme value (GEV), reflecting the risky nature of currencies. The exchange rate distribution seems to be a concern to the exporter and importer, as the nature of the distribution could help to categorize the level of FOREX risk with a specific currency.

Keywords: Distribution nature, Exchange rate, FOREX, Nepal.

1. **Introduction**

Foreign exchange refers to the currency (or interest-bearing bonds) of another country. In other words, the money of one nation held by citizens of another nation, either as currency or as deposits in banks, is called foreign exchange. Similarly, a FOREX market is a meeting platform for buying, selling, and speculation on currency conversion rates.

A foreign exchange, or FOREX, transaction involves the purchase of one currency against the sale of another currency for settlement or delivery on a specified date. The rate of exchange is the price per unit of one of the currencies expressed in units of the other currency (Roth, 1996). In other words, the foreign exchange rate is the rate at which one country's money can be turned into another's. The foreign currencies are exchanged or transferred in the foreign exchange market. Thus, an exchange rate is simply the rate at which one currency can be exchanged for another currency (Adhikari et al., 2017).

Exchange-market places with flaws would be ineffective. One prevalent claim is that FOREX markets are unstable when exchange rates are floating because speculators enter the market to distort normal and realized values, as opposed to interest rate parity. Others contend that the increased risk of a flexible system leads to higher trade prices. To obtain a temporary trading advantage, several nations may devalue their currencies during a time of domestic strife.

A symmetric stable distribution, rather than a normal distribution, provides a fair explanation of exchange rate movements under fixed and floating rate regimes, according to Westerfield (1977). Extreme ramifications result from this discovery. For instance, the sample variance is probably useless as a risk indicator if fluctuations in exchange rates obey a stable probability law. This suggests that mean-variance models have little application to describing economic issues in global finance.

From a nonlinear approach, Li and Miller (2015) looked into the inefficiency of the FOREX market and found that this is consistent with a number of confusing facts about the market. Kitamura (2017) acknowledged the effectiveness of the FOREX markets and provided efficiency metrics for them. In their study of the efficiency of the FOREX market, Levich et al. (2019) showed how these markets occasionally displayed excess predictability and inefficiency, such as during the global financial crisis. Similar findings were made by Han et al. (2020) about the multifractal structure and inefficiencies of the foreign currency market. Technically speaking, it is possible to forecast and evaluate exchange rate movements, which opens up the market to arbitrage.

In general, an economy's inefficiency is implied by a FOREX market that is flawed. Due to the effects of exchange rate volatility on trade flows, models of foreign currency transaction costs, mean-variance analyses of international portfolios, or studies of FOREX market efficiency, the distribution pattern or statistical features of FOREX are therefore of great concern, especially to nations like Nepal, whose trade dependency is extremely high with a single neighboring nation, India, as well as having a pegged FOREX rate with its currency, Indian Rupees (INR).

2. **Literature Review**

Historical Background of FOREX Regime

Historically, a concept of FOREX was conceived in 1694 during the period of English King William III, who urgently needed money to finance the war against France, popularly known as the Battle of Beachy Head, and then established the Bank of England. Further, until 1832, the Bank of England lost its monopoly, and foreign banks also emerged in England to provide banking services. Then, after the incident, the concept of the gold standard emerged in the market (Roth, 1996).

After World War II, the turning point came in the international foreign exchange regime. The United Nations Monetary and Financial Conference held at Bretton Woods, New Hampshire, on July 22, 1994, sought to reconstruct the world monetary system by designing an adjustable peg system of foreign exchange rates and by establishing the International Monetary Fund (IMF) and the International Bank for Reconstruction and Development, the World Bank (Roth, 1996). A financial pact known as Bretton Woods was signed on July 22, 1944, in Bretton Woods, New Hampshire. After World War II, the agreement was intended to stabilize currencies and advance global trade. The Bretton Woods agreement required each signatory nation to peg its currency to gold and set a limit on how much might deviate from the peg. Currencies from around the world were pegged against the U.S. dollar, which was in turn pegged against the value of gold, in an attempt to bring stability to global economic events. In 1971, this act finally failed. However, it did manage to stabilize major economies around the world, including those within the Americas, Europe, and Asia (Martinez, 2022).

