



## Measurement of Indian stock market efficiency through random walk model

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### Abstract

The study aims to examine the stock price efficiency of NSE Index- Nifty 50 in its weak form. For the purpose, weekly stock price returns are examined in two parameters i.e. Normality and Randomness. As return data failed to exhibit approximately normal distribution, non-parametric run test has been used to verify the randomness of the data.

Based on the result of non-parametric run test, the weekly stock price return follows Random Walk Model. Null hypothesis is retained there by confirming weak form of efficiency.

**Keywords:** national stock exchange (NSE), NSE index- nifty50, random walk model (RWM), securities and exchange board of India (SEBI)

### Introduction

In this globalized world, the efficient functioning of the country's stock market depicts economic development. Channelizing the liquid capital of the economy, quickly and accurately into the most efficient sector will lead to industrial development. This economic development in general and industrial development in particular is achieved through transactional efficiency (or operational efficiency) and pricing efficiency.

With the establishment of SEBI and introduction of online screen based platform by NSE over the traditional trading practices, it is presumed that Indian Stock Market achieved transactional efficiency. NSE launched electronic screen based trading in 1994 and internet trading in 2000. It is the leading stock exchanges in terms of equity trade volume and ranked largest in India in terms of total and average daily turnover for equity shares based on annual reports of SEBI. NSE in India is a 'pioneer in technology ensuring the reliability and performance of its system through innovation and investment in technology', leading Indian stock market towards minimum transactional cost and more competitive market.

Pricing efficiency, on the other hand is one of the most debated topic which we are going to deal with. Fama (1970)<sup>[4]</sup> 'a market in which prices always "fully reflect" all available information is called "efficient".' Further stated that 'empirical work concerned with the adjustment of security prices to three relevant information subsets is considered. First *weak form test* in which the information subset of interest is just past price (or return) histories. Most of the results here come from random walk literature. When extensive tests seemed to support the efficiency hypothesis at this level, attention was turned to *semi strong form tests* in which the concern is the speed of price adjustment to other obviously publicly available information. Finally, strong form tests in which the concern is whether any investors or groups have monopolistic access to any information relevant for the

formation of prices have recently appeared'. Weak form of efficiency is examined through randomness in the stock prices in this study. Various studies concluded their results based on the workings on the Random Walk Hypotheses on Indian Capital Market but there exists contradictions. Possibly due to the varied socio-economic and political factors and the dynamic nature of these factors do not lead to same conclusion of all the studies. Therefore, there appear two schools of thoughts, one supporting the Random walk Hypothesis in the Indian Capital Market and the others who failed to find out any evidence of random walk on their study. The studies supporting weak form of efficiency like Sharma & Kennedy (1977) who worked on the stock indices of Bombay, London and NYSE during the period 1963 to 1973. They performed run tests and spectral analysis and both the test confirmed the random movement of stock indices for all the three stock exchanges. Alam (1999) through his study concluded the presence of Random Walk Hypotheses for stock price changes on the Bombay stock exchange (India) and Dhaka stock exchange (Bangladesh) respectively. Ramasastri (1999) in his study revealed the acceptance of null hypothesis that stock prices are random during the post liberalization period, using three Dickey Fuller hypotheses on Indian Stock Market. Debasish & Mishra (2003)<sup>[8]</sup> in their study investigate Random Walk Hypotheses in the Indian Stock Market which support informational efficiency and Random Walk Hypotheses more in case of daily and weekly stock return compared to the stock indices return. Later, Ramasastri. A. S. (2007) in their study on stock market efficiency spectral analysis found that Indian Stock Market was efficient enough and revealed the presence of periodic cycles in the movement of share prices.

Thus, there are several other studies testing the Indian Stock Market behavior and on the basis of the test results, they conclude that the Indian Stock Market follows random walk and thus efficient in weak form. Amongst the various studies

conducted, the following reject the presence of Random walk Hypothesis in Indian Capital Market. Barman & Samanta (2001) in their study on Indian Market revealed the presence of stock market inefficiency. Thus, their findings do not support weak form of efficiency. Ahmad *et al.* (2006) tested two major equity markets in India that is BSE & NSE for the period of 1999-2004. Using econometric techniques are used like unit root test (ADF & PP), Autocorrelation function, Ljung-Box (Q) statistics, GARCH model, run test and K S test. The Random Walk Hypotheses for the Nifty and the Sensex stock indices is rejected and it was found that both the stock market have become relatively more inefficient in recent times with high and increasing volatility. Gupta & Basu (2007) also found similar result testing Random Walk Hypotheses for the period 1991 to 2006 on Bombay Stock Exchange & National Stock Exchange. Pradhan *et al.* (2009) [8] examined random walk model through unit root test on the sample of daily stock returns of National Stock Exchanges (NSE) and Bombay Stock Exchanges (BSE) from Jan 2007 to July 2009. It also failed to follow random walk model.

