Do Nifty 50 follow a Normal Model- An Empirical Investigation?

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Abstract

For many years, researchers have used a normal model to study the behaviour of the market returns. But, later studies have revealed that a normal model may not best fit the data, as the height of the returns curve is more peaked than a normal curve. This made researchers to use alternative models to study the behavior of the model. But, the conflict in selection of either a normal or a non-normal model still exists amongst the researchers. This paper is an attempt to check whether Nifty 50 follows a normal model or not. We use data drawn from National Stock exchange for the period 2010 to 2015 and attempt has been made to fit the model year-wise and test the same. This is to check for which year a normal model is appropriate and for which it is not. Kolmogorov-Smirnov test is used to test the hypothesis associated with normality. At the end of the paper we look at how trimming improves the performance of a normal model in modelling the market returns. We note that except 2013 and 2015, the returns variable do not follow a normal pattern. Trimming proved effective in showing that the trimmed variable follows a normal model. This suggests that if one wishes to test hypotheses on returns variable in later part of the analysis, a trimmed variable can be used to the original variable. In this paper we also test few hypothesis

constructed on returns variable and show how trimming will be useful in testing especially while using ANOVA. Also, the second objective of the paper is to find the difference between various years with respect to returns variable. The T-test for the two years (2013, 2015) has revealed that there exists difference between the two years with respect to average returns. ANOVA has been used to check whether there exists significant difference between the years 2010, 2011, 2012, 2013, 2015 with respect to average returns. ANOVA revealed that there exists significant difference and the years 2011 and 2012 are homogeneous with respect to average returns.

Keywords: *ANOVA, Nifty 50, Normality, Market returns, K-S test, Trimming.*

Introduction

In empirical studies related to the stock market returns, one of the important aspect in the analysis is to identify appropriate probability structure of the returns variable. This is seen as an important aspect as it helps the researcher to study the characteristics of the market using this probability model. For example, expected market returns, volatility in market returns etc. One of the important model that is being used very frequently is a normal model. The smooth behaviour of the model helps the researcher to understand the market characteristics better than using any other model. One of the important point related to a normal model is that most of the models (either discrete or continuous) can be approximated to a normal model, as the sample size increases. The tails of the normal model are symmetric and lighter than other models that are being used

to study the behavior of the market returns. For example, a stable-Pareto model, whose tails are heavier than a normal model. Another important aspect relating to a normal model is the 3-sigma limits, which include 99.73% of the data points. But, there are studies related to market returns that argue that a normal model do not fit the market returns appropriately as the tails of the returns variable is more heavier and using a normal model may underestimate the market characteristics (see Mandelbrot (1965), Fama (1965)). There exists always a conflict in selection of the model and few others argue that stable models also may not sometimes fit the market returns appropriately (see Officer (1972), Akgiray and Geoffrey Booth (1988), Hing lau et.al. (1990)). Though the works cited was age old, the problem of selecting a model between a normal and a non-normal has always been a contemporary issue.

The tail behavior of a normal model is given by

$$P(Y > x) = \int_x^{\infty} f(x)dx \cong \frac{1}{x\sqrt{2\pi}} e^{-\frac{x^2}{2}} \qquad (1)$$

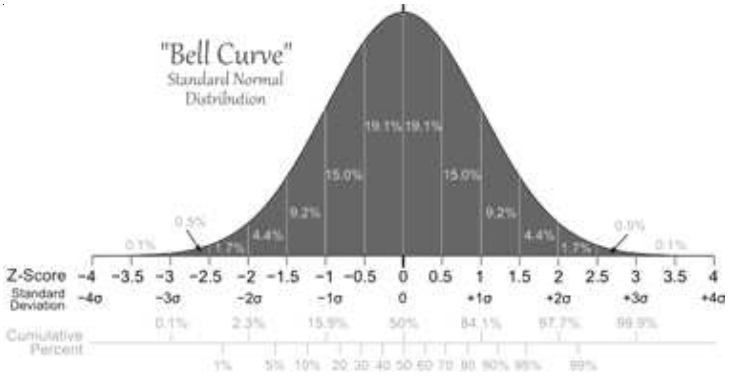

Figure 1 : Normal distribution tails and sigma limits

Source: www.mathsisfun.com, retrieved on 07-12-2015.