Determination of FOREX Rate

The FOREX market deals with the buying, selling, and speculation of foreign currencies. The FOREX market includes both spot markets for immediate dealing and future markets for delivery on future dates at pre-arranged prices. The foreign exchange rate is an important determinant of the prices of exports and imports in international trade. The change in FOREX rate has a direct impact on the external trade balance and domestic economy (Adhikari et al., 2017). There are mainly two systems or regimes for determining the exchange rate. There are floating or flexible exchange rate systems and pegged or fixed exchange rate systems.

Flexible (Floating) Exchange Rate System

An exchange rate with no government or central bank action to keep it stable is known as a floating exchange rate. This is also known as a flexible exchange rate. In a pure or clean float, there is no government or central bank intervention at all in the FOREX market, and the determination of the exchange rate is left to the market force.

When there is no official intervention in the forex market, the rate is freely floating and will rise or fall to the equilibrium rate determined by the supply of and demand for that currency. The system of exchange rate determination in which the value of currency is allowed to adjust freely or to float as determined by demand for and supply of FOREX is called the flexible (floating) exchange rate system (Adhikari et al., 2017).

The combination of currency supply and demand on the market determines this exchange rate. A high exchange rate may result from increased demand, and a low rate may result from increased supply. Independent float and controlled float are the two types of floating exchange rates.

Because there is no involvement by the government or central bank in the demand and supply of the currency, an independent float is also known as a clean float. While in the managed floating exchange rate regime, central banks intervene in the market to limit the volatility of the currency market so that it has no impact on the stability of the economy or the price of currency, there is still a risk of abrupt currency appreciation and depreciation (Dwivedi, 2010).

Pegged (Fixed) Exchange Rate System

A system in which a country's exchange rate remains constant is called a fixed exchange rate. Before 1971 AD, the industrial world was on a fixed exchange rate system called the Bretton Woods System.

A fixed exchange rate exists when authorities (central banks) specify the rate at which their currency will exchange against other currencies. The central bank then intervenes as and when necessary, as buyer or seller, to maintain the specified exchange rate. The objective of intervention is to neutralize changes in supply or demand for currency on the FOREX market so that the exchange rate neither appreciates nor depreciates against other countries (Adhikari et al., 2017).

Inflation is controlled, trade and investment are stabilized, and the currency system is kept stable under this exchange rate regime. A nation with a low GDP may choose a fixed exchange rate regime. Even in cases of surplus currency supply and demand, the rate will be controlled in accordance with the previous decision (Dwivedi, 2010). Nepal has followed a fixed exchange rate with Indian currency, and the Bretton Woods system accepted this system until 1971.

Review of Empirical Studies

Rogalski and Vinso (1978) looked into how exchange rates behaved. Empirical studies show that during fixed rate periods, the distribution of the underlying stochastic process for changes in foreign exchange rates was constant proportionally, whereas a student model offers a relatively better explanation of floating rates.

McFarland et al. (1982) investigated the nature of price changes in a variety of major and minor foreign exchange markets. The findings revealed that a non-normal stable distribution function appears to govern the log of price movements over intervals of one trading day.

Boothe and Glassman (1987) argued that the FOREX rates have fatter tails than the normal distribution, which leads to a fit on non-normal distributions. Using maximum likelihood parameter estimates and chi-square goodness-of-fit tests, the paper examined the empirical fits of three non-normal candidates and the normal distribution for daily variations in the logarithms of exchange rates. The student and mixture of two normal offered the best fits; however, there is evidence that the parameters of the distribution could change with time.

Johnston and Scott (1999) stated that much of the existing research on the distribution of exchange rates suggests that high-frequency data are not independent and identically distributed. However, their paper concluded that models that assume independence should not be overlooked since existing models of dependence do not dominate the alternatives that assume independence.

