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Validating Stationarity as an Antecedent to Studying the Impact of Exchange Rate Volatility on Bankex Values

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Abstract: The time series data were experimented for Unit-Root. This test normally conducted to ascertain the time series stationarity and to agree on the array of assimilation of the variables. It is obligatory to conduct the Unit-Root test for the rationale that the trouble of variables with non-stationary producing spurious or meaningless effects due to the occurrence of trend in the data series. This testing procedure is completed by means of the Unit-Root testing methodology. In this paper stationarity assessed for the data collected for the purpose of studying the impact of exchange rate instability on stock prices of banking organizations recorded in the BSE (BSE Bankex) for the data collected from April 2010 to March 2020. To decide the nearness of Unit-Root in the time series data, Augmented Dickey-Fuller and Kwiatkowski-Phillips-Schmidt-Shin tests are used. The results reveal that the data collected are said to be stationary. This stationarity status of the data could help in validating the results on significant effect on the stock index values of BSE Bankex.

Keywords: Unit-Root analysis, Time series, Exchange rate volatility, ADF test, KPSS test

1. Introduction

There are definite ingredients compulsory to build rationalization for exchange rate volatility (Devereux & Engel, 2002). The relationship between exchange rate and some macro factors like stock index values of a particular sector is an important component of predicting movements of those market values (Sahoo & Trivedi, 2018). The exchange rates have had been extremely volatile in the last three decades that affects various micro and macro level markets' financial volatilities. Further, there is a consensus in the empirical literature regarding higher vulnerability to market shocks (Dua& Suri, 2018).

Estimation of the volatility pattern of S&P BSE Bankex index of India is significant in relation to various applications of the financial market, India is one of the fastest growing country in the world and this reflected by emerging capital market (Agrawal, 2019). Financial modeling highlights the facts that

the stock price or market movement exhibits certain major formalized facts such as volatility clustering, conditional Heteroscedasticity, asymmetric volatility effect, unconditional time-varying movement. (Khan & Javed, 2017).

The time series data were tested for the presence of Unit-Root. This is a check carried out to institute the time series' stationarity and to agree on the order of assimilation of the variables (Diebold & Nerlove, 1989). And also, the data is said to be not in stationarity if the variance and/or the mean are not stable over time. It is necessary to perform the Unit-Root test for the reason that the dilemma of variables with non-stationary producing spurious or meaningless effects due to the occurrence of trend in the data series. According to Dickey and Fuller (1979), testing for Unit-Root is the first step of time series model building. In analyzing time series, both single-equation as well as multi-equation regression models are used in econometrics and statistics for modelling its variables and their interrelations. According to Box and Jenkins (1970) the basic assumption of these use is stationarity of time series data. The calculation and then verification of integration order requires certain Unit-Root tests (Shiller & Perron, 1985). This composes the check more constructive to the approval of Unit-Root hypothesis in different economic time series.

The beginning of the time series analysis is finding the stationarity property of the time series data. Several research works on this area opines that there might be a fake relapse on account of non-fixed data series. Subsequently, testing the stationarity is the fundamental advance in both determining and dynamic modeling analysis. To have significant outcomes from an econometric model, it is fundamental to decide if the information are fixed or not. There are a great number of econometric books that have characterized fixed series as the one having factual properties such a mean, fluctuation, and covariance as consistent (Diebold & Nerlove, 1989). Notwithstanding, essentially, there is generous number of examples where mean of the variable isn't differing, however generally information tend to return to their mean. In such situations, time series is fixed regardless of the way that mean of the series is nonconstant. Subsequently the idea of stationarity is for the most part associated with the inversion of series to its mean as opposed to placing this with regards to steady mean or difference. On the off chance that the time series isn't fixed, at that point the investigation of the series is significant just for the viable time period. The conduct can't be summed up for the other time series because of its non-mean-inversion property (Devereux & Engel, 2002). The idea of stationarity is truly significant in building a right econometric model.

Testing for Stationarity

There are a few tests to check the stationarity properties in the time series information. On the off chance that we need to get a speculation about the time series, at that point we will plot the information series. It will provide an underlying insight and natural feel about the time series information. It merits referencing that plotting the information is significant also. Chatfield (2004) takes note of that "Any individual who attempts to break down a time series without plotting it initially is requesting inconvenience".

