

An Empirical Analysis on the Weak form Market Efficiency in the Bangladeshi Pharmaceutical Industry- A Case Study of Renata Ltd

Zaeem-Al Ehsan

Institute of Business Administration, University of Dhaka, Bangladesh.
E-mail: zaeemal-2016718366@iba.du.ac.bd

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Abstract: The paper aims to assess the market efficiency of Renata Ltd in the weak form by analyzing monthly returns ranging from December 2007 to April 2021. Past literature on the same topic uncovered the non-existence of efficiency in the weak form in the Dhaka Stock Exchange. Initially, a descriptive analysis was done using the 4 moments of Renata Ltd and the Dhaka Stock Exchange broad market exchange. A graphical analysis using P-P and Q-Q plots rejected the assumption that the returns of Renata Ltd come from a normal distribution. This was further supported by Jarque-Bera and Shapiro-Wilk tests of normality which also rejects the null hypothesis of the returns of Renata Ltd having come from a normal distribution. Graphical tests of autocorrelation were made to uncover the presence of any correlation between returns of Renata Ltd, which was found to not exist. Thus, we can assert that there is no presence of serial correlation, and therefore, the market is efficient in the weak form according to the graphical analysis of correlograms. To quantifiably test the presence of a random walk effect, the Durbin-Watson, Breusch Godfrey, Portmanteau, runs, Augmented Dickey-Fuller (ADF) and variance root tests were undertaken. All tests support the fact that Renata Ltd.'s return does follow a random-walk process, implying the existence of weak form market efficiency.

Keywords: EMH, random-walk, ADF, Breusch Godfrey, P-P, Durbin Watson, Portmanteau, unit root, Jarque-Bera, Shapiro-Wilk, Q-Q, variance-root, structural break

JEL code: C01, C22, C40, C50, C58, O16, P34

1. Introduction

The conundrum for policymakers as Bangladesh ventured into the last year of its 7th FYP was to harness the momentum in GDP growth for FY2020 which would put Bangladesh on course of achieving the Upper Middle Income Country (UMIC) status by 2031. Having relied on the domestic market to usher in rampant economic growth over the last decade, Bangladesh had to seek out foreign markets to ensure sustainable increase in GDP growth with LDC graduation possibly on the horizon.

Global trade has strengthened Bangladesh's foothold as a rapidly developing country. Capitalism sits on the premise of free market mechanisms guided by the "invisible hand". Automatic stabilizers built into non-discretionary fiscal policies have thwarted economic demise to some extent time and time again. However, the global economy has been brought to an abrupt standstill due to the newfound "invisible enemy"- COVID 19; what started off as China's headache has paralyzed and crippled the world economy in a matter of months. Despite the initial dismissal of a possible coronavirus onslaught, Bangladesh's gross domestic product may contract by as much as 1.1 per cent in the hypothetical worst-case scenario of a significant outbreak of coronavirus in the country, as per an Asian Development Bank (ADB) analysis in April 2020.

Global stock markets saw almost a V-shaped recovery during the coronavirus pandemic. However, Bangladesh's stock market is an exception. The local market did not rebound even after the government rolled out a massive stimulus package amounting to Tk 103,117 crore, which is 3.7 per cent of the GDP, to pull the economy out of the wreckage. From February 27, 2020 to June 10, 2020, the market value of equities tumbled by 11.50 per cent along with daily market volatility (standard deviation) of 2.20 per cent (in annualized term it becomes as large as 98.30 per cent). Few weeks before the lockdown was imposed, the Bangladesh Securities and Exchange Commission (BSEC) introduced floor prices for all the listed securities to recover the normally-declining market trends. However, that doesn't appear to help much so far as trade volume trends to decline, and the emergence of the COVID-19 pandemic adds to the injuries through adverse micro and macro-level impacts. After resuming the market, investors appear shaky and worried about overall economic and financial uncertainty, reflected by a sharp decline in trading activities.

Possibly the most controversial issue in finance is whether the financial market is efficient in allocating or using economic resources and information or not. The Bangladeshi stock market has been the subject of scrutiny for years. The pharmaceutical industry in Bangladesh has been growing at a consistent pace over the years. With LDC graduation around the corner, there needs to be major restructuring in this sector to ensure global competitiveness. However, this paper solely focuses on an investigation of the weak form market efficiency of Renata Ltd by carrying out econometric analyses that are outlined in the subsequent sections.

2. Objectives

The Dhaka Stock Exchange has been notoriously riddled with wild speculations and been dubbed risky by investors. Following the 2010 stock

market crash, there have been reforms and pressure on regulatory bodies to properly monitor the stock market. Therefore, this paper aims to examine the weak-form market efficiency of the Renata Ltd stock. In the weak-form of market efficiency, no investor can predict the future movement of the stock/market by using past price movement because the stock/market accounts for all historical price movements/information. In layman's terms, past prices have no correlation with the current stock price. In its essence, this implies that investors cannot use technical analysis to exploit supernormal returns.