Rimarčík (2006) concentrated on specific statistical aspects of the logarithmic returns of the three most significant currencies for Slovakia: the euro, dollar, and Czech koruna. Despite the SKK/USD returns having an almost normal distribution, none of the three currencies exhibited a normal distribution of returns. They are all non-stationary return time series.

Blau (2017) found that exchange rate volatility is associated with greater kurtosis and more negative skewness. Similarly, the fluctuation pattern in the FOREX market was also found to be associated with the fluctuation of the stock market in the nation.

Han et al. (2020) hypothesized that multifractal features occur at various levels in the subsamples, demonstrating how these events have an impact on the efficiency of the foreign exchange market from both a statistical and fractal perspective. According to the study, empirical findings have implications for the effectiveness and nonlinear mechanism of the foreign exchange markets, which could aid investors in

efficiently managing market risks and in maintaining a stable global economy.

Charfi and Mselmi (2022) examined exchange rate volatility using GARCH models with a new innovation distribution, the Normal Tempered Stable. The study discovered that the effectiveness of GARCH models with a normal-tempered-stable distribution helps to improve risk measure accuracy, which is crucial for international traders and investors.

Luanglath (2022) analyzed the extreme devaluation of currencies in ten ASEAN countries. The concept of extreme value theory (EVT) was adopted to analyze the distribution pattern of the devaluation of currencies. The paper found that the Weibull distribution perfectly predicted the devaluation of currencies in the ASEAN region.

3. **Methodology**

The paper tried to find out the statistical properties or distribution nature of the FOREX rates prevailing in the Nepalese FOREX market. Hence, a descriptive research design has been followed to explain the facts and characteristics related to the issue raised by the paper.

The paper has used secondary data related to the foreign exchange rates between the Nepalese rupees (NPR) and other foreign currencies that are eligible to exchange as directed by the central bank of Nepal, the Nepal Rastra Bank (NRB). All the published buying and selling rates by the NRB are considered population for the study.

Nevertheless, the paper has taken a sample of the foreign currencies, which have been regularly published by the NRB since the last decade. Though, the central bank has been publishing buying and selling rate for twenty-one (21) different foreign currencies, the paper has considered the published daily buying and selling rates of sixteen (16) currencies from July 16, 2013 to July 16, 2023, covering 3,653 days.

The paper has used descriptive statistics to determine the basic distribution nature of the FOREX rates. Similarly, the paper has also used the Kolmogorov-Smirnov Test (KS Test) and the Anderson Darling Test (AD Test) to find out the significance of the fitted distribution.

4. **Findings**

This section illustrates the results of the data analysis. The descriptive statistics of the FOREX rates and distribution nature of the FOREX rates of major foreign currencies exchanged in Nepalese market are being presented in this section.

Table 1: Descriptive Statistics of FOREX

Statistic	USD (Buying)	USD (Selling)	EUR (Buying)	EUR (Selling)	GBP (Buying)	GBP (Selling)	CHF (Buying)	CHF (Selling)
Mean	111.03	111.63	127.81	128.50	151.41	152.23	116.61	117.24
SD	10.01	10.00	9.30	9.31	9.95	9.99	11.97	11.99
Sk.	+0.41	+0.41	-0.14	-0.15	-0.48	-0.48	+0.79	+0.79
Ku.	-0.70	-0.70	-0.88	-0.88	-0.82	-0.83	-0.49	-0.49
Var.	100.17	100.17	86.42	86.71	98.95	99.78	143.38	143.65
Range	39.28	39.28	42.18	42.22	45.04	45.09	55.70	55.81
Statistic	AUD (Buying)	AUD (Selling)	CAD (Buying)	CAD (Selling)	SGD (Buying)	SGD (Selling)	JPY* (Buying)	JPY* (Selling)
Mean	83.09	83.55	87.33	87.81	82.12	82.56	9.82	9.88
SD	5.15	5.17	6.45	6.46	6.70	6.70	0.81	0.81
Sk.	+0.17	+0.17	+0.22	+0.22	+0.75	+0.75	-0.03	-0.03
Ku.	-0.99	-0.98	-1.10	-1.10	-0.19	-0.19	-0.66	-0.67
Var.	26.56	26.77	41.62	41.74	44.93	44.91	0.65	0.65
Range	29.53	29.72	28.99	29.15	28.67	28.70	3.56	3.48

