TIME-VARYING VOLATILITY OF CURRENCY EXCHANGE RATE: A CASE STUDY OF SAARC NATIONS

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Abstract
This research paper examines the existence of the volatility of annual exchange rates of SAARC countries against the US dollar. The nature and characteristics of the volatility of a group of currencies of SAARC nations are examined. The time series data of foreign exchange rate of SAARC countries' currencies both nominal and real exchange rate are expressed into returns, and the phenomenon of autocorrelated heteroscedasticity is observed over the study period. Therefore, the variant versions of volatility modeling in the literature, namely, ARCH and GARCH model is constructed. The volatility estimators, as well as various diagnostic tests, are employed to validate the model. The asymmetrical effects of shock prevailed in the exchange rates of these SAARC countries' currencies is also incorporated in the present study. The study is designed to verify whether the shocks in any one of the exchange rate of a member of SAARC is persistent temporarily or permanent. The empirical findings of this paper have revealed that persistence of volatility is a common phenomenon of the exchange rate of SAARC nations and shocks observed in the changes in the exchange rate returns are having an impact on conditional variance of the exchange rate of currencies of SAARC countries.

Keywords: Economics Integration, Exchange Rate, Volatility, ARCH, GARCH, EGARCH.

Introduction
The exchange rate of any national currency is the principal concern of the monetary policy of the central bank of the nations. The price of domestic currency regarding foreign currency is generally known as the exchange rate. The exchange rate is determined directly from the demand and supply factors of currencies. Therefore, an imbalance in the demand and supply factors causes the fluctuation in the exchange rate of the currency.

The exchange rate of national currency has more impact on the international trade, balance of payment and investment of the nation, therefore, the concern on its volatility is also increased during later decades of the 1900s. The study found that the higher volatility (Krugman, 2008; Salvatore, 2013) of the national currency against foreign currency is detrimental to the economic well-being and it has a negative influence on the international trade, balance of payment and foreign investment of the nation.

Modeling the volatility of the exchange rate and forecasting is one of the primary concern in international finance as well as in macroeconomics. The volatility of the exchange rate has played a prime role in the currency derivative market. Currency options, contract, hedging, and arbitrage are primarily depending on the volatility of the exchange rate. One cannot ignore the impact of volatility of the exchange rate on the nation's balance of payments. The international multinational operations operate across the globe, and the future cash flow and viability of the projects depends on the awareness of exchange rate volatility.

In the process of creation of regional co-operation among South Asian countries, SAARC came into existence in 1985. The SAARC as trade bloc does have more than 2.0 percent of world goods trade (Panchamukhi, 1990) and more than the 6% of PPP based global GDP (Dubey, 2007). In the way towards free trade among SAARC countries, South Asian Preferential Trading Arrangements (SAPTA) was agreed in 1995. The SAARC report of 1999 gave a call for "greater coordination of monetary and exchange rate policy." Therefore, the present research paper is envisaging the existing condition of the exchange rate of SAARC countries against the US dollar and estimating the volatility of SAARC countries with an appropriate model of volatility measurement.

IJMSRR
E- ISSN - 2349-6746
ISSN -2349-6738

Literature Review

Theoretical Reviews

The study related to stylized features of financial series are most common; however, the stated research about currency exchange rate was found earlier in the work of Mandelbrot (Mandelbrot, 1997) and later by Fama (Fama, 1984). The common characteristics of non-linear and leptokurtic of currency exchange rate are found in the works of Friedman (Friedman & Vandersteel, 1982). The study of Bollerslev, Diebold and Hsieh stated the clustering of returns for small and large changes in the exchange rate (Bollerslev, 1986; Diebold, 2012; Hsieh, 1988, 1989a, 1989b). The ARCH model proposed by Engle is a great break-through in the field of both theoretical and applied financial econometrics which laid the foundation for extension of volatility model by various applied Econometricians. The non-constancy of variance over a time period of a series was first studied and modeled for UK inflation rate in 1982 (Engle, 1982). However, the more parsimonious and robust method of measure of volatility was developed by Bollerslev in the name of GARCH (Bollerslev, 1986) in 1986. Refinement and modification of the time-varying variance of the series were found in many works of econometrics practitioners (Bollerslev, Engle, & Nelson, 1994), (Brooks & Burke, 1998; Brooks, Burke, Heravi, & Persand, 2005; Brooks, Burke, & Persand, 2001).

Empirical Reviews

The vast and rich literature for modeling the financial time series become more popular to practice to apply due to the advent of most sophisticated and specialized econometrics software.

In the empirical studies, most noted works are founded in the Financial Econometrics work of Brook. C (Brooks, 2014) where the lead-lag relationship among the exchange rate is analyzed. The fat tail and high-frequency data analysis are found in the work of Ruey S.Tsay (Tsay, 2005). The various form of volatility model with an ample number of empirical cases is found in the work of Walter Enders (Enders, 2008), and univariate and multivariate volatility models are specified and estimated with the diagnostic test in the work of Richard Harris (Richard & Sollis, 2003).

Objectives

The primary objective of the paper is to examine the volatility of the exchange rate of the SAARC countries. However, other interlinked objectives can be stated as follows:

1. To explore the nature and characteristics of the volatility of exchange rates of members of SAARC countries
2. To evaluate the asymmetrical effects of shock prevailed in the exchange rates of member nations of SAARC
3. To verify whether the shocks in any one of the exchange rate of member nations of SAARC is persistent permanent or temporarily

Hypothesis

The stated objectives are studied by testing the following hypothesis:

H1: The existence of ARCH effect is a common phenomenon in the exchange rates of members of SAARC.

H2: There is no evidence of the existence of asymmetrical shocks in the exchange rates of member nations of SAARC.

H3: The persistence of the shocks to the returns of exchange rates of SAARC is temporary.

Research Design

Period of Study

The present study is based on the values of the exchange rate from 2010 through 2019. Since SAARC as economic integration came into existence from 1985, the study period is extended to post establishment of SAARC. The time span of the data used in the research paper is from 12 March 2010 to 9 January 2019. The time series data is pooled on a daily basis; hence, the total number of observations is 3226.