### Objective

The basic objective of the study is to examine whether the market is efficient in its weak form. For the purpose, this study aims at

- Whether the weekly return data follows Random Walk Hypotheses.

### Hypotheses

The main hypotheses for the purpose of the study area is Indian Stock Market represented by NSE Index- Nifty50, Stock of the nation is efficient in its weak form. The testable hypotheses are

**H<sub>0</sub>**: weekly return follows random walk model.

**H<sub>1</sub>**: weekly return does not follow random walk model

### Methodology

#### Data

The data has been collected from the Capitaline Database Package-2000. The weekly stock price of NSE Index- Nifty50 for the period 01-01-2000 to 31-08-2017 has been used for the purpose. All the Statistical tests and Results in the study are performed and obtained by using IBM SPSS Statistics 20.

The weekly Stock price returns are calculated as follows:

$$R_t = \ln\left(\frac{P_t}{P_{t-1}}\right)$$

Where  $R_t$  the return at period t is,  $P_t$  is the price index at period t,  $P_{t-1}$  is the price index at time period t-1 and  $\ln$  is the natural log. The natural log ( $\ln$ ) is used as it is more likely to be normally distributed.

### Random Walk Model

Fama (1965)\* [3] 'the theory of random walk in stock prices actually involves two separate hypotheses: (1) Successive price changes are independent, and (2) the price changes conform to some probability distribution.' Thus as per random

walk theory successive price changes (or return) are independent of one another and identically distributed. To illustrate this notion, it is assumed that the price of stock at t is equal to its price at time (t-1) plus error term  $u_t$  with 0 mean and variance  $\sigma^2$ .

$$R_t = R_{t-1} + u_t$$

Investigation of randomness requires statistical tools for distribution comparison. When the distribution of the given data is unknown, hypotheses are: H<sub>0</sub>: sequence is independent and identically distributed. H<sub>1</sub>: sequence is not independent and identically distributed.

Since true pattern of distribution is hard to estimate. Researchers resort to Non-parametric test which is also known as distribution free test.

### Test of Normality

The main proponent of the theory is that the distribution derived from random occurrence should follow approximately normal distribution. Normality of the distribution is used in two prospective firstly, it is used examine whether the pattern of distribution follows approximately normal distribution. Thus use of statistical tools and tests are made on the basis of normality as it is one of the assumed conditions for some statistical operations. So for appropriate selection of statistical tests it is one of the important parameter to be considered. Secondly, as stated by Fama normality criterion can be used to test the stock price efficiency. For the purpose of our study three test are conducted for normality: Skewness, Kurtosis, and Kolmogorov- smirnov test.

### Skewness

It is the measure of asymmetry in the frequency distribution. For a symmetric distribution, skewness is zero i.e. the values of the variable equidistant from mean have equal frequencies. The test statistic of skewness ( $r_1$ )-

$$(r_1) = \frac{M_3}{M_2^{3/2}} \times \left(\frac{n}{6}\right)^{1/2}$$

$$M_3 = \frac{n^2 m_3 - 3n m_2 m_1 + 2m_1^3}{n(n-1)(n-2)}$$

$$M_2 = \frac{n m_2 - m_1^2}{n(n-1)}$$

Where  $M_2$  and  $M_3$  are second and third central moment, n= number of observation.  $m_r = r^{\text{th}}$  order raw moment of the variable stock price return.

### Kurtosis

it is the measure of concentration of the values. Degree of peakedness of a frequency curve represents kurtosis. For normal distribution it is neither very peaked nor flat-topped known as mesokurtic the measure of which is zero. The test statistic of kurtosis ( $r_2$ )-

$$(r_2) = \frac{M_4}{M_2^2} \times \left(\frac{n}{24}\right)^{1/2}$$

$$M_4 = \frac{(n^3 - n^2)m_4 - 4(n^2 + n)m_3 m_1 - 3(n^2 - n)m_2^2 + 12m_2 m_1^2 - 6m_1^4}{n(n-1)(n-2)(n-3)}$$

$$M_2 = \frac{n m_2 - m_1^2}{n(n-1)}$$

Where n= number of observation,  $m_r = r^{th}$  order raw moment of the variable stock price return.

In reality it is impractical to compare the calculated value with absolute value of normal distribution i.e. zero but it should be closed to zero. For the purpose the calculated values are standardized by dividing it with standard error. Calculated values of Skewness and Kurtosis were compared with table valued. So the tabulated value of Z (denoted by  $Z_{\alpha/2}$ ) at 1% level is  $\pm 2.58$  and 5% level  $\pm 1.96$ . if  $r_1$  and  $r_2$  lies within  $Z_{\alpha/2}$  the test confirms normality of the distribution otherwise it is statistically significant.