3. Literature Review

Since the groundbreaking work of Fama (1965) that investigated the degrees of efficiency in financial markets, a plethora of study have attempted to uncover the nature of market efficiency in developed and in emerging markets using various techniques.

With regard to studying the market efficiency, Harvey (1995) studied volatility of returns of 6 Latin-American, 8 Asian, 3 European and 2 African emerging stock markets. The study uncovered the presence of strong serial correlation in the stock returns.

To assess the market efficiency of two promising markets, Malaysia and Singapore, Laurence (1986) applied both the runs and autocorrelation test on the Kuala Lumpur Stock Exchange (KLSE) and the Stock Exchange of Singapore (SES) from the period 1973-78 for both KLSE and the SES. The results of both tests suggest that both markets are not weak form efficient. Opposing the findings of Laurence (1986), Barnes (1986) found KLSE to be weak form efficient. He assessed 30 companies and 6 sector indexes for the six years period ended 1980. The study shows that the KLSE exhibit a high degree of efficiency in the weak-form.

Butler and Malaikah (1992) examined the weak-form efficiency for the Kuwait and Saudi Arabian stock markets. The study incorporated the use of autocorrelation test by using daily stock returns of two stock markets for the period of 1985-89. Their analyses uncovered that the Kuwait stock market was efficient in the weak form, but the Saudi Arabian market was not.

Similar to the aforementioned study, Abraham et al. (2002) assessed weak-form efficiency in three major Gulf stock markets including Kuwait, Saudi Arabia, and Bahrain using the variance ratio and runs tests for the period of 1992-98. The study rejects the random walk hypothesis in all markets.

A study on weak form efficiency test of twenty one stocks listed based on weekly price from the Nigerian stock exchange for 1978 to 1979 was

done by Samuels & Yacout (1981) using autocorrelation tests. The result did not find the existence of random walk behavior of the stock price and concluded that the Nigerian stock market is weak-form efficient.

Stock markets of Turkey and Jordan also showed the absence of weak form efficiency in the study of El-Erian and Kumar (1995). In China, to uncover the existence of random walk behavior of Shanghai stock exchange & Shenzhen stock exchange, research was conducted by Darrat and Zhong (2000). The study used variance ratio test and the model comparison method. They found that variance ratio test & model comparison method did not follow a random walk and are not weak form efficient.

A study on South Asian securities exchanges of Bangladesh, India, Pakistan, and Sri Lanka was done by Cooray and Wickermalsgle, (2005) by using the unit root tests and Elliot-Rothenber-Stock (ERS) test. The result indicated that Bangladesh stock market was not weak form efficient. Mobarek and Keavin (2000) also applied various tests on the Dhaka Stock Exchange for the period 1988 to 1997. The study used parametric and non-parametric tests to reveal autocorrelation at different lags. Hence, the study has grounds to dismiss the existence of weak form efficiency. Autocorrelation test, Augmented Dickey Fuller test, Phillips-Perron test, ARIMA models & GARCH models were applied by Hossain and Uddin (2011) to test the weak form efficiency on index of Dhaka Stock Exchange. This study found the absence of weak form efficiency. Studies done by Siddik and Azam (2011), Ali (2012), Alom and Raquib (2014) also found the stock exchange of Bangladesh has absence of weak form efficient.

Based on the extensive literature review, the study attempts to concoct the different statistical measures incorporated by different academics over the years, the details of which are elaborated in the following section.

4. Data and Method

4.1. Data

To analyze the market efficiency of Renata Ltd, daily and monthly data pertaining to the stock price has been gathered electronically from "Investing.com", ranging from December 2007 to April 2021. The return calculated does not include dividends.

4.2. Method

Preliminary analysis of the return of Renata Ltd has been conducted using its 4 moments- kurtosis, skewness, mean and standard deviation. This has been compared with the return of the Dhaka Stock Exchange broad market

