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Persistence In The Indian Stock Market Returns: An Application Of Variance Ratio Test

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Abstract

Participants in the Indian Stock Market range from "tick traders" with very short investment horizons to "long-term investors" who hold positions for several years or more. Each participant in the market makes deals at the same moment, despite the fact that they each have different time horizons for their investments. The research finds evidence of long memory in the returns that were generated from the data received from the Indian Bombay Stock Exchange. The Fractal Market Hypothesis, sometimes referred to as FMH for short, is an investigation into the ways in which chaos theory and fractals could be applicable to the field of finance. The idea that investors do not always respond instantly to fresh information is at the heart of the fractal model. This is the fundamental premise that underpins the model. Instead, it's possible that investors will reply slowly the vast majority of the time. The standard combination of statistical methods that is used to the task of finding predictable market structure is able to recognize regular periodic cycles. One of the advantages of making use of these strategies is the capacity to do so. The stock market in India is known for its dogged determination, which is one of its defining characteristics.

keywords: Indian Stock Market, Returns, Risk and variance.

Introduction

Historically speaking, the stock market has been considered to be efficient due to the fact that, in accordance with the opinions of the experts, the prices correctly represent all of the information that is currently available on the many potential outcomes of an asset. On the other hand, as of late, a number of academics have started casting doubt on the reality of the theory that proposes that markets are efficient. They have implemented the numerous regular patterns that they found in the fluctuations of the stock prices after discovering them. These patterns are evident in the stock price variations. The current investigation zeroes in on only one of these peculiar patterns displayed by stock prices in the Indian market; more specifically, the phenomena that is referred to as mean reversion. "Feedback traders" are those who examine data from the past and get to the conclusion that if returns have been high in the recent past, then they will continue to be high in the future as well. These traders look at historical data to make their predictions. To put it another way, they believe that price drops will be followed by other price

declines, whereas they believe that price increases will be followed by additional price increases. They will start buying in the case that a rise is predicted, which would drive prices over levels that are sustainable. Consequently, the situation will become untenable. If, on the other hand, they come to the realization that the future performance will not live up to their expectations, they will turn into sellers, which will result in prices returning to their usual levels. Mean reversion is the process by which prices return to their "normal" levels following an overreaction in the market, and the phrase "mean reversion" alludes to this process. There is a large body of written material on the subject, despite the fact that the idea that prices on stock markets have a tendency to revert to their mean is a relatively recent one in the field of stock market ideas. This is due to the fact that the theory has only been around for a short period of time. The examination into the concepts of mean reversion and overreaction in the stock market was kicked off by the research that was carried out by De Bondt and Thaler (2015). They believed that participants in the stock market often overreact to new information, in particular the pieces of news that connected to profits. This was shown beyond a reasonable doubt by them in their newest piece of study. Utilizing variance ratio tests, Poterba and Summers (2016) arrived at the conclusion that the prices on the United States stock market had a tendency to return to their mean. This was one of their findings. In addition, Fama and French (2016) discovered evidence for the mean reversion hypothesis in the markets of the United States by dissecting the stock returns into components that were permanent and components that were transitory. They did this by separating the stock returns into permanent and transitory components. When dividends are used as a gauge of fundamental values, Fama and French (2016) came to the conclusion that using regression techniques, US markets are mean reverting. This was the result that they reached after analyzing the markets with the use of regression techniques. According to the findings of the research that Campbell and Shiller conducted in 2016, which used dividends and profits as an assessment of fundamental worth, price movements have a tendency to revert back to the mean. In addition, Lo and MacKinlay (2016) use variance ratios to distinguish between the permanent and transitory aspects of stock returns, and they provide data that contradicts the random walk model. They presented a test statistic that is trustworthy even when acting under the premise that there is a heteroscedastic random walk in the data. In Lo and MacKinlay's (2017) study, "these tests in finite samples," a detailed Monte Carlo investigation was carried out so that the authors could evaluate the size and power of "these tests." They found that the variance ratio test is substantially more successful than the Dickey-Fuller and Box-Pierce tests when testing against the null hypothesis of a heteroscedastic random walk. This was one of the things that they observed. Cochrane (2016) made an effort, making use of the method of variance decomposition, to establish the extent of the random component that was present in GNP. carried out a variance decomposition analysis on the stock returns. He claims that by carrying out this decomposition, he was able to demonstrate that the expected rate of return on an investment changes over the course of time in a relatively reliable fashion. Everyone arrives at the same verdict: there is mounting evidence that the returns on the US stock market have a tendency to regress to the mean over time.