The Sample
The study aimed to evaluate the exchange volatility of SAARC countries. Therefore, the eight countries of SAARC groups are considered. Though the entry of Afghanistan to form regional block at South Asia region, to make similarity in the study, the exchange rate of Afghanistan is also considered on par with rest of the member countries.

Database
The daily exchange rates of all eight SAARC nations are pooled from the various intentional and official data sources. The prime data source of the study is as follows:

1. World Bank Database: https://data.worldbank.org browsed on 10 January 2019.
2. IMF Data Library: http://data.imf.org/ browsed on 30 December 2018.
3. SAARC Statistics: http://www.saarcstat.org/ browsed on 20 November 2018.

In addition to the stated sources, web resources from the respective central bank of respective SAARC have been used.

The daily exchange rate has been converted into daily returns by taking logarithmic of the exchange rate. For example, p_t is the average daily exchange rate of a country, r_t is the change in the return of exchange rate. It is calculated by using continuously compounded returns formula:

$r_t = 100 \times ln\left(\frac{P_t}{P_{t-1}}\right)$ Where ln denotes the natural logarithm, p_t denotes the currency exchange rate of a country against US dollar at day t, p_t denotes the currency exchange rate of a country against US dollar at day (t-1), i.e., the previous day. The returns are expressed in terms of percentage. To achieve similarity in the study and from the availability of data, the exchange rate of all SAARC nations are considered against to US dollar.

Econometric Methodology
The classical linear regression model is best suited to model when the important assumptions are fulfilled so that they obtained regression parameters yield the BLUE estimators. Among the main assumptions, the constant variance of error terms is violated in the study involves financial time series data. Moreover, the classical linear regression models are incapable of handling the time-varying volatility of the series. Serial correlation, skewness, asymmetry, leptokurtic are the common characteristics in the data involves exchange rate or any other financial time series. Therefore, the present work depends on the econometric literature of volatility clustering by using the ARCH model proposed by Robert Engle (1982) and extensions of ARCH model especially GARCH model, proposed by Bollerslev (1986) and EGARCH model proposed by Nelson (1991). Nelson modeled the known property of the skew distribution of financial data as EGARCH (Braun, Nelson, & Sunier, 1995) and modeling of good news as well as bad news effect on conditional variance (Engle & Ng, 1993) become familiar in applied econometrics.

Specification, Characteristics, and Estimation of the Model

The ARCH Model
Most often financial time series exhibit the stylized patterns and time-dependent variance on the past information. The most frequently applied Engle proposed model of volatility clustering model of ARCH in 1982 (Engle, 1982). The ARCH model basically consists of two equations, i.e., mean and variance. The mean equation regarding AR (1) (Brooks, 2014; Pindyck & Rubinfeld, 1988) is specified as,

$$r_t = \mu + \beta_1 r_{t-1} + u_t \quad (1)$$

Here μ = Constant, r_t = Changes in the daily logarithmic exchange rates and $u_t \sim N(0, \sigma_t^2)$

The variance equation of ARCH (1) is given as,

σ_t^2 = var $(u_t/u_{t-1}, u_{t-2}, u_{t-3}, u_{t-4}, \dots\dots.) = \gamma_0 + \gamma_1 u_{t-1}^2$ (2)

Equation (2) represents the dependency of the variance of the error terms on first lags of the squared error terms.

Here $\gamma_0 \geq 0$ and $\gamma_1 \geq 0$

The equation (2) can be generalized to p[th] order of ARCH (p) as

$$\sigma_t^2 = \gamma_0 + \gamma_1 u_{t-1}^2 + \gamma_2 u_{t-2}^2 + \gamma_3 u_{t-3}^2 + \dots\dots\dots\dots\dots\dots. \gamma_p u_{t-p}^2 \quad (3)$$

In general,

$$\sigma_t^2 = \gamma_0 + \sum_{i=1}^{p} \gamma_i u_{t-p}^2$$

Here $\gamma_i \geq 0 \ \forall \ i = 1, 2, \dots. p$ (4)

Equation (4) represents the dependency of the variance of the error terms on p lags of the squared error terms.

The existence of ARCH effect is tested by using the following hypothesis of

H_o: $\gamma_1 = \gamma_2 = \gamma_3 = \dots\dots. \gamma_p = 0$, i.e., No ARCH effect

The hypothesis is tested by running the regression of squared residuals on the lagged squared residuals obtained by the equation (1).

The GARCH Model

In empirical research, equation specified in (3) practically needs the higher order of lags to capture the ARCH effect, the principles of parsimonious will be violated, requires more number of parameter and leads to loss of a degree of freedom. Therefore, the stated problems are addressed by Bollerslev and Taylor (1986) by proposing the GARCH model (Bollerslev, 1986). The GARCH model is the extension of the higher order of ARCH model in a parsimonious way without the loss of more of the degree of freedom.

The GARCH (1,1) model (Brooks, 2014; Gujarati, 2014) with a mean and conditional variance of u_t is represented as:

$r_t = \mu + \beta_1 r_{t-1} + u_t$ Here $u_t \sim$ N $(0, \sigma_t^2)$ (5)

σ_t^2 = var $(u_t/u_{t-1}, u_{t-2}, u_{t-3}, u_{t-4}, \dots\dots.) = \gamma_0 + \gamma_1 u_{t-1}^2 + \lambda_1 \sigma_{t-1}^2$ (6)

The model (6) indicates that the conditional variance of the error term depends both on squared error term and conditional variance of the previous period (Enders, 2008). The generalized to p[th] order of GARCH (q, p) is represented as:

$$\sigma_t^2 = \gamma_0 + \gamma_1 u_{t-1}^2 + \gamma_2 u_{t-2}^2 \dots. \gamma_p u_{t-p}^2 + \lambda_1 \sigma_{t-1}^2 + \lambda_2 \sigma_{t-2}^2 \dots\dots \lambda_q \sigma_{t-q}^2 \quad (7)$$

In general,

$$\sigma_t^2 = \gamma_0 + \sum_{i=1}^{p} \gamma_i u_{t-p}^2 + \sum_{i=1}^{q} \lambda_i \sigma_{t-q}^2$$

Here $\gamma_i \geq 0 \ \forall \ i = 1, 2, \dots. p$ (8)