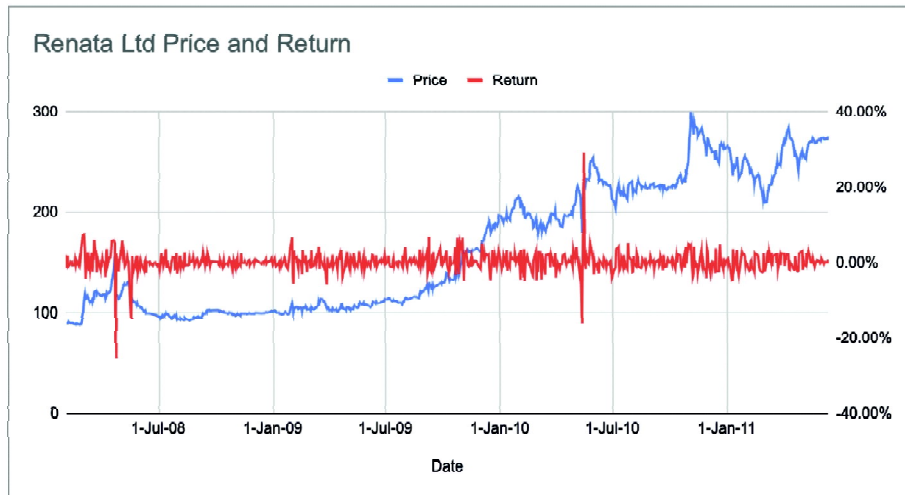


Figure 1: Renata Ltd monthly price and return

index, the DSEX index. Through the preliminary graphical analysis from Figure 1, 3 extreme values were identified. To attest the normality of returns of Renata Ltd, Q-Q and P-P plots were used for graphical analysis. The Jarque-Barre and Shapiro-Wilk tests have been used to statistically test the normality of the returns. To test the weak market efficiency the Durbin Watson (AR 1), Breusch-Godfrey, Bradley(runs), Augmented-Dickey Fuller and variance ratio tests have been used. These tests will examine the random walk hypotheses, and hence, the weak form of market efficiency for Renata Ltd. A structural break test has been conducted to understand whether there has been any breaks in the sample, as can be expected due to stock market crashes. Lastly, a month-on-month effect has been tested to assess whether any particular month had any significantly different return than the rest.

4.3. Variables used

Based on the monthly returns of Renata Ltd and the DSEX, returns for each has been computed and been used for further statistical analysis.

$$Renata_{return} = \text{Log} \left(\frac{price_t}{price_{t-1}} \right) \quad (1)$$

$$DSEX_{return} = \text{Log} \left(\frac{DSEX_t}{DSEX_{t-1}} \right) \quad (2)$$

Where DSEX is the Dhaka Stock Exchange broad market index, $price_t$ and $DSEX_t$ are prices at time t , and $price_{t-1}$ and $DSEX_{t-1}$ are prices at time $t-1$. The log transformation is suggested in Praetz (1969, p.126) to reduce skewness in the often positively skewed return distribution.

5. Results & Discussion

5.1. Descriptive Statistics

The figure below shows the 4 moments of Renata Ltd.'s return and DSEX's return. Both Renata Ltd and DSEX show slight extreme values, as is shown by the Kurtosis measures. DSEX had a higher mean return than that of Renata Ltd, of about 0.5% over the period analyzed. DSEX exhibited a positive skew of 0.533, while Renata Ltd had a slight negative skew of 0.22. Both Renata Ltd and DSEX showed similar volatility, having standard deviations of 5% and 7% respectively.

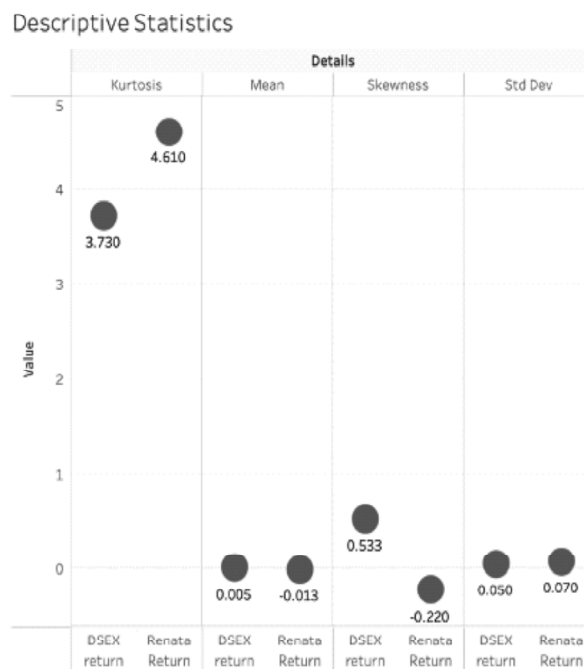


Figure 2: Descriptive statistics of Renata Ltd

The figure below shows the daily returns of Renata Ltd over the period analyzed. 3 extreme fluctuations were observed in the time period under consideration- 23 April 2008, 8 May 2008, 13 May 2010. Removal of these outliers from the data analysis shows considerable changes in the descriptive