Need of the Study

The Rescaled Range Analysis is a strong method for uncovering persistent and long-range dependencies in stochastic time series such as stock price returns. These types of dependencies are characterized by nonperiodic cycles. This study made use of the aforementioned analysis. The R/S analysis has two primary objectives: first, to evaluate the fractal dimension of a time series; and second, to give an evaluation of how the apparent variability of a series changes with the length of the time-period that is being taken into consideration. Both objectives are intended to be achieved via the use of the R/S analysis. If the investors analyze the fractal dimension of asset returns, they may have a better knowledge of the systematic pattern of price returns, and as a consequence, they may be able to adjust their techniques of asset pricing in a manner that is acceptable.

Objectives of the Study

The objective of the research is to determine whether or not the monthly index returns of the Sensex are stable and the degree to which they are dependant on elements that are relevant over a longer period of time.

Hypotheses of the Study

H1 - The index returns of the Sensex on a monthly basis are neither stationary, nor do they follow a simple trend.

H2 - There is no dependence on the monthly index results of the Sensex over a lengthy span of time.

Research Methodology

On a monthly basis, the index returns of the BSE Sensex were evaluated so that evidence of non-periodic cycles and long-range reliance could be looked for. The Bombay Stock Exchange, often known as the BSE, is the oldest stock exchange in India. The entire equity market value of the companies that were listed on the BSE was one trillion United States dollars as of December 2019. With such a high valuation, the BSE was ranked as the sixth largest stock exchange in India and the fourteenth largest in the world. The Bombay Stock Exchange has the biggest number of companies listed on its market than any other stock exchange in the whole globe. Following the extraction of the required information from an internal database known as PROWESS, it was subjected to an analysis. The remaining required material was extracted from a variety of publications, such as books, journals, and sources available online.

Period of the Study

The duration of the study was ten years, commencing on November, 2009, and ending on November, 2019. The research was carried out over this period of time.

Tools Used in this Study

The following tools were used for this study.

Descriptive Statistics

The mean, the median, and the standard deviation are the components of the descriptive statistics.

Augmented Dickey Fuller Test

An Augmented Dickey–Fuller test (ADF) is a test that is used in the disciplines of statistics and econometrics to locate a unit root in a time series sample. Both of these subjects are subfields of econometrics. The more negative it is, the more strongly the premise that there is some degree of confidence in rejecting the concept that there are unit roots is strengthened. In other words, the more negative it is, the stronger the premise that there is some level of confidence. The testing technique for the Dickey–Fuller test and the testing procedure for the ADF test are virtually identical; the only variation is that the ADF test is performed on a model instead of a real person.

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

where an is a constant, b is the coefficient on a time trend, and p is the lag order of the autoregressive process. where an is a constant, b is the coefficient on a time trend. where b is the coefficient of an ongoing temporal trend. By introducing delays of a given order, which is p, the ADF formulation makes it feasible for higher-order autoregressive processes to take place. This suggests that the lag period p needs to be determined before actually putting the test into action. The hypothesis of the null model, which claims that = 0, is compared to the hypothesis of the alternative model, which states that 0, in order to perform the test for the unit root.