One can observe that the tail structure above is valid for a data pattern that has lesser volatility. Figure-1 gives the tail structure and sigma limits of the normal distribution. One can easily note that the tails are lighter than a stable distribution and becomes fatter as variance increases.

The present paper has one major objective. That is to test the significance of a normal model with respect to Nifty 50 indices. It is very well known that Nifty 50 is computed by taking into consideration all the top 50 organizations listed in the India National stock exchange. A country's economic status can be determined based on its stock market returns.

The following description on Nifty 50 index is retrieved from NSE website:

The Nifty 50 is a well diversified 50 stock index accounting for 13 sectors of the economy. It is used for a variety of purposes such as benchmarking fund portfolios, index based derivatives and index funds. Nifty 50 is owned and managed by India Index Services and Products Ltd. (IISL). IISL is India's first specialised company focused upon the index as a core product.

- The Nifty 50 Index represents about 66.17% of the free float market capitalization of the stocks listed on NSE as on March 31, 2015.
- The total traded value of Nifty 50 index constituents for the last six months ending March 2015 is approximately 46.22% of the traded value of all stocks on the NSE.

- Impact cost of the Nifty 50 for a portfolio size of Rs.50 lakhs is 0.06% for the month March 2015.
- Nifty 50 is professionally maintained and is ideal for derivatives trading.

Nifty 50 reflects the return one would get if investment is made in the index portfolios. As Nifty 50 is computed in real-time, it takes into account only the price movements. However, the price indices do not consider the return from dividend payments of index constituent stocks. Only the capital gains due to price movement is measured by the price index. In order to get a true picture of returns, the dividends received from the index constituent stocks also needs to be included in the index movement. Such an index, which includes the dividends received, is called the Total Returns Index. The Total Returns Index is an index to reflect the returns on the index from index gain/loss plus dividend payments by constituent index stocks. (Source: NSE website, retrieved on 07/12/2015-20:08)

One of the major reasons for heavy tails is higher variance and the reason for higher variance is the presence of extremes/outliers in the data set. One way of handling these extremes/ outliers is to separate them out from other observations so that the remaining observations show a normal behaviour. The process of excluding the extreme observations or outliers is termed as trimming. Trimming plays an important role in data analysis as it provides

the researcher an option to identify those observations that are considered to be as outliers and study the pattern of remaining data using normal model. Stigler (1973) paper gives researchers an opportunity to find the percentile points at which the trimming has to be done so that the total returns follow a normal model. In this paper we look at how trimming improves the modelling of Nifty 50 and show how trimming decreases the volatility of the returns variable. Also, show how the tails come closer to mean when trimming is done at different percentile points. This forms the second objective of the paper.

In section 2 we present relevant literature related to the usage and non-usage of a normal model and also the motivation for the present study. In section 3 we present the objectives of the study. Section 4 looks at testing the significance of a normal model using Kolmogorov-Smirnov test for normality and look at how trimming will improve the performance of normal model. In the same section, we also test whether there exists significant difference between the average Nifty 50 indices for those years for which normality assumption is not violated. In section 5 we present the suggestions and conclusion.

Literature Review

In this section, we present the earlier work on the studies related to the behavior of the stock market returns and also the motivation to consider the current work.

The first one to point out about the use of normal distribution was Mandelbrot (1963). In this paper he points that the returns do not follow a normal model and suggests that a stable-Paretian will be an appropriate model to study the behavior of returns. Fama (1965) points that if the variance of distribution of returns is large, statistical tools developed based on the assumption of finite variance will not work. One of the main goals of his paper is to test the hypothesis of Mandelbrot for the case of stock prices. Hsu, Miller and Wichern (1974) proposes an alternative model to study the rates of return based on the hypothesized phenomenon of a changing variance. Akgiray and Booth (1988) investigates the tail shapes of empirical distributions of returns on an extensive group of common stocks. Their study found that the returns distributions have tails thinner than an infinite variance stable distributions. They also argue that economic and statistical inferences drawn from stable-law parameters estimated from samples of stock returns may be misleading. Gray and French (1990) examine the ability of the normal distribution to model log price returns from the S&P 500 composite index and compare its performance to three alternative finite variance distributions (scaled- distribution, logistic distribution, and exponential power distribution). Hing-Ling