Here $\lambda_i \geq 0 \ \forall \ i = 1, 2, \dots. q$

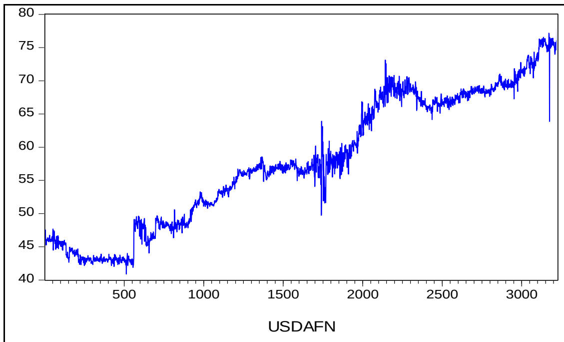
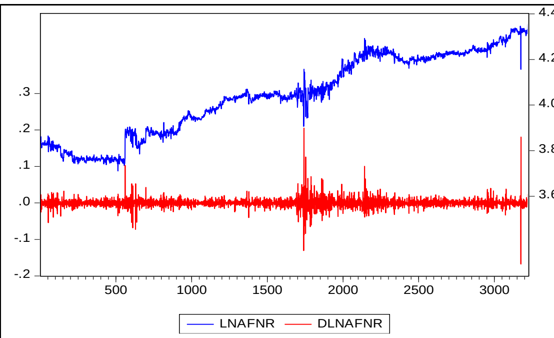


Figure 1



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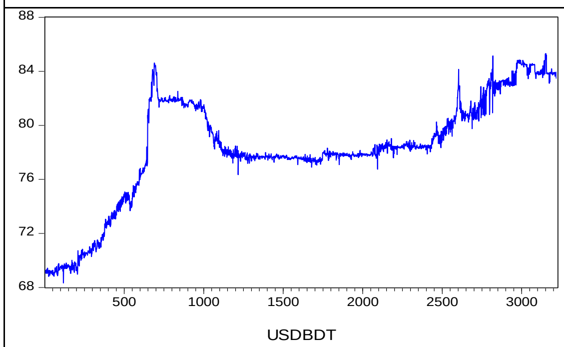

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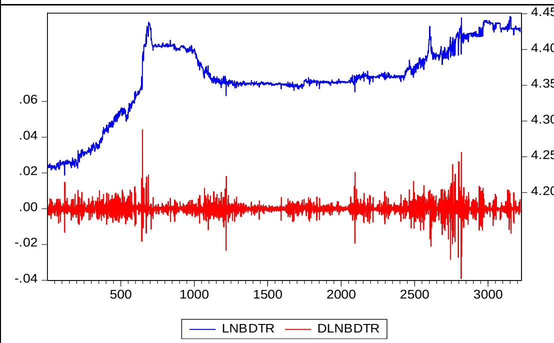

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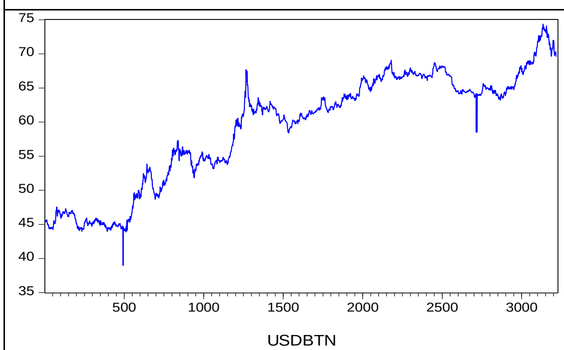

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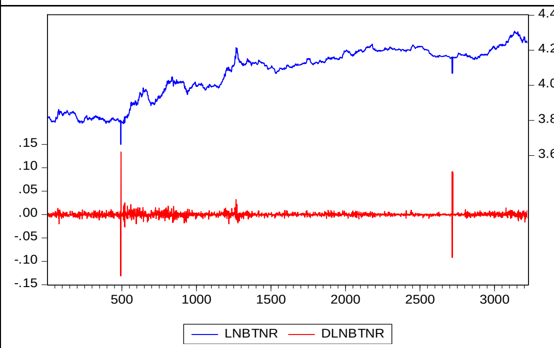

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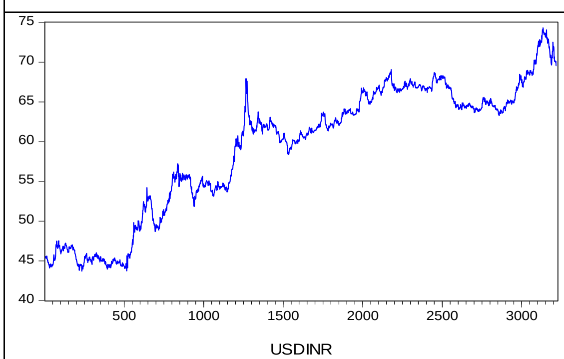

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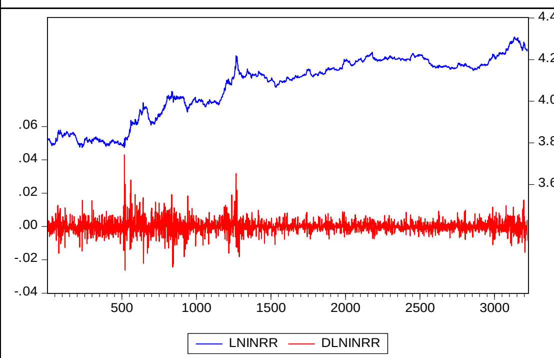

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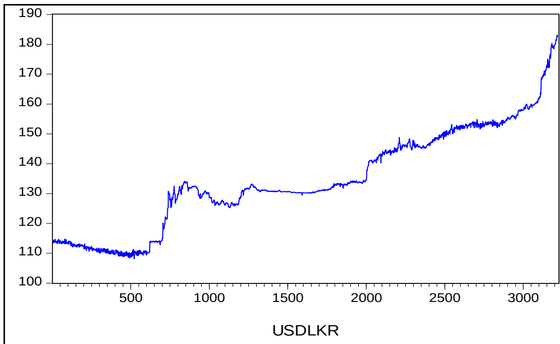
IJMSRR
E- ISSN - 2349-6746
ISSN -2349-6738