Analysis

The rescaled range analysis is a statistical method that was developed by Hurst (1965) with the goal of conducting an in-depth investigation of voluminous data of natural occurrences and occurrences in the past. This analysis makes use of two different factors: first, the range R, which is the difference between the minimum and maximum 'accumulated' values or cumulative sum of X (t,tau)of the natural phenomenon at discrete integer-valued time t over a time span tau, and secondly, the standard deviation S, which is estimated from the observed values Xi(t). The range R is the difference between the minimum and maximum 'accumulated' values or cumulative sum of X (t,tau). The difference between the lowest and highest 'accumulated' values, also known as the cumulative sum of X (t,tau), constitutes the range known as R. According to what Hurst found, the following empirical relationship is able to very precisely represent a wide range of naturally occurring occurrences in terms of the ratio R/S. This was shown to be the case after Hurst applied his findings.

$$\frac{R}{S} = (C.T)^H$$

where "tau" refers to the entire time period and "H" signifies the Hurst exponent. Hurst arrived at the conclusion that a value of 0.5 ought to be assigned to the coefficient c. The meaning of R and S may be summarized as follows:

$$\mathbf{R}(\tau) = \max_{1\le t\le \tau} \mathbf{X}(\mathbf{t},\tau) - \min_{1\le t\le \tau} \mathbf{X}(\mathbf{t},\tau) \quad \text{and}$$

$$\mathbf{S} = \left(\frac{\mathbf{1}}{\tau} \sum_{t=1}^{\tau} \left[\xi(\mathbf{t}) - \langle \xi \rangle_{\tau} \right]^2 \right)^{\frac{1}{2}}$$

$$\text{Where, } \langle \xi \rangle_{\tau} = \frac{\mathbf{1}}{\tau} \sum_{t=1}^{\tau} \xi(\mathbf{t}) \text{ and}$$

$$\mathbf{X}(\mathbf{t},\tau) = \sum_{u=1}^{t} \left[\xi(\mathbf{u}) - \langle \xi \rangle \tau \right]$$

An Analysis of the Stationary and Long-Range Dependence in the Returns of the BSE Sensex

The following is an analysis that was conducted so that this study can accomplish its objectives:

1. A Study of the Investigated Descriptive Statistics of the Returns on the BSE Sensex
2. Using the Augmented Dickey-Fuller test (ADF), an inquiry was conducted into the returns of the BSE Sensex.
3. Figuring out the Hurst Exponent by Making Use of the Rescaled Range An investigation of the returns of the BSE Sensex
4. R/S Chart for the periods of 20 months, 30 months, 50 months, 80 months, and 120 months of BSE Sensex returns

Analysis of Descriptive Statistics of BSE Sensex Returns

The results of the descriptive statistics done on the BSE Sensex Returns are shown in Table-1 along with the conclusions that were reached as a result. The information that was shown in the table that came before this one not only makes it abundantly evident that the Sensex has generated positive average returns of 0.0164, but it also gives proof that the price series have continuously grown over the course of time. The fact that the returns on the Sensex have gained a standard deviation of 0.0768 might be seen as an indication of the risk that is there in the market. The fact that the skewness is negative, which corresponds to a value of -2.06832, indicates that the distribution is biased toward a greater number of negative values than positive ones. The fact that the skewness value is in the negative range demonstrates this point. The results of the study made it abundantly evident that the market had a negative skewness, which is a phrase that describes the degree to which a distribution is asymmetrical around its mean. This was

made clear by the data. The positive return distribution's Kurtosis measure has a value of 4.150352, which suggests that it has a positive value. This is evidence that the value is positive. The degree to which this number was relative to the peak of the distribution was used to calculate its value. Because the value of kurtosis was found to be positive, it was determined that the likelihood of a distribution was leptokurtic. This was due to the fact that the value of kurtosis was found to be positive. Following this line of reasoning, one arrives to the conclusion that the distribution is leptokurtic. It would appear that there is a higher potential for severely bad results in BSE during the time period investigated by the study if investors are active during that time period. This would be consistent with the findings of the study.