As indicated by Bamber, Barron & Stevens (2010), a key idea fundamental time series forms is that of stationarity on the grounds that non-stationary series nullifies the standard measurable tests since its difference isn't consistent. In the event that key variables of the time series are seen as stationary, at that point it is important to remember them for the regression model (Barguellil, Ben-Salha & Zmami, 2018). Then again, on the off chance that at least one of the key variables of the series are seen as non-

stationary, their incorporation into a regression model commonly brings about fake regression and, in this way, broken analysis (Devereux & Engel, 2002).

A time series that is non-stationary is said to show Unit-Root. Consequently, the standard suspicions for regression analysis won't be substantial thus speculation tests about the regression can't truly be embraced (Dominguez, 1998). It is, in this manner, imperative to initially test for the stationarity of time series variables to build up the status of a Unit-Root. This testing procedure is completed by means of the Unit-Root testing methodology. There are a few techniques for testing the nearness of Unit-Root in the time series model they include: Dickey-Fuller (DF) test; Augmented-Dickey-Fuller (ADF) test; Philip-Peron (PP) test; and Kwiatkowski Phillips Schmidt Shin (KPSS) test.

As indicated by Gassen (2014), the most significant analysis of DF, ADF and PP tests is that their capacity is low if the procedure is stationary yet with a root near the non-stationary limit. In any case, Gassen (2014) opines that the KPSS test procedure was designed to enhance a few shortcomings present in the DF, ADF, and PP tests especially in the end of conceivable autocorrelation. According to Gassen (2014) KPSS is a prevalent model since one can perceive series that emit an impression of being fixed, arrangement that appear to have a Unit-Root and series for which the tests are not edifying on whether the arrangement is fixed or incorporated.

ADF Test:

Augmented-Dickey-Fuller test is a testing practice for the Unit-Root proposition, popularly known as ADF test (Dickey and Fuller (1981)). This test is based on appropriating auto-regression of the same order. The formula for ADF test is given below:

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \cdots + \delta_{p-1} \Delta y_{t-p+1} + \varepsilon_t,$$

Where α = constant, β = coefficient of time trend and p refers to lag order of auto regressive process. Here, the Unit-Root test is conducted null hypothesis against the alternative hypothesis. As this test is non-symmetrical, absolute value need not be considered. Based on the result, if critical value is less, the null hypothesis is declined and decided that no Unit-Root is present.

KPSS Test:

The Kwiatkowski–Phillips–Schmidt–Shin test is simply called as KPSS test. Kwiatkowski, Phillips, Schmidt & Shin (1992) propounded a test that an observable stationarity of time series is in a deterministic trend. The formula for KPSS test is

$$KPSS = \left(T^{-2} \sum_{t=1}^{T} \hat{S}_t^2 \right) / \hat{\lambda}^2$$

Where regression's (y_t) residual is calculated as $\hat{S}_t = \sum_{j=1}^{t} \hat{u}_j,\ \hat{u}_t$ on D_t and λ^2 which is a constant approximation in case of longitudinal variance u_t and $\hat{}u_t$.

2. Research Methodology

Before studying the exchange rate's impact on instability of stock prices of banking organizations recorded in the BSE (BSE Bankex), this research paper is an analysis of time series' stationarity data collected. After estimation of the model, all the applicable tests to find out the econometric legitimacy of the assessed models were done and introduced. McNichols (2000) contends that series tests ought to be performed so the model at long last picked is a decent model as in all the evaluated coefficients have the correct signs, and are measurably noteworthy based on the t and F tests. Similarly, Viswanathan (2005) explains that traditional linear regression procedure necessitates that all the essential suppositions be made close by the satisfaction of specific aspects that should clasp for the variables under investigation. Thus, for the purpose of testing stationarity, Unit-Root tests are conducted.

Unit-Root Analysis

As indicated by Bamber, Barron & Stevens (2010), a key idea fundamental time series forms is that of stationarity on the grounds that non-stationary series nullifies the standard measurable tests since its difference isn't consistent. In the event that key variables of the time series are seen as stationary, at that point it is important to remember them for the regression model (Vasani, Selvam & Selvam, 2019). Then again, on the off chance that at least one of the key variables of the series are seen as non-stationary, their incorporation into a regression model commonly brings about fake regression and, in this way, broken analysis.