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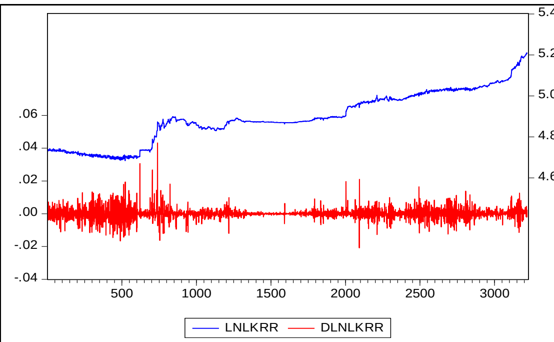

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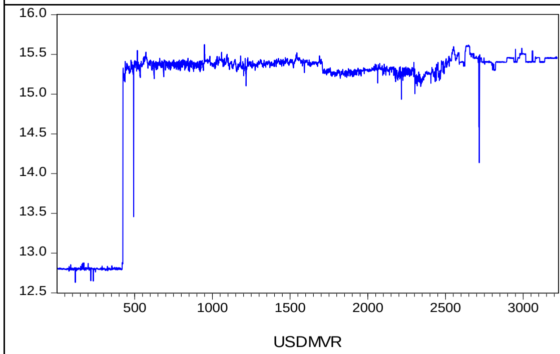

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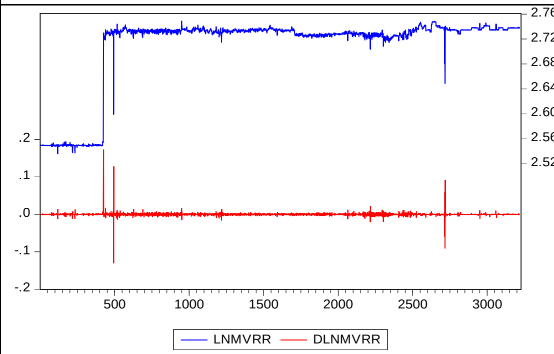

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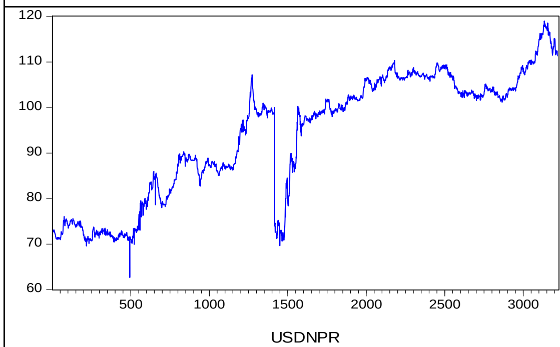

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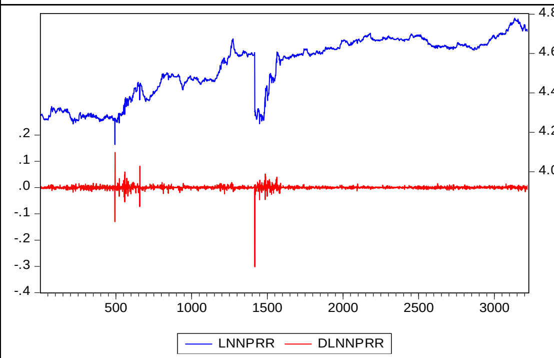

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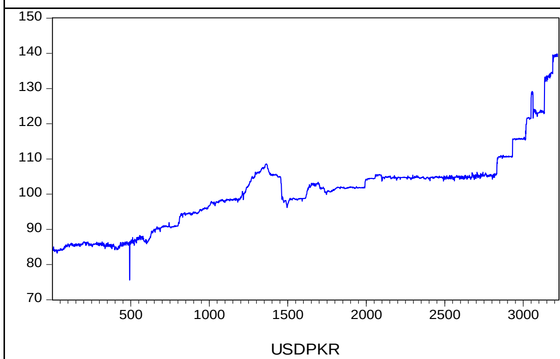

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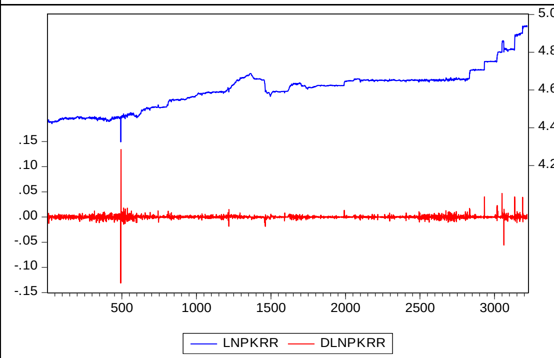

Figure 16

The EGARCH Model

The model to allow the asymmetric news effect, Nelson (1991) (Bollerslev et al., 1994) advocated the EGARCH model. The previous specified model of (4) and (8) require the fulfillment of conditionality of non- negativity constraint, however, the fulfillment of this non-negativity constraint, i.e., estimated coefficients must always be positive is relaxed in EGARCH model and it also ensures to test the leverage effects. Therefore, the EGARCH model (Braun et al., 1995) captures the impact of a shock in a well-defined way.

The mean model as similar as ARCH means model of (1) or GARCH mean model of (5) but the variance model is represented as follows:

$$\ln(\sigma_t^2) = \omega + \lambda_1 \ln(\sigma_{t-1}^2) + \theta_1 \left(\frac{u_{t-1}}{\sqrt{\sigma_{t-1}^2}}\right) + \gamma_1 \left[\frac{|u_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}}\right] \quad (9)$$

In model (9), λ_1 measures the conditional volatility, θ_1 measures the asymmetry and γ_1 indicates the γ_1 captures the magnitude effect. The symmetry of the model is expected when $\theta_1 = 0$ and less effect of positive shocks on volatility than the negative shock is indicated when $\theta_1 < 0$. When $\left(\frac{u_{t-1}}{\sqrt{\sigma_{t-1}^2}}\right)$ is positive, the effect of news or shock on $\ln(\sigma_t^2)$ is $\theta_1 + \gamma_1$. When $\left(\frac{u_{t-1}}{\sqrt{\sigma_{t-1}^2}}\right)$ is negative, the effect of news or shock on $\ln(\sigma_t^2)$ is $-\theta_1 + \gamma_1$. The presence of leverage effect is performed by testing the hypothesis of $\gamma_1 = 0$ (Wang, 2005).