An analysis of how the Augmented Dickey-Fuller (ADF) indicator affects the performance of the BSE Sensex

The results of the ADF Test in connection to the returns of the BSE Sensex are presented in Table-2. The time span covers the whole period. The table that was just provided indicated that the probability of the Augmented Dickey-Fuller (ADF) statistic was 0.00000, while its statistical value was -9.557375. This information was obtained from the ADF statistic. The test critical values were -3.486064 when applied to the 1% level, -2.885863 when applied to the 5% level, and -2.579818 when applied to the 10% level when applied to the 1% level. It is important to bring to your notice that the key values (-3.486064) at the 1% level, (-2.885863) at the 5% level, and (-2.579818) at the 10% level were all lower than the computed statistical value (-9.557375). It is not at all difficult to deduce that the ADF Test was the source of the proof of stationary about the monthly returns of the Sensex. The overall analysis of the ADF test showed that the null hypothesis (NH1), which states that the monthly index returns are not stationary, cannot be accepted. This was proved by the fact that the null hypothesis was rejected. The findings led to this conclusion being drawn about the situation. It was not necessary to conduct a further in-depth analysis of the data because it passed the unit root test with flying colors at every level of scrutiny.

C. In order to estimate the Hurst Exponent, we will be doing Rescaled Range Analysis on the BSE Sensex.

It is essential to bear in mind that the presence of a Hurst Exponent value H that is fairly close to 0.5 is suggestive of a random walk of the return. This is something that you should keep in mind at all times. It is said that a time series exhibits "ant persistent behavior" if the value of the Hurst Exponent H is between 0 and 0.5. It seems to imply that there will be a decrease in the prices in the future if they have increased in the past, and the opposite would be true if there has been an increase in price in the past. A time series is said to exhibit "persistent behavior" if the value of the Hurst Exponent H is between 0.5 and 1, since this range is considered to be the sweet spot. According to this inference, the fact that there was a tendency toward higher prices in the past implies that there will also be a trend toward higher prices in the future and vice versa. Table 3 presents the findings of

an inquiry into the Hurst Exponent estimate of a time series. Throughout the course of the study period, the R/S analysis for the Sensex returns consistently produced a value of 0.5690 as its value. It is clear that there is a consistent pattern in the monthly index returns since the Hurst value is more than 0.5. This is evidenced by the fact that this value was calculated. In addition, the comprehensive analysis of the data shown in the table located above reveals that the monthly index returns of the Sensex were discovered to have lengthy memory during the course of the research period. This was proven to be the case as a result of the findings of the study. As a consequence of this, we can come to the conclusion that the null hypothesis (NH2), which indicated that the monthly index results did not have any long term dependence, was erroneous. The formula D=2-H was used to find the fractal dimension of the time series of stock returns for the Sensex, and the result was 1.4289. The formula was used to determine the fractal dimension of the time series of stock returns. It is well knowledge that the most recent series of stock prices do not faithfully reflect the information that was included in the most recent series of stock prices. This inaccuracy may be seen in the current stock prices. As a consequence of this, investors are required to foundation their investment selections on the substantial information that is easily accessible in the stock market.

An Analysis of Non-Periodic Cycles on the BSE Sensex Using an Estimate of the Hurst Exponent

In addition to its other benefits, this approach has the capability of rescaled range analysis to detect cycles within the data. This is one of the method's many advantages. This not only encompasses periodic cycles that occur at predetermined intervals but also cycles that take place at unequally spaced intervals. Table 4 presents the values of the Hurst Exponent for the years. A study of the Hurst exponent for non-periodic cycles of the Sensex may be used to calculate the value of the Hurst exponent in the long range dependence. It is crucial to note that none of the values for the time delays were equal to 0.50, which shows that the Indian Stock Market did not follow a random walk in terms of the monthly returns. This conclusion can be drawn from the fact that none of the values for the time delays were equal to 0.50. Despite the fact that the values for time delays for 80 months were close to 0.50, which suggests that the trend was not firmly established, this implies that there was a substantial probability for persistence in the Sensex returns. This demonstrates that there was unquestionably the potential for durability in the Sensex returns. However, when looking at the longer time periods, the values were substantially more than 0.5, which shows that there is a distinct possibility that the trend will continue for the foreseeable future. As a consequence of this, investors may be subjected to the same level of risk despite the fact that the time horizons they have for their investments are different. This would lead to a stable market.