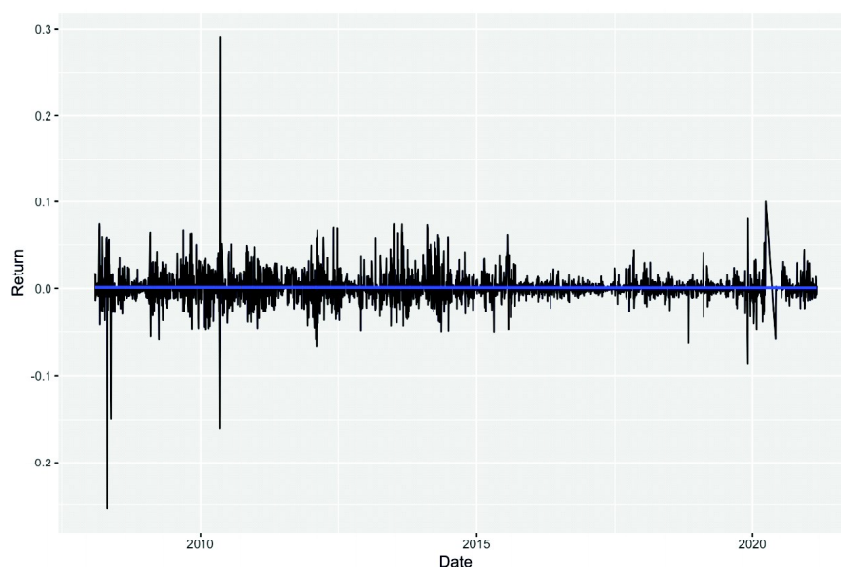


Figure 3: Renata Ltd return analysis

statistics of Renata Ltd's share returns. However, there is only a minor decrease in standard deviation from the exclusion of the 3 observations.

The blue line running through the centre in Figure 3 is the average of the daily returns of Renata Ltd over the period analyzed. This shows a reversion of the mean. Mean reversion is a financial term for the assumption that an asset's price will tend to converge to the average price over time.

5.2. Testing for Normality

5.2.1. Graphical Normality Tests

In statistics, a probability-probability plot (P-P plot) is used for assessing how closely two datasets agree. The upper whisker extends to this adjacent value - the highest data value within the upper limit = $Q3 + 1.5 IQR$ where the inter quartile range IQR is defined as $IQR = Q3 - Q1$. Similarly the lower whisker extends to this adjacent value - the lowest value within the lower limit = $Q1 - 1.5 IQR$. The P-P plot is a very popular tool for testing the normality assumption. A P-P plot compares the empirical cumulative distribution function of a data set with a specified theoretical cumulative distribution function. If the plots turn out to be a straight line, i.e., there are no curves around the line, it implies that there are no outliers and the normality assumption has been fulfilled. If there is a curve around the centre line, there is presence of outliers, voiding the assumption of normality.

Normal P-P plots presented in Figures 5 and 6 are taken from Imon (2015). The first plot shows a normality pattern and the second one exhibits non-normality and the existence of an outlier.

A quantile-quantile (Q-Q) plot compares the quantiles of a data distribution with the quantiles of a standardized theoretical distribution from a specified family of distributions. A normal Q-Q plot is that which we can shape by plotting quantiles of one distribution versus quantiles of normal distribution. In a Q-Q plot, when the quantiles of two distributions are plotted, if the plot mimics that of a $y=x$ line, it can be said that the distribution is that of a normal distribution. However, if there are curves around the plot, then there is presence of outliers, voiding the normality assumption.

The graphs below in Figure 4 show the P-P and Q-Q plot of the monthly returns of Renata Ltd. For both cases, there are presence of curves around the hypothetical normal distribution line that runs through the $y=x$ line. It can be said that the returns of Renata Ltd are different from that of the returns predicted by a normal distribution. **Hence, based on the P-P and Q-Q plots, we can graphically attest that the returns of Renata Ltd do not come from a normal distribution.** To complement our findings from the graphical analysis, statistical computations have been carried out in the sections to follow.