Estimation Method

In the family of the ARCH model, both mean and variance equations are estimated simultaneously by maximizing the log-likelihood function under the normality assumption is given as

$$lnLF = -\frac{T}{2} ln(2\pi) - \frac{T}{2} ln\sigma^2 - \frac{1}{2\sigma^2} \sum_{t=1}^{T} (r_t - \mu + \beta_1 r_{t-1})^2$$

with subject to σ^2 and β.

Table 1: Descriptive Statistics of Changes in Daily Returns of SAARC Countries' Currencies

	DAFNR	DBDTR	DBTNR	DINRR	DLKRR	DMVRR	DNPRR	DPKRR
Mean	0.000158	6.04×10^{-5}	0.000136	0.000137	0.000147	5.85×10^{-5}	0.000136	0.000157
Median	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	9.05×10^{-5}
Maximum	0.2048	0.0443	0.1341	0.0430	0.0432	0.1725	0.1341	0.1341
Minimum	-0.1676	-0.0391	-0.1311	-0.0262	-0.0208	-0.1301	-0.3018	-0.1311
Std. Dev.	0.0131	0.0037	0.0059	0.0039	0.0034	0.0057	0.0086	0.0047
Skewness	1.4561	0.2387	0.2597	0.7544	1.1612	8.5320	-13.2612	0.9114
Kurtosis	52.0422	23.8424	231.9118	14.5828	19.1276	479.5617	522.3838	393.9434
Jarque-Bera	324329.60	58403.74	7041368.0	18333.65	35675.75	30557180.0	36343459.0	20537882.0
Probability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	3225	3225	3225	3225	3225	3225	3225	3225

Source: Author's computation by using data

Empirical Results

The E-Views software is used to estimate the model which relay on the Marquardt optimization algorithm by assigning the initial coefficients by using OLS values. The algorithm is designed with a maximum of 500 iterations with 0.0001 of convergence.

The investigation of the volatility clustering is examined by plotting the exchange rate series, log of exchange rates and changes in the returns of the exchange rate of SAARC countries. The odd numbered figures from **Figure 1** to **Figure 16**. represent the plot of the exchange rate of respective SAARC nations currency against US dollar and even numbered figures from **Figure 1** to **Figure 16** describes the scenario of exchange rate returns and changes in the exchange rate returns of respective SAARC nations currency against US dollar.

The exchange rate returns and changes in the exchange rate returns are plotted in the same diagram of the respective country. Hence, the non-constancy in the variance and clustering in the variance can be portrayed in these plots. These clustering in volatility provide an avenue to the modeling of change in the exchange rate returns through the ARCH and GARCH model.

Descriptive statistics on the changes in the daily returns of SAARC nations' currencies exchange rate per unit of US dollar is summarized in **Table 1.** The average of relative changes in the returns is very close to zero for all eight nations' currencies. The maximum relative changes of Afghanistan (Afghan Afghani) is higher with higher standard deviation it is on par with the theoretical line of "higher the risk, higher the returns." The skewness is positive for all relative changes in the returns of currencies except Nepal (Nepalese Rupee). Therefore, the presence of common phenomena of widespread right tail distribution is observed in the skewness value in **Table 1.** The leptokurtic characteristics of the fat tail are also evident from the Kurtosis value in **The EGARCH Model**. Since the value of Jarque-Bera statistics is statistically significant at 5%, therefore, changes in the returns of SAARC nations currencies follows a non-normal distribution.

Formal Pretest: Serial Correlation and the ARCH Effect

The existence of ARCH effect is always viable to fit the volatility model of the series; therefore, as a preliminary, the ARCH pre-test is conducted by using Ljung-Box Q test to test the presence of serial correlation and ARCH-LM test to verify the heteroscedasticity in the series.

The volatility clustering in the changes in the log of daily dollar and respective SAARC countries' currency exchange rate is observed in **Figure 2** (Afghanistan – Afghan Afghani), **Figure 4** (Bangladesh – Bangladeshi Taka), **Figure 6** (Bhutan – Bhutanese Ngultrum), Figure **8** (India – Indian Rupee), **Figure 10** (Sri Lanka – Sri Lankan Rupee), Figure **12** (Maldives – Maldivian Rufiyaa), **Figure 14** (Nepal – Nepalese Rupee) and **Figure 16** Pakistan – Pakistani Rupee).

The simple model of $r_t = \mu + r_{t-1} + u_t$ is estimated by using OLS technique and applied to capture the presence of volatility in the exchange rate exhibited in **Figure 2, 4, 6, 8, 10, 12, 14 and 16.** Here r_t = Percentage change in the exchange rate, μ = Constant used to measure the average value of daily returns of the exchange rate. u_t = Random term. By using the daily exchange rate returns data from 12 March 2009 to 01 January 2019, the following results are obtained.

The average changes in the daily return of all the eight nations currencies are very close to zero; however, the results obtained by using the model $r_t = \mu + r_{t-1} + u_t$ and presented in **Table 2** is not much importance since the model neither has any explanatory variable, however, AR (1) terms is used for better mean equation to nullify the specification error. The residuals and square of the residuals obtained from the above result is the base for the study to conduct the formal pre-test of ARCH effect.

The results of auto-correlation measured by using Q-Stat of Ljung-Box presented in **Table 3**. Even at the higher order of lags and 95% confidence interval for autocorrelation is given by $\pm 1.96 \times \frac{2}{\sqrt{T}}$ and the auto-correlation coefficients are lies outside the range (-0.03451, +0.03451); thus, the null hypothesis of auto-correlation coefficients is zero is rejected. The auto-correlation is significant only at higher lag for Indian Rupee, and the hypothesis of the auto-correlation coefficient of zero is not rejected for Nepalese Rupee where the p-value of Ljung-Box q statistics significant.

The results of the ARCH-LM test of heteroscedasticity is presented in **Table 3.** The ARCH-LM test result of F statistics and the chi-square distribution of Obs.*R-squared are statistically significant at 5% for changes in the returns of all SAARC countries' currencies except Nepalese Rupee. Therefore, the presence of ARCH is a common phenomenon. The hypothesis of the *existence of ARCH effect is a common phenomenon in the exchange rates of members of SAARC* cannot be rejected on the basis of the data used in the study.