Statistic	CNY (Buying)	CNY (Selling)	SAR (Buying)	SAR (Selling)	QAR (Buying)	QAR (Selling)	THB (Buying)	THB (Selling)
Mean	16.81	16.90	29.60	29.76	30.46	30.62	3.36	3.38
SD	1.17	1.17	2.66	2.66	2.72	2.72	0.33	0.33
Sk.	+0.62	+0.61	+0.40	+0.40	+0.40	+0.40	+0.14	+0.14
Ku.	-0.79	-0.79	-0.71	-0.71	-0.71	-0.71	-1.54	-1.53
Var.	1.36	1.36	7.07	7.08	7.38	7.38	0.11	0.11
Range	4.67	5.11	10.42	12.08	10.79	10.79	1.14	1.14
Statistic	**AEB (Buying)**	**AED (Selling)**	**MYR (Buying)**	**MYR (Selling)**	**KRW* (Buying)**	**KRW* (Selling)**	**INR (Buying)**	**INR (Selling)**
Mean	30.23	30.39	27.55	27.70	9.60	9.66	1.60	1.615
SD	2.74	2.73	1.86	1.87	0.49	0.49		
Sk.	+0.41	+0.41	-0.36	-0.34	+0.32	+0.32		
Ku.	-0.70	-0.70	-0.39	-0.38	-0.73	-0.72		
Var.	7.43	7.43	3.46	3.49	0.24	0.24		
Range	10.69	10.70	9.99	9.95	2.44	2.44		

Note: USD=United States Dollar, EUR=Euro, GBP=Great Britain Pound, CHF= Confoederatio Helvetica franc (Swiss Franc), AUD= Australian Dollar, CAD=Canadian Dollar, SGD= Singapore Dollar, JPY=Japanese Yen, CNY=Chinese Yuan, SAR= Saudi Riyal, QAR= Qatari Riyal, THB= Thai Baht, AED=United Arab Emirates Dirham, MYR= Malaysian Ringgit, KRW= South Korean Won, INR= Indian Rupees

*JPY exchange rate is for 10 JPY and KRW exchange rate is for 100 KRW

Source: Nepal Rastra Bank and Author's Calculations

The average buying and selling rate for the respective currencies is determined by various economic factors and the economic condition of the respective country and of Nepal. Similarly, especially in the context of Nepal, the composition of trade, the geographical position of the nation, and the possibility of capital flight enhance the level of confidence in the local currency. Nepal is also bound to peg its FOREX rate with the neighboring nation, India. Historically, it was found that on June 6, 1966, the Government of India substantially devalued its currency. Nepal's involvement was minimal because the Nepalese rupee was already linked to the Indian rupee. However, as a result of the pegging effect, the Nepalese currency automatically increased in value relative to the Indian currency. The new exchange rate between the two currencies was set from 101 Nepalese rupees to 100 Indian rupees as a result.

The last time the two currencies were changed was on February 1, 1993, when the previous exchange rate of 160 Nepalese rupees to 100 Indian rupees was reinstated. Thus, despite the Foreign Exchange Regulation Act of 1962 allowing the convertibility of Nepalese rupees with all other currencies, the exchange rate between the Nepalese and Indian rupees has mainly remained the same for a very long time. Hence, the buying-selling rate with INR has remained the same and there has been no fluctuation in the exchange rate. The data shows that the exchange rate between NPR and INR has been revised eight times and has remained at the exchange rate of NPR 1.60 for INR 1.00 (Maskey, 2001).

However, the remaining currency exchange rate is determined by the Nepal Rastra Bank (NRB) and addressed time-to-time through monetary policy. Table 1 shows that the exchange rate for different foreign currencies varies and has different exchange rates determined by the NRB. The buying and selling rates are varied at a very minimal rate. Similarly, only the exchange rates for EUR, GBP, JPY, and MYR are negatively skewed, while the others are positively skewed. At the same time, a distribution that has a lower or negative kurtosis value than the normal distribution is said to have lighter tails. Hence, all buying or selling exchange rates are found to have a negative kurtosis, reflecting lighter tails.