Lau et.al. (1990) presents an effective procedure for determining whether a reasonably large sample comes from a stable population against the alternative that it comes from a population with finite higher moments. This procedure shows convincingly that stock returns, when taken as a group, do not come from stable populations. Even for individual stocks, their results show that the Stable-population- model null hypothesis can be rejected for more than 95% of the stocks. Tucker (1992) investigates the general (asymmetric) stable Paretian distribution and three finite-variance, time-independent distributions applied to daily stock-return series. The study shows that finite time-independent models outperform the asymmetric stable Paretian distribution. Mittinik and Rachev (1993) shows that a Weibull model associated with both the non-random- minimum and geometric- random summation schemes dominates the other stable distributions considered including the stable Paretian model. Piero (1994) suggests the use of Student's t- distribution to any other finite variance distributions including the normal distribution. Dillen and Stoltz (1999) shows that the market returns have a Leptokurtic distribution and their results suggest that much of the Leptokurtic can be attributed to a jump component in the distribution. Qi-Man Shao et.al. (2001) proposed a test statistic to discriminate between models with finite variance and models with infinite variance. Aparico and

Estrada (2001) considers daily stock returns of 13 European securities markets and shows that normality may be a plausible assumption for monthly (but not for daily) stock returns. Hoechsoetter, Rachev and Fabozzi (2005) analyses the returns of stocks comprizing the German stock index DAX with respect to the stable distributions and shows that the stable hypothesis cannot be rejected. They also show that stable distribution outperforms the skew t-distribution. Weidong Xu et.al. (2011) demonstrate that a stable distribution is better fitted to Chinese stock return data in the Shanghai Composite Index and the Shenzhen Component Index than the classical Black–Scholes model. Gü̈nay (2015) checks whether daily returns of Brent crude oil, dollar/yen foreign exchange, Dow&Jones Industrial Average Index and 12-month libor display power law features in the scaling exponent and probability distributions or not, using different methods. They show that the Brent crude oil and 12 -month libor have a high persistency in the returns, while the dollar/yen foreign exchange and Dow&Jones Industrial Average Index returns have short memory. According to the alpha-stable parameter estimations, all of the return series have thicker tails than normal distribution.

From the above papers, one can note that the problem of selecting an appropriate model to model the stock market returns is still an open problem. Also, the conflict in

selecting a normal to stable model exists till date. All these works motivated us to consider the Indian Nifty 50 indices and test whether a normal model fits the indices or not.

In this paper we try to test the normality hypothesis and also check how trimming works in improving the performance of a normal model in fitting the market returns.Also, its effect on testing hypothesis on returns variable.

Objectives of the Study

1. To test the significance of a normal model in studying the behaviour of Nifty 50.
2. To test whether there exists significant difference between the average Nifty 50 indices for those years for which the normality is satisfied.
3. To look at how trimming has an effect on the significance of a normal model.
4. To repeat the hypothesis stated in 3 using ANOVA across the years.

Model testing and the Effect of Trimming

In this section, we test the significance of a normal model in studying the behavior of market returns especially Nifty 50. We consider the Nifty 50 indices year-wise and test the significance of a normal model. Later we present how trimming can improve the performance of the normal model in modelling the market returns, year wise.

Summary statistics for the market returns across the years.

Table 1 : Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Ret_10	252	5860.40	7917.48	6817.9265	549.33080	.361	.153	-1.085	.306
Ret_11	247	5763.88	7727.31	6732.1563	420.26917	-.201	.155	-.709	.309
Ret_12	250	5881.28	7622.38	6823.7632	408.56713	.153	.154	-.660	.307
Ret_13	250	6860.50	8279.62	7652.8270	304.25501	-.255	.154	-.286	.307
Ret_14	244	7814.96	11303.65	9641.2298	1069.34503	-.288	.156	-1.312	.310
Ret_15	229	10047.15	11856.58	11021.2956	405.44083	-.109	.161	-.866	.320
Valid N	229								

Source : Researcher's Analysis

*Ret _ 10 :2010; Ret _11 : 2011; Ret_ 12:2012; Ret_13 :2013;Ret_ 14:2014; Ret_15:2015 *Ret : Returns

Testing the Model

The null hypothesis is that a normal model is an appropriate model in studying the behaviour of the market returns and the alternative hypothesis is that a normal model is not an appropriate model. We first consider year 2010, the year immediate to the recovery from the financial crisis.