Since the existence of ARCH effect is significant, the volatility model for all SAARC countries except Nepal Rupee is constructed by using mean model of AR(1) process of equation (1) of $r_t = \mu + \beta_1 r_{t-1} + u_t$. By using the model selection criterion of AIC, SIC, and HQC, the order of the ARCH is found. ARCH (8) is best suited for all the exchange rates except Nepal rupees. The ARCH (7) is appropriate for Indian Rupee. Hence, AR (1)-ARCH (8) are best suited for the changes in returns of exchange rates of Afghanistan, Bangladesh, Bhutan, Sri Lanka, Maldives, Pakistan, and AR (1)-ARCH (7) for India. All these models have the highest value for log-likelihood function and minimum a value of AIC and SIC. The appropriateness of the ARCH model is tested by examining the diagnostic test. The ACF, PCF, and Q-Stat of Ljung-Box was examined for residuals and squared residuals of from the fitted ARCH model. The ARCH-LM and normality test are examined.

Table 2: Regression Results of Changes in the Log of Daily Exchange Rate of Currencies of SAARC countries and US $

Co-efficient	Afghanistan	Bangladesh	Bhutan	India	Sri Lanka	Maldives	Nepal	Pakistan
	Afghan Afghani	Bangladeshi Taka	Bhutanese Ngultrum	Indian Rupee	Sri Lankan Rupee	Maldivian Rufiyaa	Nepalese Rupee	Pakistani Rupee
μ	0.0002	$6.01X10^{-5}$	0.0001	0.0001	0.0001	$5.83X10^{-5}$	0.0001	0.0002
Std. Error	0.0002	$4.67X10^{-5}$	$9.05X10^{-5}$	$6.93X10^{-5}$	$4.78X10^{-5}$	$7.39X10^{-5}$	0.0001	$7.64X10^{-5}$
t-Statistic	0.8923	1.2882	1.5053	1.9737	3.0823	0.7897	1.0492	2.0504
P Value	0.3723	0.1978	0.1323	0.0485	0.0021	0.4297	0.2942	0.0404
AR(1)	-0.2291	-0.3115	-0.1369	-0.0019	-0.2198	-0.2931	-149502	-0.09
Std. Error	0.0171	0.0167	0.0175	0.0176	0.0172	0.0168	0.0174	0.0175
t-Statistic	-13.3608	-18.6061	-7.8468	-0.1064	-12.7932	-17.4003	-8.5823	-5.1315
P Value	0.000	0.000	0.000	0.9153	0.000	0.000	0.000	0.000
F-Statistic	178.5113	346.1873	61.572	0.0113	163.6652	302.7692	73.6561	26.3321
P Value	0	0	0	0.9153	0	0	0	0
R^2	0.0525	0.097	0.0188	0.00	0.0483	0.0859	0.0223	0.0081
Adjusted R^2	0.0522	0.0967	0.0184	-0.0003	0.048	0.0856	0.022	0.0078
DW Statistics	2.0957	2.0792	2.0293	1.9994	2.0184	2.0879	2.0043	2.0431

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ISSN -2349-6738

Table 3: Pre-Formal Test for ARCH Effect

Currencies	Lag (k)	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Afghan Afghani	ACF	-0.05	-0.223	-0.057	-0.046	-0.02	-0.057	0.015	0.014	-0.001	-0.007	-0.072	0.036	0.02	0.03
	Q-Stat	7.484	168.3	178.8	185.6	187	197.5	198.2	198.8	198.8	199	215.8	220	221.3	224.2
	Prob.		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	ARCH LM	F-statistic = 24.19241 & Prob. F (10,3203) = 0.000							Obs.*R^2 = 225.7071 & Prob. Chi-Square (10) = 0.000						
Bangladeshi Taka	ACF	-0.04	-0.161	-0.119	-0.048	-0.036	0.03	0.08	-0.004	-0.025	-0.027	0.003	0.04	0.012	0.039
	Q-Stat	5.058	88.33	133.9	141.2	145.5	148.3	168.8	168.8	170.9	173.2	173.2	178.3	178.8	183.6
	Prob.		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	ARCH LM	F-statistic = 29.56409 & Prob. F (10,3203) = 0.000							Obs.*R^2 = 271.5883 & Prob. Chi-Square (10) = 0.000						
Bhutanese Ngultrum	ACF	-0.02	-0.119	-0.076	0.037	-0.07	0.013	0.036	0.0	0.012	0.004	0.001	0.008	0.019	0.015
	Q-Stat	0.71	46.79	65.31	69.74	85.48	86.01	90.1	90.1	90.56	90.6	90.6	90.81	92.02	92.73
	Prob.		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	ARCH LM	F-statistic = 93.7903 Prob. F (10,3203) = 0.000							Obs.*R^2 = 727.9619 & Prob. Chi-Square (10) = 0.000						
Indian Rupee	ACF	0	-0.017	-0.012	-0.02	0.001	0.053	0.034	0.037	-0.003	-0.007	-0.03	0.049	0.001	0.011
	Q-Stat	0	0.916	1.344	2.665	2.672	11.68	15.36	19.67	19.7	19.88	22.76	30.51	30.51	30.88
	Prob.		0.338	0.511	0.446	0.614	0.04	0.018	0.006	0.012	0.019	0.012	0.001	0.002	0.004
	ARCH LM	F-statistic = 42.6441 Prob. F (10,3203) = 0.000							Obs.*R^2 = 377.6291 & Prob. Chi-Square (10) = 0.000						