Table 2: Fitted Distribution of FOREX

Currency	Fitted Distribution	Parameter	KS Test	AD Test
USD (B)	Beta	α_1=1.4614, α_2=1.9519, a=93.244, b=135.4	0.0491	18.38
USD (S)	Beta	α_1=1.4614, α_2=1.9519, a=93.844, b=136.0	0.0491	18.38
EUR (B)	Beta	α_1=2.4691, α_2=2.0288, a=104.02, b=147.28	0.0284	4.758
EUR (S)	Beta	α_1=2.4692, α_2=2.0206, a=104.65, b=147.95	0.0275	4.823
GBP (B)	General Extreme Value	k=-0.5327, σ=10.986, μ=149.1	0.0559	34.65
GBP (S)	Triangular	m=160.44, a=125.79, b=172.78	0.0569	21.90
CHF (B)	General Pareto	k=-0.2635, σ=18.683, μ=101.82	0.09831	332.15
CHF (S)	Lognormal (3P)	σ=0.58531, μ=2.8649, =96.51	0.12296	70.387
AUD (B)	General Pareto	k=-0.8277, σ=15.27, μ=74.75	0.0479	326.73
AUD (S)	General Pareto	k=-0.8277, σ=15.27, μ=74.75	0.0478	326.73
CAD (B)	General Pareto	k=-0.8277, σ=15.27, μ=74.75	0.0479	326.73
CAD (S)	General Pareto	k=-0.8277, σ=15.27, μ=74.75	0.0479	326.73
SGD (B)	Beta	α_1=1.7047, α_2=5.2794, a=71.69, b=114.55	0.0580	20.99
SGD (S)	General Pareto	k=-0.4041, σ=12.593, μ=73.592	0.0361	339.49
JPY (B)	General Extreme Value	k=-0.28684, σ=0.81414, μ=9.5395	0.0369	8.0736
JPY (S)	General Extreme Value	k=-0.28646, σ=0.81598, μ=9.5922	0.03643	8.0925
CNY (B)	Gamma (3P)	α=3.3733, β=0.6506, =14.616	0.0966	46.842
CNY (S)	Rayleigh (2P)	σ=1.9018,=14.478	0.0976	70.193
SAR (B)	Beta	α_1=1.4661, α_2=1.9439, a=24.856, b=36.044	0.04941	18.262
SAR (S)	Beta	α_1=3.623, α_2=6.584, a=23.305, b=41.516	0.05543	20.154
QAR (B)	Beta	α_1=1.4816, α_2=1.9871, a=25.606, b=37.116	0.04812	16.42
QAR (S)	Beta	α_1=1.4739, α_2=1.9738, a=25.775, b=37.264	0.04833	16.46
THB (B)	Uniform	a=2.80, b=3.94	0.12452	194.85
THB (S)	Uniform	a=2.81, b=3.95	0.1233	194.25
AED (B)	Beta	α_1=1.463, α_2=1.957, a=25.386, b=36.871	0.04955	18.342
AED (S)	Beta	α_1=1.468, α_2=1.967, a=25.546, b=37.047	0.04946	18.269
MYR (B)	Weibull	α=18.152, β=28.367	0.04642	352.09
MYR (S)	Weibull	α=18.172, β=28.52	0.046	17.51
KRW (B)	General Extreme Value	k=-0.68995, σ=1.2684, μ=8.8531	0.0581	19.271
KRW (S)	General Extreme Value	k=-0.1391, σ=0.4501, μ=9.452	0.05714	18.515

Source: Nepal Rastra Bank and Author's Calculations

The distributions for the USD buying and selling rate, EUR buying and selling rate, SGD buying rate, SAR buying and selling rate, QAR buying and selling rate, and finally AED buying and selling rate were best-fitted on the beta distribution. This nature reflects that the uncertain future exchange rate could be estimated using two parameters, 'a' and 'b', and similarly, the Markov Chain Monte Carlo (MCCM)

model could be used to predict the future rate for the respective foreign currencies.