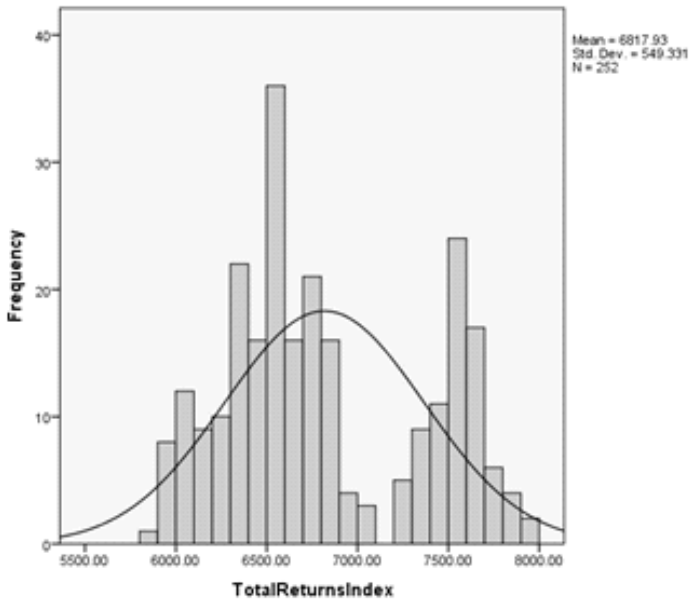

Figure 2 : Histogram Showing the Behaviour of Nifty 50 for 2010

Sources : Researcher's Analysis

From the above figure it is very apparent that a normal model is not an appropriate model and the following table gives the results of K-S test.

Table 2 : Results of K-S test

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of TotalReturnsIndex is normal with mean 6,817.927 and standard deviation 549.33.	One-Sample Kolmogorov-Smirnov Test	.001	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Source : Researcher's Analysis

Since the p-value is less than 5% level of significance, we reject the null hypothesis and conclude that Nifty 50 for the year 2010 do not follow a normal model. But, one can note that the pattern till a point (7000), the model looks like normal and trimming the other part may improve the model. We present the same towards the end of the section.

Now we present the results for years starting from 2011 to 2015 together and a similar conclusion can be drawn for each of them. We only present the results of K-S test and graphs will be presented for those cases where the null hypothesis is not rejected.

From the above table, one can note that for the years 2013 and 2015, the null hypothesis is not rejected. This indicates that Nifty 50 follows a normal patterns in these years. The following two figures gives the respective histograms.

Table 3 : Results for K-s test for other years

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Ret_11 is normal with mean 6,732.156 and standard deviation 420.27.	One-Sample Kolmogorov-Smirnov Test	.042	Reject the null hypothesis.
2	The distribution of Ret_12 is normal with mean 6,823.763 and standard deviation 408.57.	One-Sample Kolmogorov-Smirnov Test	.020	Reject the null hypothesis.
3	The distribution of Ret_13 is normal with mean 7,652.827 and standard deviation 304.26.	One-Sample Kolmogorov-Smirnov Test	.327	Retain the null hypothesis.
4	The distribution of Ret_14 is normal with mean 9,641.230 and standard deviation 1,069.35.	One-Sample Kolmogorov-Smirnov Test	.001	Reject the null hypothesis.
5	The distribution of Ret_15 is normal with mean 11,021.296 and standard deviation 405.44.	One-Sample Kolmogorov-Smirnov Test	.473	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Source : Researcher's Analysis