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Currencies	Lag (k)	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Sri Lankan Rupee	ACF	-0.01	-0.064	-0.1	0.013	0.016	0.035	0.017	-0.006	-0.004	-0.015	-0.012	0.027	-0.035	0.043
	Q-Stat	0.273	13.46	45.98	46.54	47.41	51.4	52.3	52.43	52.5	53.26	53.73	56.04	59.95	65.9
	Prob.		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	ARCH LM	F-statistic = 9.6967 & Prob. F (10,3203) = 0.0000							Obs.* R^2 = 94.44043 Prob. Chi-Square (10) = 0.0000						
Maldivian Rufiyaa	ACF	-0.04	-0.143	0.011	-0.041	-0.006	0.01	-0.002	-0.017	-0.005	0.002	0.015	-0.015	-0.01	0.035
	Q-Stat	6.235	72.61	73.02	78.35	78.47	78.78	78.79	79.74	79.81	79.83	80.59	81.34	81.66	85.67
	Prob.		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	ARCH LM	F-statistic = 12.8890 & Prob. F (10,3203) = 0.0000							Obs.* R^2 = 124.3292 & Prob. Chi-Square (10) = 0.0000						
Nepalese Rupee	ACF	-0	-0.011	0.02	-0.016	0	0.038	0.028	-0.004	-0.001	0.001	0.028	-0.013	0.001	0.009
	Q-Stat	0.016	0.443	1.799	2.64	2.64	7.212	9.706	9.761	9.768	9.773	12.26	12.78	12.78	13.04
	Prob.		0.506	0.407	0.451	0.62	0.205	0.138	0.203	0.282	0.369	0.268	0.308	0.385	0.445
	ARCH LM	F-statistic = 0.7087 & Prob. F (10,3203) = 0.7171							Obs.*R^2 = 7.095578 & Prob. Chi-Square (10) = 0.7164						
Pakistani Rupee	ACF	-0.02	-0.241	-0.009	-0.024	-0.023	0.026	0.007	0.032	0.036	-0.049	-0.02	0.041	-0.055	0.01
	Q-Stat	1.514	189	189.2	191.2	192.8	194.9	195.1	198.4	202.5	210.4	211.6	217	226.7	227
	Prob.		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	ARCH LM	F-statistic = 175.0088 & Prob. F (10,3203) = 0.000							Obs.*R^2 = 1135.611 & Prob. Chi-Square (10) = 0.0000						

Table 4: Results of GARCH (1, 1) Model

	Afghanistan		**Bangladesh**		**Bhutan**		**India**		**Sri Lanka**		**Maldives**		**Pakistan**	
	Coefficient	p	Coefficient	p	Coefficient	p	Coefficient	p	Coefficient	p	Coefficient	p	Coefficient	p
γ_0	$5.45X10^{-6}$	0.00	$3.68X10^{-7}$	0.00	$1.54X10^{-5}$	0.92	$2.90X10^{-7}$	0.03	$2.00X10^{-8}$	0.03	0.00017	0.10	$1.49\ X10^{-6}$	0.04
γ_1	0.1509	0.00	0.4532	0.00	0.8474	0.09	0.1225	0.01	0.3464	0.00	1.2763	0.10	1.2817	0.04
λ_1	0.827	0.00	0.7474	0.00	0.8477	0.00	0.9338	0.00	0.8566	0.00	0.601	0.00	0.633	0.00
$\gamma_1 + \lambda_1$	0.9779		1.2006		1.695		1.056328		1.2031		2.0174		1.914	
LLF	10654.4		14926.37		14251.8		14059.98		15212.3		13681.59		15205.22	
AIC	-6.6057		-9.2558		-8.8374		-8.71835		-9.4332		-8.4842		-9.4288	
BIC	-6.5944		-9.2445		-8.826		-8.70704		-9.4219		-8.4749		-9.4175	
$\frac{\gamma_0}{1-\lambda_1-\gamma_1}$	0.000246		$-1.83X10^{-6}$		$-2.22X10^{-5}$		$-5.15X10^{-6}$		$-9.85X10^{-8}$		$-9.2X10^{-8}$		$-1.63X10^{-6}$	

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E- ISSN - 2349-6746
ISSN -2349-6738

Table 5: Results of the EGARCH Model

	Afghanistan		Bangladesh		Bhutan		India		Sri Lanka		Maldives		Pakistan	
	Coefficient	p	Coefficient	p	Coefficient	p	Coefficient	p	Coefficient	p	Coefficient	p	Coefficient	p
ω	-0.47062	0.00	-0.86756	0.00	-0.46610	0.00	-0.16592	0.00	-0.17214	0.00	-0.37865	0.00	-0.22387	0.00
λ_1	0.96593	0.00	0.95014	0.00	0.96630	0.00	0.99136	0.00	0.995333	0.00	0.97228	0.00	0.98363	0.00
θ_1	-0.00472	0.82	-0.03730	0.19	0.15806	0.02	0.14123	0.00	-0.02999	0.09	-0.16031	0.00	0.05893	0.00
γ_1	0.23717	0.00	0.52743	0.00	0.48546	0.01	0.05950	0.00	0.243415	0.00	0.26679	0.00	0.13771	0.00
LLF	10660.03		14938.86		14278.92		14066.86		15241.93		16166.02		13337.54	
AIC	-6.6086		-9.2629		-8.8536		-8.7220		-9.4510		-10.0242		-8.2696	
BIC	-6.5954		-9.2497		-8.8404		-8.7088		-9.4378		-10.0110		-8.2564	

The ACF values are shown decay with higher lag length. However, the PCF for squared residuals become non zero even after higher lag length. Posttest of ARCH-LM homoscedasticity is satisfied and normal distribution of the residuals is violated. The concern of ACF and PCF, loss of a degree of freedom and to support the principle of parsimonious, the GARCH model is constructed.

The result of GARCH (1, 1) is presented in **Table 4**. The GARCH (1, 1) is appropriate for changes in the exchange rate return of Afghanistan since the sum of γ_1 and λ_1 is less than one but very close to one and unconditional variance is 0.000246. The GARCH (1, 1) model for the other changes in the returns for Bangladesh, Bhutan, India, Srilanka, Maldives, and Pakistan is not appropriate. Since $\gamma_1 + \lambda_1 > 1$, the unconditional variance of u_t is undefined, and it is generally known as 'non-stationary in variance' (Brooks, 2014), and these models usually have undesirable properties.