At the same time, the GBP buying rate, the JPY buying and selling rate, and finally the KRW buying and selling rate best fit the generalized extreme value (GEV) distribution. This shows that these exchange rates are fitted under Extreme Value Theory (EVT), i.e., a combination of the Gumbel, Frèchet, and Weibull families. The risk associated with GBY, JPY, and KRW can be determined through a VaR calculation.

The general Pareto distribution was fitted for the AUD buying and selling rate, the CAD buying and selling rate, the CHF buying rate, and the SGD selling rate. This reflects that the exchange rates for AUD, CAD, CHF, and SGD will reach certain extreme levels in the near future, or at the same time, there is a chance of extreme losses from FOREX trading for these currencies.

The FOREX trading for THB brings equal probability of profit or loss as it's buying and selling rates, both best-fitted in uniform distribution. In context to the MYR buying and selling rate, the best-fitted distribution is the Weibull distribution. This shows that the MYR is in a weakening condition, and the devaluation of the MYP is still going to take place in the coming days.

The selling rate of CHF followed log-normal (3P), reflecting that the flow of CHF in the market could be easily determined, as well as that the peak of the selling rate for CHF could also be determined as it was fitted to the respective distribution.

The GBP selling rate best fits the triangular distribution, which shows the rate is backed by less information about the exchange rate fluctuation. Similarly, the CNY buying rate and CNY selling rate best fit the Gamma (3P) distribution and the Rayleigh (2P) distribution. This shows that the CNY buying rate is determined by the various economic or political events that might take place in the future, while the CNY selling rate will reflect a significant high value in the coming future.

5. **Conclusion and Implication**

Economic expansion is the only appropriate means of raising people's quality of life. In the context of Nepal, remittances and tourism are related to economic growth. Foreign currencies can be used as productive capital to improve economic activities, which will both increase economic growth and help earn more foreign currency.

Remittances are a more dependable source of foreign currency for developing countries than other capital inflows. Export, tourism, and remittance profits in foreign currencies are inversely correlated with the country's economic growth.

The inflow of foreign currencies in Nepal can be categorized into four parts: first, from the Arab countries, i.e., the amount remitted by Nepalese for foreign employment; second, from a few amounts from Southeast Asian countries; third, from the tourism sector; fourth, from foreign trade; and finally, the fourth sector is foreign aid to Nepal. Since the beginning of the millennium, remittances from foreign employment have been the main source of foreign currency inflow in Nepal.

The distribution nature of the exchange rate for the currencies of Arab nations followed the same nature. The distribution of the SAR buying and selling rate, the QAR buying and selling rate, and finally the AED buying and selling rate were best-fitted on the beta distribution, reflecting the prediction that the future exchange rate could be feasible and could manage the FOREX balance for trade with the Arab nations. Similarly, two major foreign currencies, USD and EUR, also followed the beta distribution. Two currencies, mainly USD and EUR, are used to maintain the balance of payments for the nation. Demand and supply for USD and EUR are determined by the foreign trade position of Nepal. Hence, after the INR, these two currencies play a vital role in the Nepalese economy.

The exchange rate for JPY, MYR and KRW is of huge concern as large number of Nepalese have gone for foreign employment. Hence, weakening of these currencies also make inverse impact on Nepalese economy. All these currencies exchange rate is fitted on EVT-based distribution reflecting that the exchange rate reaches at certain peak threshold and fall in future, which is risky.

Above all distribution patterns, the pegged exchange rate of NPR with INR and absence of randomness in exchange rate brought no distribution pattern for the buying rate or selling rate of INR. The central bank, the NRB, also needs to peg the exchange rates of NPR and INR to stabilize the local currency. Although it is bordered on the northern side of Nepal, the concern about CNY in the Nepalese economy is limited, and Nepalese are just expecting the need in the coming future, while THB was seen having equal chances

of profit or loss from FOREX trade, though Nepal has limited level of trade with Thailand.

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