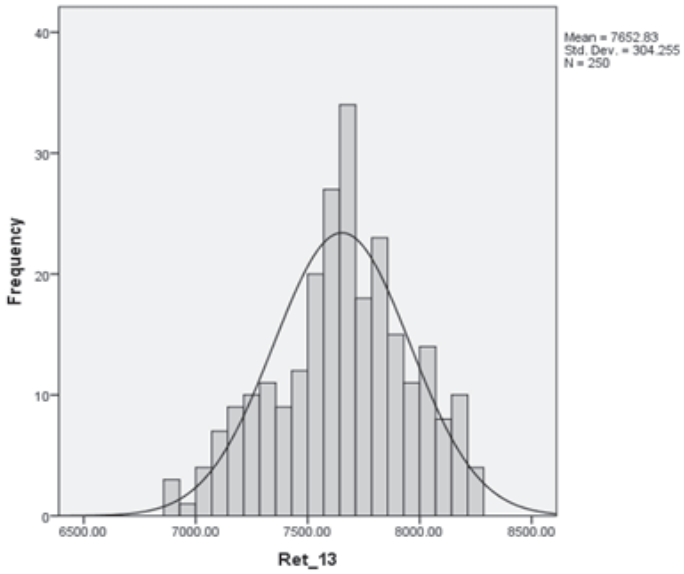

Figure 3 : Histogram for the year 2013

Source : Researcher's Analysis

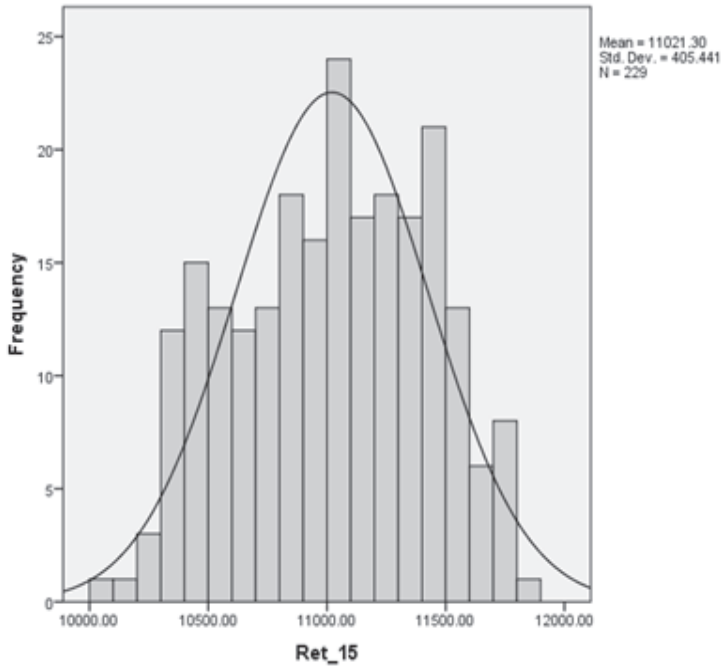

Figure 4 : Histogram for the year 2015

Source : Researcher's Analysis

The above graphs supports the non-rejection of null hypothesis and we now use a t-test to test the significant difference between the years 2013 and 2015 in terms of average Nifty indices. The null hypothesis is that there exists no significant difference between the average Nifty 50 indices for years 2013 and 2015. The alternative hypothesis is that there exist some significant difference. We test the hypothesis at 5% level of significance. The following table gives the result of a t-test. Here, t-test can be used without hesitation because, the assumption of normality is satisfied

Table 4 : Results of a t-test

Levene's Test for Equality of Variances		t-test for Equality of Means						
F	Sig.	t	df	p-value	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
							Lower	Upper
27.967	.0001	-103.378	477	.0001	-3368.46859	32.58396	-3432.49444	-3304.44275

Source : Researcher's Analysis

From the above table, one can note that the p-value is less than level of significance. Hence, we reject the null hypothesis and conclude that there exists significant difference between the two years. Now one can question at this stage, the reasons for the differences. This do not depend on the data analysis and has to be looked at from the point of political, economic reasons etc.

We now look at how trimming helps in improving the performance of the model in modelling the behavior of the market returns. We delete the outliers from the data for each year and the following table gives the results of the testing. The data points are deleted at different places and the number of observations deleted also vary from year to year. For example, for the year 2010 last 40 observations are deleted so that the normality is satisfied by the remaining data. Similarly, for the year 2011, the data with highest frequency is deleted (data points in the range 6900 to 7000 have more frequency than the normal frequency). The trimming has been applied similarly to other years except 2013 and 2015. This also shows that trimming can be done at places where the data affects the normality. The following table gives the descriptive statistics for the average returns for each of the year for which trimming is applied.

Table 5 : Summary Statistics of Nifty 50 Indices after trimming

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Ret_10	174	5860.40	7065.39	6489.4348	274.97666	-.330	.184	-.611	.366
Ret_11	247	5763.88	7727.31	6758.4604	450.83051	-.081	.155	-.789	.309
Ret_12	224	5881.28	7622.38	6784.9587	399.52271	.218	.163	-.555	.324
Valid N	174								

Source : Researcher's Analysis

Comparing Table-1 with Table-5, one can note the change in the value of Kurtosis. After trimming the value of Kurtosis has come down.