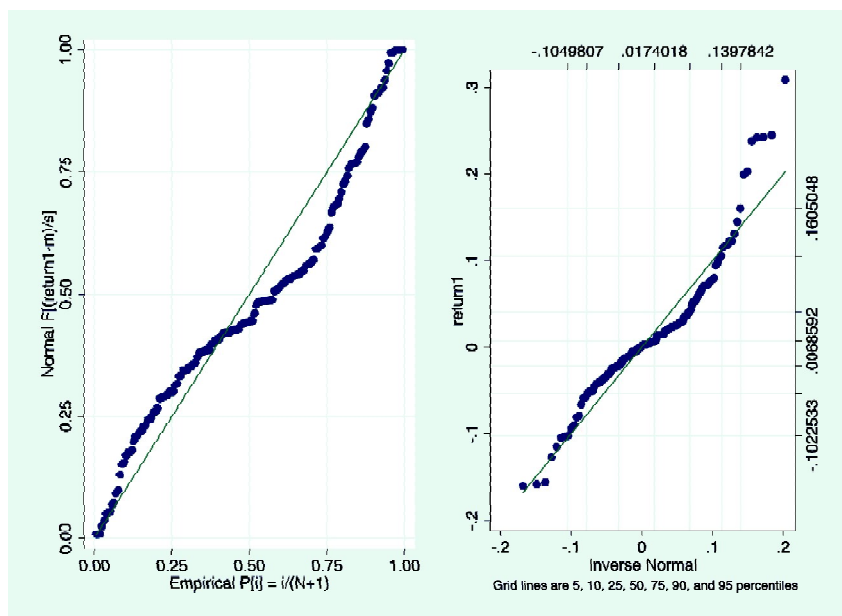


Figure 4: P-P and Q-Q plot of Renata Ltd's monthly returns

5.2.2. Parametric Normality Tests

5.2.2.1. *Jarque-Bera and Shapiro-Wilk tests of normality:* The Jarque-Bera normality test tests the variables with a null hypothesis of them coming from a normal population. It is a goodness-of-fit test that checks whether sample data have the skewness and kurtosis matching a normal distribution. If the data comes from a normal distribution, the Jarque-Bera statistic asymptotically has a chi-squared distribution with two degrees of freedom, so the statistic can be used to test the hypothesis that the data are from a normal distribution. The null hypothesis is a joint hypothesis of the skewness being zero and the excess kurtosis being zero. As the table below outlines, the test statistic of the monthly returns of Renata Ltd has probabilities of 0.0120. **Hence, we can strongly reject the null hypothesis and claim that the returns do not in fact come from a normal population as is posited.** Similarly, the Shapiro–Wilk test is a test of normality with a null hypothesis that the sample data has come from a normal distribution. **The Shapiro Wilk test reaffirms this finding, since the test statistic is less than 5%.**

Table 1: Jarque-Bera test for normality

<i>Skewness/Kurtosis tests for Normality of daily and monthly return</i>				
<i>Variable</i>	<i>Probability Skewness</i>	<i>Probability Kurtosis</i>	χ^2	<i>Prob> χ^2</i>
Monthly Return	0.2427	0.0035	8.85	0.0120

Table 2: Shapiro-Wilk test for normality

Shapiro-Wilk W test for normal data of monthly return

<i>Variable</i>	<i>z</i>	<i>Prob>z</i>
Monthly Return	4.060	0.00002

5.3. Testing for Efficiency in the Weak Form

In weak-form efficiency, future prices cannot be predicted by analyzing prices from the past. Excess returns cannot be earned in the long run by using investment strategies based on historical share prices or other historical data. Technical analysis techniques will not be able to consistently produce excess returns, though some forms of fundamental analysis may still provide excess returns. Share prices exhibit no serial dependencies, meaning that there are no “patterns” to asset prices. This implies that future price movements are determined entirely by information not contained in the price series. Hence, prices must follow a random walk.

Random walk theory suggests that changes in stock prices have the same distribution and are independent of each other. Therefore, it assumes the past movement or trend of a stock price or market cannot be used to predict its future movement. In short, random walk theory proclaims that stocks take a random and unpredictable path that makes all methods of predicting stock prices futile in the long run.

$$Renata_{price(t)} = \rho Renata_{price(t-1)} + \varepsilon \quad (3)$$

Where t is the time variable.

5.3.1. Graphical tests

5.3.1.1. *Correlogram and partial correlogram*: A correlogram (also called Auto Correlation Function ACF Plot or Autocorrelation plot) is a visual way to show serial correlation in data that changes over time. Serial correlation is where an error at one point in time travels to a subsequent point in time. For example, you might overestimate the value of your stock market investments for the first quarter, leading to an overestimate of values for following quarters.

Correlograms can give you a good idea of whether or not pairs of data show autocorrelation. However, they cannot be used for measuring how large that autocorrelation is (for a mathematical way to test for serial correlation, try the Durbin Watson test).

A correlogram gives a **summary of correlation** at different periods of time. The figure above shows both the correlogram and partial correlogram

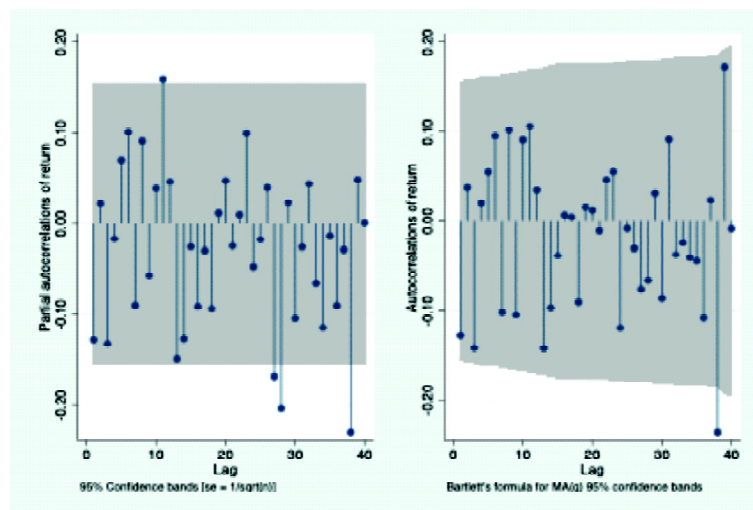


Figure 5: Graphical test for autocorrelation

for the monthly returns of Renata Ltd across the time period analyzed. It is evident from the figure above that almost none of the lagged returns of Renata Ltd have any impact on future returns of Renata Ltd, i.e., no returns have a statistically significant impact on returns in future time periods. **Thus, we can assert that there is no presence of serial correlation, and therefore, the market is efficient in the weak form.**

5.3.2. Durbin-Watson Test

The Durbin Watson Test is a measure of autocorrelation in residuals from regression analysis. Autocorrelation is the similarity of a time series over successive time intervals. It can lead to underestimates of the standard error and can cause you to think predictors are significant when they are not. The Durbin Watson test looks for a specific type of serial correlation, the AR(1) process.