A time series that is non-stationary is said to show Unit-Root. Consequently, the standard suspicions for regression analysis won't be substantial thus speculation tests about the regression can't truly be embraced. It is, in this manner, imperative to initially test for the time series' stationarity to build up the status of a Unit-Root. This testing procedure is completed by means of the Unit-Root testing methodology. There are a few techniques for testing the nearness of Unit-Root in the time series model they include: Dickey-Fuller (DF) test; Augmented-Dickey-Fuller (ADF) test; Philip-Peron (PP) test; and Kwiatkowski Phillips Schmidt Shin (KPSS) test.

As indicated by Gassen (2014), the most significant analysis of DF, ADF and PP tests is that their capacity is low if the procedure is stationary yet with a root near the non-stationary limit. In any case, Gassen (2014), states that the KPSS test procedure was designed to enhance a few shortcomings present in the DF, ADF, and PP tests especially in the end of conceivable autocorrelation. Gassen (2014) states that KPSS is a predominant model since one can recognize series that give off an impression of being stationary. Along these lines, to decide the nearness of Unit-Root in the time series data, this investigation applied both the Augmented-Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests.

The target population for this study comprised of all the listed banks in the BSE. The data utilized right now dependent on month-to-month stock prices of all banks listed in the BSE. For this study the data pertaining to the following are utilized:

1. S&P BSE Bankex
2. INR/USD Exchange Rate
3. Inflation rate.
4. RBI money lending rate.
5. Commercial banks interest rates.
6. Inter-bank lending rates.

S&P BSE Bankex indices (has constituents of the S&P BSE 500 which are categorized as components of the banking segment as defined by the BSE industry classification system) and exchange-rate

(INR/USD) volatility was analysed. The data are collected from April 2010 to March 2020 which are shown in the following table 1.

Table 1: Monthly mean values for Bankex and other monetary variables for the period from April 2010 to March 2020

Month	*Bankex*	*Daily RBI Rate*	*Monthly RBI Rate*	*Monthly Mean Inflation Rate*	*RBI Repo Rate*	*Inter Bank Lending Rate*	*Commercial Banks Interest Rate*
Apr 10	11155.07	44.46214	44.275	13.33	5.25%	12	11.75
May 10	10656.56	45.83548	46.365	13.91	5.25%	12	11.75
Jun 10	10765.03	46.48357	46.445	13.73	5.25%	12	11.75
Jul 10	11539.55	46.81805	46.405	11.25	5.50%	8	11.75
Aug 10	12190.64	46.57014	47.065	9.88	5.50%	8	12.25
Sep 10	14025.04	45.87271	44.57	9.82	6.00%	8	12.25
Oct 10	14016.21	44.35167	44.325	9.7	6.00%	8.5	12.5
Nov 10	13618.77	44.99524	45.8	8.33	6.25%	8.5	12.5
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Aug 19	30949.72	71.30538	71.453	6.31	5.40%	9.4	13.8
Sep 19	32889.09	71.35352	70.645	6.98	5.40%	9.4	13.7
Oct 19	33924.81	71.01033	70.98	7.62	5.15%	9.4	13.7
Nov 19	36190.99	71.50538	71.749	8.61	5.15%	9.4	13.7
Dec 19	36671.5	71.14319	71.355	9.63	5.15%	9.4	13.2
Jan 20	35289.35	71.2659	71.555	7.49	5.15%	9.4	13.2
Feb 20	33416.19	71.537	72.539	6.84	5.15%	9.4	13.2
Mar 20	22050.02	74.6451	75.343	5.91	4.40%	9.4	12.9

Source: *Data (2020)*

3. Findings and Discussions

This study applied the Jarque-Berra (J-B) test to establish whether the residuals were normally distributed. The null hypothesis for Jarque Berra test states that the observed data fit the normal distribution, while the alternative hypothesis says that the experimental data is not fitting the normal distribution. Usually, the Jarque-Berra critical value (CV) at 5 percent significant level is 5.991. Hence, in order not to decline the null hypothesis which states that the observed data fits the normal distribution, the computed J-B statistic should be less than the critical value, while the computed corresponding P-value should be greater than 0.05. If the corresponding P-value is minute, typically smaller than or equal to the connotation level, then it suggests that the observed data is not consistent with the supposition that the null hypothesis is right hence null-hypothesis is rejected. According to Thomas (2017), in a normal distribution series, the skewness should be zero (0) and the kurtosis should be three (3). The output results of Jarque-Berra normality test were generated, summarized and presented as shown in Table 2.