The following table gives the testing of normality afte trimming.

Table 6 :

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Ret_10 is normal with mean 6,489.435 and standard deviation 274.98.	One-Sample Kolmogorov-Smirnov Test	.098	Retain the null hypothesis.
2	The distribution of Ret_11 is normal with mean 6,758.460 and standard deviation 460.83.	One-Sample Kolmogorov-Smirnov Test	.314	Retain the null hypothesis.
3	The distribution of Ret_12 is normal with mean 6,784.959 and standard deviation 399.52.	One-Sample Kolmogorov-Smirnov Test	.078	Retain the null hypothesis.
4	The distribution of Ret_13 is normal with mean 7,652.827 and standard deviation 304.26.	One-Sample Kolmogorov-Smirnov Test	.327	Retain the null hypothesis.
5	The distribution of Ret_15 is normal with mean 11,021.296 and standard deviation 405.44.	One-Sample Kolmogorov-Smirnov Test	.473	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Source : Researcher's Analysis

From the above table one can note that after trimming has an effect on years 2010, 2011, 2012 but not on 2014. The graph below reveals this fact.

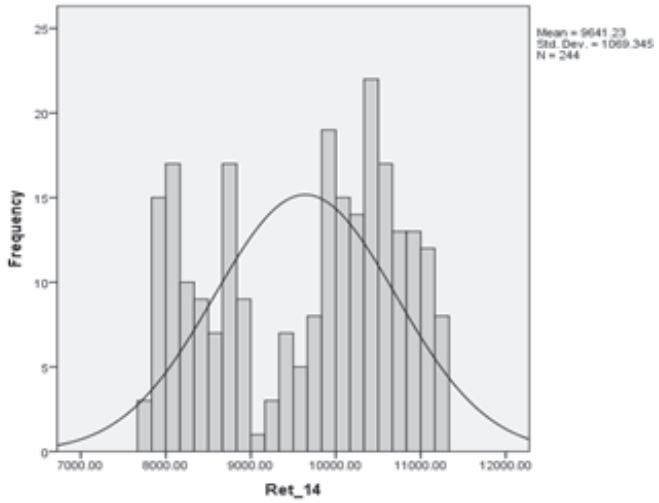

Figure 5

Source : Researcher's Analysis

Now, we test the hypothesis on the difference between the years that follow a normal model using Analysis of variance (ANOVA). The following table gives the results of the same.

Table 7: Anova

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3179161269.420	4	794790317.355	5586.349	.0001
Within Groups	159204215.875	1119	142273.651		
Total	3338365485.295	1123			

Source : Researcher's Analysis

From the above table one can note that there is a significant difference between the years with respect to the average Nifty indices (market returns). Now applying the Tukey's honest significance difference test to find which two years differ with respect to average Nifty 50 indices.

Table 8 : Table with years that are homogeneous wit respect to average returns

Tukey HSD[a,b]					
Factor	N	Subset for alpha = 0.05			
		1	2	3	4
2010	174	6489.4348			
2011	247		6758.4604		
2012	224		6784.9587		
2013	250			7652.8270	
2015	229				11021.2956
Sig.		1.000	.947	1.000	1.000

Source : Researcher's Analysis

The above table reveals that years 2011 and 2012 are homogeneous with respect to average Nifty 50 indices. Now one has to look at market conditions prevailing at times associated with above years stated.

Suggestions and Conclusion

From the above analysis we conclude that Nifty 50 do not follow a normal pattern. Hence, if one wishes to study the behaviour of the total market returns using Nifty 50 indices, then it is necessary to either remove the outliers extremes from the model or use alternative models such as student-t distribution, log-normal distribution or stable models. We also, conclude that trimming has an effect on the performance of a normal model in modelling the market returns.

We hence, suggest that

a. Before using a normal one has to test whether the current sample supports the model.

b. If the data do not support a normal model, use trimming first before choosing any other alternative model. It is better to use a normal model while studying the pattern of the markets, in general, so that the smooth properties of a normal model will help the researcher to understand the characteristics of the market better.

As in any study, the current paper also has its limitation. It only considered testing a normal model but haven't looked at alternative models and compared the performance of a normal model against the performance of alternative models. This can be taken as the future work by any researcher.

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