R/S Chart of BSE Sensex Returns for 20 Month, 30 Month, 50 Month, 80 Month, and 120 Month Periods

The findings of applying the Rescaled Range Analysis to the variations in the monthly index returns of the Sensex may be seen presented in Figures 1 through 5, which can be seen below. Figure 1 illustrates the monthly index returns of Sensex fluctuations that have occurred over the course of the preceding 20 months. The empirically rescaled ranges of the data set are shown as plots of log(R/S) and log(N) for a period of twenty months. These plots cover the period from January to December. It is essential to bear in mind that the log (R/S) values will progressively increase over the course of 20 months, although the log (N) period (i.e., the returns of Sensex values) will get longer. This is something that must be remembered. This is something that has to be brought to everyone's attention. The figure that was just displayed makes the continuity of time series readily clear to the audience. Because of this, it was feasible to forecast how the stock market (BSE) would act over the duration of the investigation because of the correlations that were found. The monthly index returns of Sensex swings throughout the course of the previous 30 months are depicted in Figure 2. As the data that was just provided to you demonstrates, the general direction of the price trend over the period of thirty months is one that advances in an upward manner. At the beginning of a study period, it points to a downward direction of price trend; however, this does not hold true over the entire period of thirty months covered by the research. The calculation of the Hurst exponent value over a period of thirty months demonstrates the presence of an increasing trend in the time series. This comes as a direct consequence of the previous statement. As a direct consequence of this, the price distribution of a time series may thus be easily defined by the investors. Figure 3 illustrates the shifts that took place in the monthly index returns that happened over the course of a period of fifty months. A general upward tendency can be seen in the advancement of the plots throughout the course of the past 50 months, as indicated by the figure that was just provided. The fact that the time series point to an increasing trend gives rise to the assumption that the data series unambiguously displays persistence. This is because the rising trend indicates that the series of values will continue. As a direct consequence of this, the current prices that are being offered on the market have an impact on the path that future prices will take. This might be because longer return periods are better at seeing trends in the stock prices that are taken into consideration when calculating the BSE Sensex returns. Figure 4 illustrates the shifts that occurred in the monthly index returns over the course of a total of 80 months. It is pretty clear from the plots, which are shown in the image that was just above it, that the trend was not firmly established at the time. The reason for this is that the plots show an upward and somewhat lower trend over the length of 80 months, and the Hurst value is near to 0.50 (that is, 0.5271) The reason for this is that the plots show an upward and somewhat downward trend over the duration of 80 months. On the other hand, when looking at a longer time frame, the series showed decent growth over a period of 80 months. This shows that there is a definite probability that the Sensex returns would be steady. When looking at a shorter time frame, the series did not show any development at all. It displays the variations in Sensex returns over the length of 80 months, which is a longer period of time and covers a wider distance, as the likelihood that the price will continue to move in the same direction. As a direct consequence of this, investors were

better able to predict the prices of equities that were trading on the market throughout the time period that the research examined. Figure 5 illustrates the variations in index returns that occur on a monthly basis over a period of one hundred twenty months. Throughout the course of the period, the stock market shown a remarkable capacity for resilience, with price patterns generally heading in an increasingly higher direction. This demonstrates that participants in the stock market have a propensity to overreact to earlier information and news. The data series has a longer memory of Sensex returns in proportion to the number of observations that are included. As the total number of observations grows, this continues to remain the case.

Table 1: The following table provides descriptive statistics regarding Sensex returns for the years 2017 to 2019.

Descriptive Variable	Sensex
Mean	0.0164
Maximum	0.2826
Minimum	-0.2389
Standard Deviation	0.0768
Skewness	-0.206832
Kurtosis	4.150352
Number of observations	120

Source: The result that was generated by using E-Views 5.1 in conjunction with the PROWESS Corporate Database

Table 2: The Sensex will be subjected to the Augmented Dickey-Fuller Test beginning in 2017 and continuing through 2019.

		t-Statistic	Probability
Augmented Dickey-Fuller test statistic		-9.557375	0.0000
Test critical values:	1% level	-3.486064	
	5% level	-2.885863	
	10% level	-2.579818	

Source: Result obtained from the PROWESS Corporate Database with the use of E-Views 5.1

Table 3: In the years 2017 to 2019, the Sensex will return to its Fractal Dimension.