Table 2: Summary of Jarque-Berra Normality Test Results

Histogram – Normality Test	Jarque – Berra Statistic	1.471834
	Probability	0.532100
Critical Value at 5%		**5.821**

Source: *Author's findings*

Output results in table 2 point out that at 5 percent significant level the computed Jarque-Berra statistic is 1.471834 which is less than the critical value of 5.821 (that is, 1.471834 < 5.821). Further, the computed corresponding P-value is 0.532100 which is greater than 0.05 (that is, 0.532100 > 0.05). Hence, as a rule of thumb, the null hypothesis couldn't be dismissed at 5 percent level of significance, which shows normal distribution. Therefore, Jarque-Berra normality test results confirm that the assumption of normality distribution was not violated by the data series. Green (2008), states that if the residuals display a normal distribution pattern then it implies normal distribution of coefficient estimates.

Unit-Root Test Output

Augmented-Dickey-Fuller (ADF) test (Alexander et al, 2013) is often criticized for its low power, this study complemented Unit-Root test with Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests procedure. Gujarati (2003) states that KPSS is a superior aspect because one can tell apart amid series that show to be stationary, sequence that come out to have Unit-Root, and cycle for which the tests are not useful on the fact that the series is immobile or not.

The results of the Augmented-Dickey-Fuller (ADF) tests were generated, summarized and presented as shown in Table 3.

Table 3: ADF Unit-RootTest Results

Variable	*Intercept Only*	*Trend and Intercept*	*Status*
Stock Price (P-value)	-4.521677 (0.000000)	-3.8235124 (0.000001)	Stationary
Daily Mean Exchange Rate (P-value)	-4.762399 (0.000000)	-6.012271 (0.000000)	Stationary
Monthly Mean Exchange Rate (P-value)	-3.39876342 (0.000001)	-4.89776432 (0.000005)	Stationary
Inflation Rate (P-value)	-2.321765 (0.000335)	-3.0122324 (0.000533)	Non Stationary
RBI Repo Rate (P-value)	-2.796453 (0.000000)	-3.123211 (0.000001)	Stationary
Inter-Bank Lending Rate (P-value)	-2.548782 (0.009322)	-2.653234 (0.027861)	Stationary
Comm. Banks Interest Rate (P-value)	-1.457832 (0.012319)	-1.548982 (0.0321345)	Non Stationary
Critical Values: **1%** **5%** **10%**	 -3.489342 -2.923124 -2.589432	 -4.313452 -3.608543 -3.213432	

Source: *Author's findings*

Note that the figures in parenthesis represent the P-values hence significant at 5 per cent level. The Augmented-Dickey-Fuller (ADF) test is stand on the null-hypothesis that the progression has Unit-Root and another supposition that the series has no Unit-Root. It is imperative to note that, if the calculated Augmented-Dickey-Fuller (ADF) statistics are superior than the asymptotic critical values in complete terms, then the null hypothesis that the progression contained Unit-Root was not accepted and the series concluded to be immobile (Judge *et al.*, 1985).

The ADF Unit-Root test result output in table 3 point outs that stock index values, daily mean exchange rate, monthly mean exchange rate, RBI Repo Rate, and inter-bank lending rates were stationary. However, ADF Unit-Root test result output in table 3 reveal presence of Unit-Root in two variables namely: Inflation Rate and Commercial Banks Interest Rate.

Since ADF Unit-Root test results show presence of Unit-Root in some variables, the data was further analyzed using Kwiatkowski-Phillips-Schmidt-Shin (KPSS) superior criterion. According to Gujarati (2003), KPSS is a superior criterion because one can discriminate amid series that become visible to be

immobile, whether the series is stationary or integrated. The results of the KPSS tests were generated, précised and presented as shown in Table 4.