The Durbin Watson test reports a test statistic, with a value from 0 to 4, where:

- 2 is no autocorrelation.
- 0 to <2 is positive autocorrelation
- >2 to 4 is negative autocorrelation

The Hypotheses for the Durbin Watson test are:

- H_0 = no first order autocorrelation.
- H_1 = first order correlation exists.

Table 3: Durbin-Watson test

<i>Lower bound</i>	<i>Upper bound</i>	<i>d-statistic</i>	<i>Comment</i>
1.720	1.747	1.97661	Fail to reject null

The Durbin-Watson test statistic for Renata Ltd is 1.97, which is approximately 2. This gives the premature impression that the returns are indeed not correlated. The table showing the critical values also show that the d-statistic lies outside the critical region. Therefore, we fail to reject the null-hypothesis, i.e. the returns of Renata Ltd are indeed not autocorrelated as per the Durbin Watson Test. This implies that the returns of Renata Ltd are efficient in the weak form.

5.3.3. Breusch Godfrey Test

The Breusch–Godfrey test is used to assess the validity of some of the modelling assumptions inherent in applying regression-like models to

observed data series. In particular, it tests for the presence of serial correlation that has not been included in a proposed model structure. Presence of serial correlation would entail past returns do have an impact on current returns of Renata Ltd, and hence there may be supernormal returns for shrewd investors.

The Breusch-Godfrey test overcomes the lacking of the Durbin Watson test. This allows us to test for serial correlation at greater levels. The table below shows the autocorrelation tests till lag 24, i.e., the autocorrelation of Renata Ltd's current return with that of 2 years ago.

Table 4: Breusch Godfrey test

$lags(p)$	χ^2	df	$Prob > \chi^2$
1	0.001	1	0.9740
5	3.910	5	0.5625
10	8.774	10	0.5537
15	16.974	15	0.3204
20	19.585	20	0.4842
24	21.650	24	0.6001

Similar to the results of the Durbin Watson test, Breusch-Godfrey test also finds no autocorrelation among the residuals of Renata Ltd till its 24th lag. The correlograms below also support these findings.

5.3.4. Portmanteau Test

In the Portmanteau test, the null hypothesis is that the variable follows a white noise process. If the test statistic is less than the level of significance, you reject the null and conclude that the variable does not follow a white noise. The Portmanteau test tests whether any of a group of autocorrelations of the residual time series are different from zero.

Table 5: Portmanteau test for white noise

	Q statistics	$Prob > \chi^2$
Renata Ltd return	55.57	0.0518

The table above shows that the probability is indeed greater than 5%. Therefore, we fail to reject the null hypothesis. **Hence, the returns of Renata Ltd does follow a white noise process, as is further supported by the periodogram white-noise test below.**

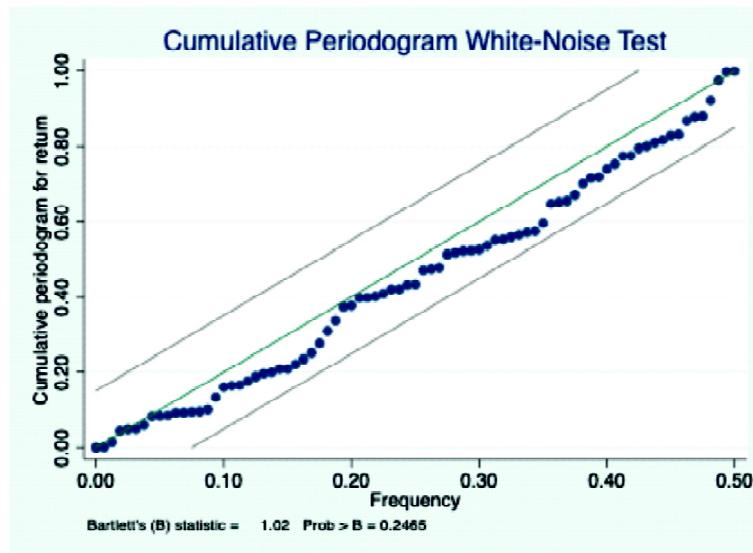


Figure 6: White-noise test

5.3.5. Runs Test

The runs test analyzes patterns in time series data by assessing and comparing expected number of “runs” with that of observed number of “runs”. The threshold for a runs test for our analyses was taken to be zero. This indicates that the test was undertaken to analyze the sequence of positive and negative returns of Renata Ltd. Under the null hypothesis, successive outcomes are independent, and assuming that the number of sample observations is sufficient, the number of Run is distributed asymptotically with the mean and variance.