Hurst Exponent	Statistic Value
Rescaled range analysis	0.5690
Standard Deviation	0.0768
Fractal dimension	1.4289
Number of Observations	120
Degrees of Freedom	2

Source: Utilizing the KaotiXL 1.1 software, this information was derived from the PROWESS Corporate Database.

Table 4: The Hurst exponent for the non-periodic cycles of the Sensex is expected to be between 2017 and 2019.

Period N	20 months	30 months	50 months	80 months	120 months
Hurst Exponent	0.5457	0.7393	0.5710	0.5271	0.5711

Source: The PROWESS corporate database served as the source for this information, and it was extracted using the KaotiXL 1.1 application..

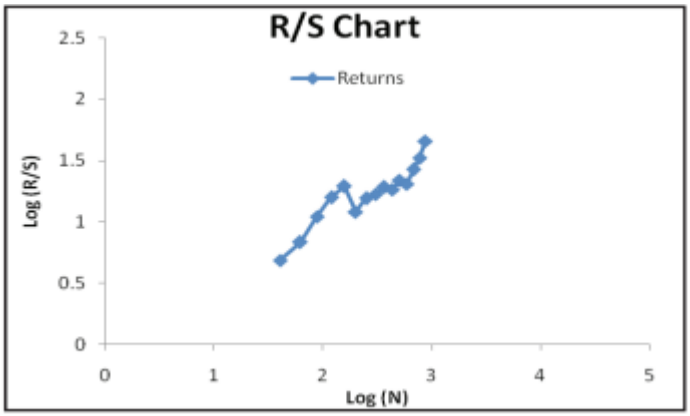

Fig. 1: Chart Showing R/S for 20 Months

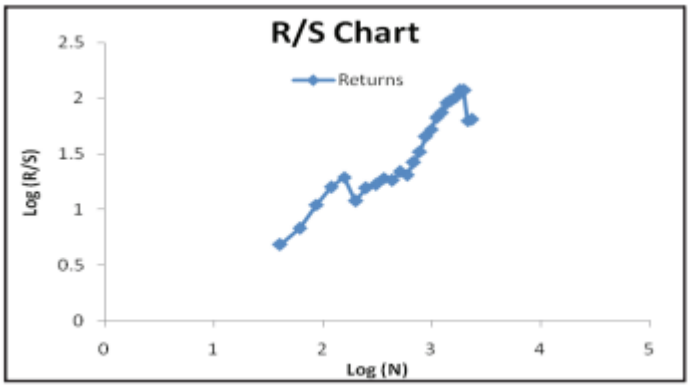

Fig. 2: Graph Displaying R/S over the Past 30 Months

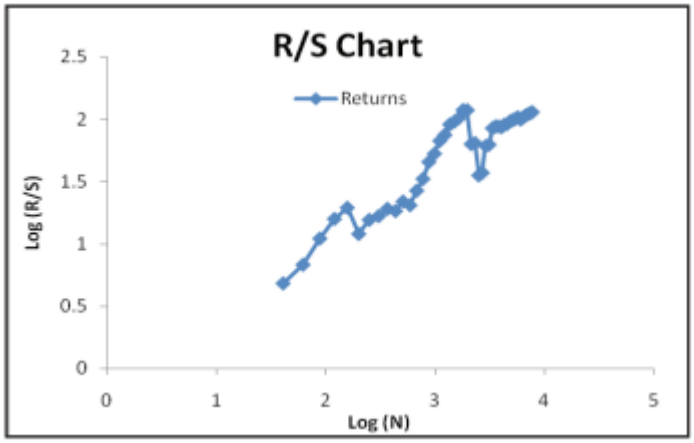

Fig. 3: Graph Displaying R/S over the Past 50 Months

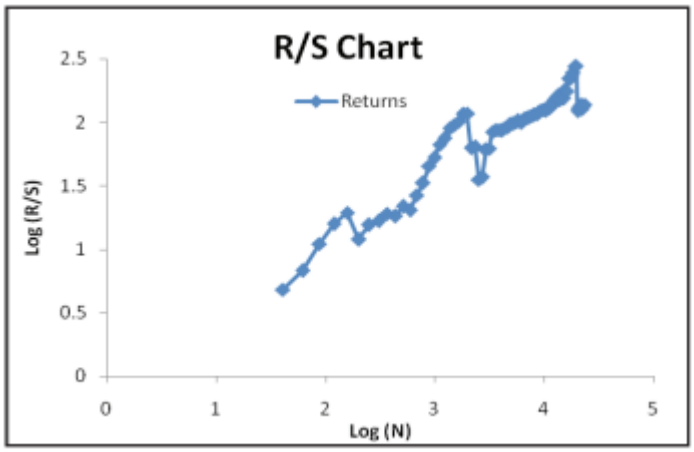

Fig. 4: Graph Displaying R/S over the Past 80 Months

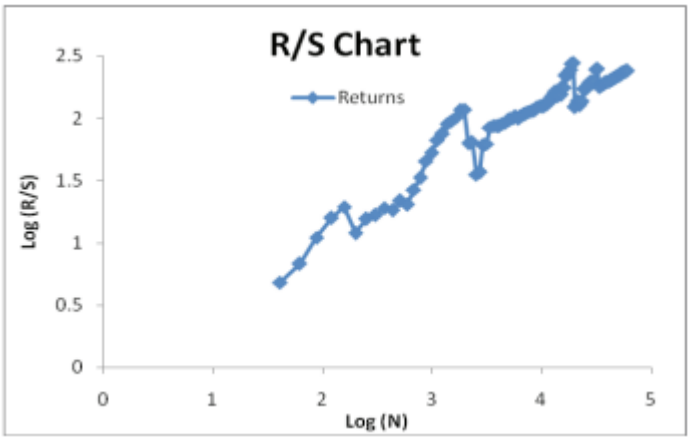

Fig. 5: Graph Displaying R/S over the Previous 120 Months

Conclusion

In this particular piece of research, the Rescaled Range Analysis was put to use in order to explore the long range dependency that was observed in the BSE Sensex returns. It was revealed that there was persistence in the stock market during the period of 20 months, 30 months, 50 months, 80 months, and 120 months that were investigated. This is due to the fact that all measurements of Hurst range from 0.5 to 1. This would imply that the level of consistency enjoyed by the index returns of the Sensex over the time period under consideration was maintained. It is clear that the investors responded to the knowledge that they obtained from prior news, and this displays a high degree of persistence in the returns of the BSE Sensex. In addition, the rescaled range analysis indicated that there is a pattern of consistency in the behavior of the Sensex returns. After conducting research into the patterns of behavior of the stock and bond returns of the Standard & Poor 500, the researchers found that the prices