Table 5 provides the results of the EGARCH model. The fitness of the EGARCH model is better than the GARCH (1, 1) except Pakistan since the AIC and BIC are lower in EGARCH than the GARCH (1, 1) model. The coefficients of θ_1 are significantly different from zero since the p values are very low; therefore, the EGARCH model for changes in the returns of the exchange rate is asymmetric (Asteriou & Hall, 2015). The coefficient of $\theta_1 < 0$ for exchange rate returns of Afghanistan, Bangladesh, Sri Lanka, and the Maldives and statistically significant, the bad news has larger effects on the volatility of the series than good news. Hence, the positive shock generates less volatility than negative shocks. The impact of the shock on volatility in the model is captured by λ_1. The value of $\lambda_1 > 0.5$; therefore, the persistence of shock does not die out rapidly (Salisu, 2011; Salisu & Mobolaji, 2013). Thus, the hypothesis of there is no evidence of the existence of asymmetrical shocks in exchange rates of member nations, and another hypothesis of persistence of the shocks to the returns of exchange rates of SAARC is temporary can be rejected.

Discussion

The present research paper found some of the important characteristics of the existence of volatility in the change of exchange rates of SAARC nations currencies. Except for Nepal, all SAARC partners do have volatility in the exchange rate against the US dollar. The shock prevailed in the volatility do not die out rapidly, and the effect of bad news has a more significant impact on the conditional variance of the series. Therefore, all SAARC members do have common properties in the variation in the exchange rate of their domestic currencies against the US dollar. Reducing the exchange rate variation enable the member nations to pursue the common goal of formation of SAARC as regional co-operation center. Exchange rate risk, uncertainties and traction cost involved in the exchange of the currency among the member nations can be reduced to a larger extent by looking forward by creating a common currency. Thus, the paper shed light for future research to look into the benefits arise by reducing the transaction cost.

Conclusion

The logic of assessing the exchange rate variation helps in analyzing the common characteristics shared by SAARC nations. As a partner of economic integration, the monetary and financial integration of the nations' depends on the similarity in the shocks of the members' nations. The present research paper highlighted that though the exchange rates of the SAARC nations do not follow the fixed exchange rate to reap the greater economic and non-economic benefits of economic integration; however, the exchange rate variation of the partner countries are very much similar. Therefore, synthesis in the political will of the policymakers in designing the monetary policy and exchange rate policies will improve the collective benefits of SAARC nations. The reductions in the barriers to making closeness among SAARC nations must require promoting the trade creating provisions.

References

1. Asteriou, D., & Hall, S. G. (2015). Applied econometrics. Macmillan International Higher Education.
2. Bollerslev, T. (1986). Generalized autoregressive conditional heteroskedasticity. Journal of Econometrics, 31(3), 307–327.
3. Bollerslev, T., Engle, R. F., & Nelson, D. B. (1994). ARCH models. Handbook of Econometrics, 4, 2959–3038.
4. Braun, P. A., Nelson, D. B., & Sunier, A. M. (1995). Good news, bad news, volatility, and betas. The Journal of Finance, 50(5), 1575–1603.
5. Brooks, C. (2014). Introductory econometrics for finance. Cambridge university press.
6. Brooks, C., & Burke, S. P. (1998). Forecasting exchange rate volatility using conditional variance models selected by information criteria. Economics Letters, 61(3), 273–278.
7. Brooks, C., Burke, S. P., Heravi, S., & Persand, G. (2005). Autoregressive conditional kurtosis. Journal of Financial Econometrics, 3(3), 399–421.
8. Brooks, C., Burke, S. P., & Persand, G. (2001). Benchmarks and the accuracy of GARCH model estimation. Elsevier.
9. Diebold, F. X. (2012). Empirical modeling of exchange rate dynamics (Vol. 303). Springer Science & Business Media.
10. Dubey, M. (2007). SAARC and South Asian economic integration. Economic and Political Weekly, 1238–1240.
11. Enders, W. (2008). Applied econometric time series. John Wiley & Sons.
12. Engle, R. F. (1982). Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. Econometrica: Journal of the Econometric Society, 987–1007.
13. Engle, R. F., & Ng, V. K. (1993). Measuring and testing the impact of news on volatility. The Journal of Finance, 48(5), 1749–1778.
14. Fama, E. F. (1984). Forward and spot exchange rates. Journal of Monetary Economics, 14(3), 319–338.
15. Friedman, D., & Vandersteel, S. (1982). Short-run fluctuations in foreign exchange rates: Evidence from the data 1973–1979. Journal of International Economics, 13(1–2), 171–186.
16. Gujarati, D. (2014). Econometrics by example. Macmillan International Higher Education.
17. Hsieh, D. A. (1988). The statistical properties of daily foreign exchange rates: 1974-1983. Journal of International Economics, 24(1–2), 129–145.
18. Hsieh, D. A. (1989a). Modeling heteroscedasticity in daily foreign-exchange rates. Journal of Business & Economic Statistics, 7(3), 307–317.

IJMSRR
E- ISSN - 2349-6746
ISSN -2349-6738

19. Hsieh, D. A. (1989b). Testing for nonlinear dependence in daily foreign exchange rates. Journal of Business, 339–368.
20. Krugman, P. R. (2008). International Economics: Theory and policy, 8/E. Pearson Education India.
21. Mandelbrot, B. B. (1997). The variation of certain speculative prices. In Fractals and scaling in finance (pp. 371–418). Springer.
22. Panchamukhi, V. R. (1990). Economic cooperation in the SAARC region: potential, constraints, and policies. Interest Publications.
23. Pindyck, R. S., & Rubinfeld, D. L. (1988). Econometric models and economic forecasts.
24. Richard, H., & Sollis, R. (2003). Applied Time Series Modelling and Forecasting. John Wiley and Sons, Chichester, ISBN 0-470-84443-4, International Journal of Forecasting, 20(1), 137–139.
25. Salisu, A. A. (2011). Modeling and Forecasting Exchange Rate Volatility in Nigeria: Does One Model Fit All? Modeling and Forecasting Exchange Rate Volatility in Nigeria: Does One Model Fit All? 1.
26. Salisu, A. A., & Mobolaji, H. (2013). Modeling returns and volatility transmission between oil price and US–Nigeria exchange rate. Energy Economics, 39, 169–176.
27. Salvatore, D. (2013). International economics. John Wiley & Sons.
28. Tsay, R. S. (2005). Analysis of financial time series (Vol. 543). John Wiley & Sons.
29. Wang, P. (2005). Financial econometrics. Routledge.