Table 4: Summary of KPSS Stationarity Test Results

Variable	*Intercept Only*	*Lag Length*	*Intercept and Trend*	*Lag Length*	*Status*
Stock Index Values (P-value)	0.453213 (0.0000)	6	0.310307 (0.000321)	6	Stationary
Daily Mean Exchange Rate (P-value)	0.189594 (0.0000)	6	0.080040 (0.043237)	6	Stationary
Monthly Mean Exchange Rate (P-value)	0.189594 (0.0000)	6	0.080240 (0.004323)	6	Stationary
Inflation Rate (P-value)	0.230057 (0.0000)	7	0.056432 (0.000792)	7	Stationary
RBI Repo Rate (P-value)	0.161121 (0.0000)	7	0.089286 (0.009790)	7	Stationary
Inter-Bank Lending Rate (P-value)	0.223922 (0.0000)	7	0.089833 (0.006193)	7	Stationary
Comm. Banks Interest Rate (P-value)	0.752108 (0.0000)	7	0.095362 (0.000000)	7	Stationary
Critical Values: 1% 5% 10%	0.739000 0.463000 0.347000		0.216000 0.146000 0.119000		

Source: *Author's findings*

Note that the figures in parenthesis represent the P-values hence significant at 5 percent level. For a variable to be fixed, the figured Lagrange Multiplier (LM) statics must be not exactly the asymptotic basic qualities at individual critical levels. The Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test depends on the invalid speculation that the information arrangement is fixed and the elective theory that the information arrangement isn't fixed. It is imperative to take note of that, if the processed Kwiatkowski-Phillips-Schmidt-Shin (KPSS) insights are not exactly the asymptotic basic qualities in total terms, at that point the invalid theory that the information arrangement is fixed was not to be dismissed subsequently

the information arrangement was closed to be fixed at particular huge levels (Dua& Suri, 2018 and Najaf, 2016).

The KPSS brings about table 4 show that all variables were fixed at either block just or with both pattern and capture. Consequently, all the variables were incorporated of request I (0). This is on the grounds that the figured Lagrange Multiplier (LM) Statistics were not exactly the asymptotic basic qualities at separate huge levels. Since KPSS Unit-Root tests uncovered that all the variables were fixed, this alluded to no presence of a since quite a while ago run connection between the variables subsequently the variables under scrutiny are not co-integrated. Along these lines, there was no requirement for taking Co-integration investigation (Mallikarjuna & Rao, 2017). The information was, in this manner, fit for estimation. The ADF Unit-Root test yield in table 3 and the KPSS stationarity test yield in table 4 demonstrate that ADF test utilizes invalid speculation that an arrangement contains a Unit-Root, while KPSS test utilizes invalid theory that the arrangement is fixed. On one hand while ADF results show nearness of Unit-Root in certain variables proposing that the information arrangement is to be differenced consequently be exposed to Cointegration tests, then again KPSS results show that all variables were fixed subsequently coordinated of request I(0).

By synthesizing both the Unit-Root speculation and the stationarity theory, one can recognize arrangement that seem, by all accounts, to be fixed, arrangement that seem to hold a Unit-Root, series for if the information (or the tests) are not effectively enlightening to be certain whether they are fixed or incorporated (Gujarati, 2003). In view of these perceptions it is reasonable that ADF tests be enhanced by KPSS tests. Henceforth, these exact outcomes are in concurrence with those by Alexander et al (2013), who expresses that ADF model has a lower intensity of testing for stationarity. Further, these discoveries are in concurrence with Gujarati (2003) who expresses that KPSS is unrivaled rule since one can recognize arrangement that give off an impression of being fixed, series might have Unit-Root, and arrangement for which the tests are not enlightening on whether the arrangement is fixed or incorporated. Consequently, these investigation results may clarify why Manu and Bhaskar (2018) differenced their information arrangement thus exposing their outcomes to Cointegration tests since they applied ADF Unit-Root test just without enhancing it with KPSS test.

4. Conclusion

The study was conducted in an effort to understand the effect of stationarity or non-stationarity of time series data. This aspect was tested from a set of data collected from 2010 to 2020 with respect to exchange rate volatility on BSE Bankex values. Here, to find the time series' stationarity and to agree on the array of assimilation of the variables, ADF tests and KPSS tests are conducted. Since, the variance and average of a time-series are constant, the data collected are decided to be stationary. Thus this data could be further analyzed to find the liaison between exchange rate instability and stock index values with respect to certain variables selected (Babu & Hariharan, 2018). This stationarity status of the data could help in validating the results on significant effect on the stock index values of BSE Bankex.

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