are reflected on the basis of a stronger influence of investors' emotions. After doing research on the relative worth of a variety of different currencies, we came to the conclusion that the establishment of a heterogeneous market is influenced by factors such as temporal value and fractal features. Utilizing the Rescaled Range Analysis enables the discovery of long-term dependency as well as non-periodic or irregular cycles in the market. This is possible since the analysis is rescaled. Research very similar to the one that was just described was carried out by Assaf.A (2006), who investigated the presence of fractional dynamics in the returns and volatility of the growing stock market in Kuwait. This study analyzed the existence of fractional dynamics in the returns and volatility of the market. The differences in the data for the returns after they had been rescaled; these statistics revealed that there was persistence and long term dependence in the Emerging Stock market of Kuwait. The findings of this inquiry provided conclusive evidence that supports the findings and interpretations drawn from it. An research of the Indian Stock Market that included fractal structure analysis came to the conclusion, among other things, that market patterns occasionally resembled a random walk. This was one of the conclusions of the inquiry. This analysis came to the conclusion that the results of Murugesan Selvam and colleagues are not supported by the

findings they obtained; as a result, their conclusions cannot be relied upon. Because of this, a description of the fractal structure of a series at large delays has been offered as a consequence of the research. Even though the observations are far apart, there is still a consistent temporal reliance on the entire series because it demonstrated a long memory. This is true even if the observations are far apart. As a direct consequence of this, the recognition of persistent and long-range dependence in the market may result in the formation of attractive trading opportunities for investors and technical analysts.

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