The graph below gives no inclination that the residuals are correlated in any manner. However, to test the statistical significance of the residuals, a runs test has been carried out to check whether the residuals are serially independent.

The table below shows that the successive returns of Renata Ltd are serially independent since we fail to reject the null hypothesis. **Thus, results of present study confirmed the weak form efficient behavior.**

Table 6: Runs test
Threshold=0

<i>N</i>	<i>N</i> <0	<i>N</i> >0	<i>Runs</i>	<i>Prob</i> > <i>z</i>
159	76	83	76	.49

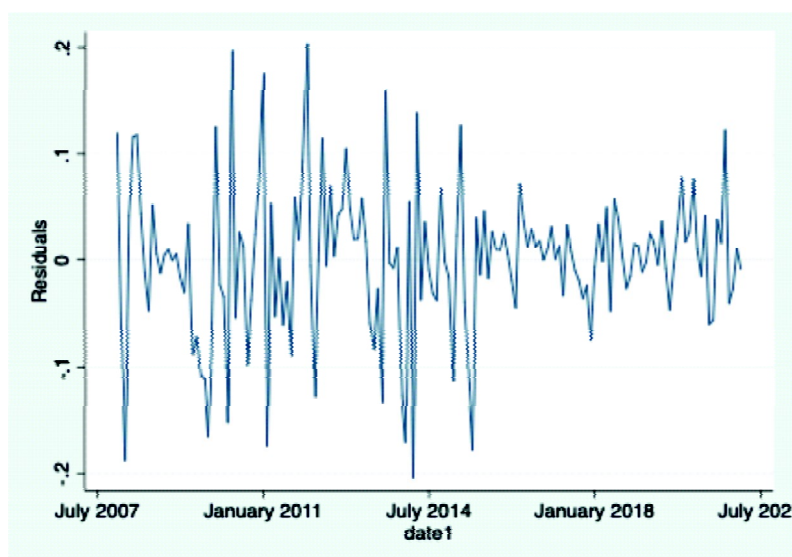


Figure 7: Residual plot

5.3.6. Unit Root Tests

A stationary time series is one whose properties do not depend on the time at which the series is observed. Thus, time series with trends, or with seasonality, are not stationary — the trend and seasonality will affect the value of the time series at different times. On the other hand, a white noise series is stationary — it does not matter when you observe it, it should look much the same at any point in time. An Augmented Dickey-Fuller (ADF) has been performed to check the random walk hypothesis for a weak form of market efficiency. In ADF, the null hypothesis that is tested is that $\rho=0$ in Equation 3. A non-stationary time series would imply that the mean return of Renata Ltd would differ.

The returns of Renata Ltd have shown to be stationary in prior analyses. However, this observation is verified by conducting a unit root test, which simultaneously allows testing of the random walk hypothesis. The tables below show the results at both the level and first difference form.

The null hypothesis of a unit root (non-stationary) is tested against the alternative of no unit root (stationary). The tables show the test statistic, with the 5% critical values in parentheses. At the level form, Renata Ltd is stationary till 3rd lag. However, at the first-difference form, it is stationary till lag 13. **The existence of a unit root in the time-series till lag 3 indicates that there is a random walk hypothesis, suggesting market efficiency to some extent. However, in the level form, they are not weak form efficient.**

Table 7: Unit root tests

<i>Level form</i>		<i>First difference</i>	
<i>Lags</i>	<i>Test Statistics</i>	<i>Lags</i>	<i>Test Statistics</i>
1	-5.321**(-2.962)	1	-8.270*(-2.963)
2	-4.312**(-2.952)	2	-4.312*(-2.953)
3	-3.410**(-2.941)	3	-6.253*(-2.942)
5	-2.189(-2.971)	5	-4.244*(-2.917)
10	-1.323(-2.843)	10	-2.838***(-2.843)
13	-1.367(-2.792)	13	-3.186*(-2.792)

*, **, *** denote significant at 10%, 5% and 1%, respectively.

5.3.7. Checking for Structural Breaks

The Dhaka stock market crash of 2010 may have created a structural break in the time series data of Renata Ltd. It's called a structural break when a time series abruptly changes at a point in time. Since we are analyzing the weak form of market efficiency in Renata Ltd's return, it is imperative to detect when any such structural break might have occurred. Structural break tests help us to determine when and whether there is a significant change in our data.

The null hypothesis for such a test is that there is no structural break in the time series data. The table below shows that we fail to reject the null hypothesis, and can conclude that there is no structural break. However, the estimated break date coincides closely to the 2010 stock market crash. Therefore, a "known-date" structural break test has been carried out.

Table 8: Structural break test (unknown date)

<i>Estimated break date</i>	<i>December 2009</i>	
<i>Test</i>	<i>Test-statistic</i>	<i>p-value</i>
swald	10.1517	0.0891

Table 9: Structural break test (known date)

<i>Break date</i>	<i>December 2009</i>	
<i>Test</i>	<i>Test-statistic</i>	<i>p-value</i>
swald	10.1517	0.006

The "known-date" structural break test rejects the null hypothesis. Thus, we can conclude that the stock market crash of 2010 indeed created a structural break in the time series data of Renata Ltd.

This date will be used to create the “crash” *dummy variable* in the variance-root tests that follow this section.

5.3.8. Variance-root Tests

Variance ratio test has been employed to examine the predictability of asset returns proposed by Lo and Mackinlay (1988). According to this test, variance of difference of time series has compared over dissimilar intervals. The variance-root test is based on one of the properties of the random walk process, namely that the variance of the random walk increments must be a linear function of a time interval. In a random walk of a time series, variance of p periods must be p times the variance of single period difference. Based on the structural break tests performed in the previous section, a dummy variable, “crash”, has been generated corresponding to that time period. Based on this, a variance-root test has been carried out.

Table 10: Descriptive statistics after “crash” dummy variable

	Obs	Mean	Std Err
0	141	-0.01	0.005
1	19	-0.034	0.025

Table 11: Variance-root test

Hypotheses	p-value
H_1 : ratio \neq 1	0.0002

The weak form efficiency hypothesis implies that the time series data of Renata Ltd’s return is stationary, i.e., there are no trends or patterns. Therefore, the variance of different periods should be equal. The alternative hypothesis to be tested is that the variance of two periods, as identified by the 2010 Dhaka stock exchange crash, should not be equal.

The table above shows that the f-statistic yields a p-value less than 5%. Therefore, we can reject the alternative hypothesis that the variance ratio of the two different time periods is not equal to 1, i.e., they are equal to one. **This implies that there is weak form efficiency present in Renata Ltd’s returns.**

5.3.9. Month-on-month Effect

To finish off the analysis on the monthly return data of Renata Ltd, a regression has been carried out to uncover whether any particular month exhibited a statistically significant impact on the return of Renata Ltd, in

regard to the base month chosen. The table below shows the regression output.

Table 12: Assessing month-on-month effect of Renata Ltd's returns

<i>Variable</i>	<i>Coeff</i>	<i>Std. Err</i>	<i>P> t </i>
1	-0.008	0.027	0.757
2	-0.027	0.027	0.325
3	-0.011	0.027	0.693
5	-0.015	0.028	0.591
8	-0.014	0.028	0.620
10	-.0015	0.028	0.957
11	-0.006	0.028	0.825

If the monthly returns of Renata Ltd indeed exhibited signs of weak form efficiency, the monthly returns will statistically be the same across the time period considered, in respect with the base month, December. The table above clearly shows that the monthly returns of Renata Ltd, from 2007 to 2021, no months had a statistically significant impact on the return of Renata Ltd in comparison to December. **The weak form of market efficiency holds in this regard due to the fact that the returns were not abnormal.**

6. Summary and Conclusion

The paper aimed to assess the market efficiency of Renata Ltd in the weak form by analyzing monthly returns ranging from December 2007 to April 2021. Initially, a descriptive analysis was done using the 4 moments of Renata Ltd and the Dhaka Stock Exchange broad market exchange. A graphical analysis using P-P and Q-Q plots rejected the assumption that the returns of Renata Ltd come from a normal distribution. This was further supported by Jarque-Bera and Shapiro-Wilk tests of normality which also rejects the null hypothesis of the returns of Renata Ltd having come from a normal distribution. Graphical tests of autocorrelation were made to uncover the presence of any correlation between returns of Renata Ltd, which was found to not exist. Thus, we can assert that there is no presence of serial correlation, and therefore, the market is efficient in the weak form according to the graphical analysis of correlograms. To quantifiably test the presence of a random walk effect, the Durbin-Watson, Breusch Godfrey, Portmanteau, runs, Augmented Dickey-Fuller (ADF) and variance root tests were undertaken. All tests support the fact that Renata Ltd.'s return does follow a random-walk process, implying the existence of weak form market efficiency.

A strong and robust equity market instills confidence on the economy at large and signals the strength of policies implemented by the government. In times of volatility, it signals investors to divulge their portfolios in order to minimize downside risk. Based on the analyses carried out for the returns of Renata Ltd, it can be asserted that the stock prices of Renata Ltd do indeed reflect all historical information relevant to Renata Ltd. Hence, the returns of Renata Ltd are indeed efficient in the weak form. The finding of the paper contradicts many of the past studies conducted on the Dhaka Stock Exchange securities. This may be an indication of an improvement in disclosures made by publicly listed companies following increased regulatory scrutiny over the financial sector.

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