**Kolmogorov-smirnov test**

It is a non-parametric test widely used for goodness of fit tests. The observed cumulative distribution for a variable is compared with a specified theoretical distribution which may be normal, poisson or exponential. The Z value is computed from the largest difference between the observed and theoretical cumulative distribution function to check whether the observation could have come from the specified distribution i.e. whether the sample distribution are homogenous.

**Run Test**

It is a non-parametric test and strongest test of randomness. It is widely used by researchers in investing the serial dependence in stock price movements. It is a distribution free test, independent of normality. It examines whether the value of one observation influences the value taken by later. If there is no influence, the sequence is considered random. The test becomes statistically significant when the expected runs differ significantly from observed runs. Too few runs indicate tendency for high and low values to cluster while too many runs indicate a tendency for high or low values to alternate.

A run is defined as 'a sequence of identical occurrences preceded and followed by different occurrences or by none at all'. The price changes are indicated by positive or negative sign no changes are indicated by zero. In case sign changes from positive to negative or from negative to positive, new runs counted ignoring zero changes. Differences of actual and expected runs are compared by employing 'Z' statistics. Therefore, the null hypotheses may be tested by using the Z-test according to the formulae:

$$Z(\text{Test Statistics}) = \sum \frac{\{r - E(r)\}}{SD(r)}$$

$$E(r)(\text{mean}) = \left( \frac{2n_1 n_2}{n_1 + n_2} \right) + 1$$

$$SD(R)(\text{Standard deviation}) = \sqrt{\frac{2n_1 n_2 (2n_1 n_2 - n_1 n_2)}{\{(n_1 + n_2)^2 (n_1 + n_2 - 1)\}}}$$

In the test null hypothesis will be accepted if the Z value lies within 95% confidence interval and rejected if the value lie outside the confidence level. The normal probability table can be used to accept or reject null hypotheses.

**Major Findings of Normality Test**

The Descriptive Statistics given below is derived from the weekly market return of NSE Index- Nifty50 data selected for the study period. The calculated value of skewness and kurtosis is .593 and 3.455 and the Z-Value is respectively 7.32 and 21.32. Thus, the data given is found skewed and kurtotic failing to depict approximately normal distribution.

**Table 1**

Descriptives				
		Statistic	Std. Error	
RET_NIFTY50	Mean	-.0020	.00106	
	95% Confidence Interval for Mean	Lower Bound	-.0041	
		Upper Bound	.0001	
	5% Trimmed Mean	-.0028		
	Median	-.0040		
	Variance	.001		
	Std. Deviation	.03183		
	Minimum	-.14		
	Maximum	.17		
	Range	.32		
	Interquartile Range	.04		
	Skewness	.593	.081	
	Kurtosis	3.455	.162	

Source: IBM SPSS Statistics 20

**Kolmogorov-Smirnov Test**

**Table 2**

	Tests of Normality					
	Kolmogorov-Smirnov <sup>a</sup>			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
RET_NIFTY50	.056	909	.000	.958	909	.000
a. Lilliefors Significance Correction						

Source: IBM SPSS Statistics 20

The non-parametric test with Kolmogorov-Smirnov Test was also found statistically significant. Since the p-value is less than 0.05 that is 0.000 which is statistically significant thereby rejecting null hypotheses and therefore we can say that market return does not follow an approximate normal distribution.

**Run Test**

**Table 3**

Hypothesis Test Summary			
Null Hypothesis	Test	Sig.	Decision
The sequence of values defined byOne-1 RET_NIFTY50<=-0.00 and >-0.00 is random.	Sample Runs Test	.370	Retain the null hypothesis.
Asymptotic significances are displayed. The significance level is .05.			

Source: IBM SPSS Statistics 20

The Run Test is found statistically insignificant thereby retaining null hypotheses. Since p-value is 0.370, more than the level of significance, the return follow Random Walk model. So, the market is found efficient in its weak form.

### Conclusion

Most of the earlier studies reflected that Indian stock market is efficient in weak form but some researchers and academicians pointed out major factors, reflecting inefficiency. The stock prices of some poorly performing companies have been seen rising due to unscrupulous activities. Theorist of fundamental and technical analysis presented predictability in stock prices. They are of the notion that Indian stock market is not transparent and 'information' plays a significant role in it. Therefore, there is continuous debate related to stock market efficiency.

After the establishment of SEBI, a formal regulatory structure in the securities exchanges enhanced the security of investors by protecting their interest. Thereafter with the introduction of online screen based trading platform initiated transaction cost to decrease considerably there by leading Indian stock market towards transactional efficiency.

In this study the evidence of efficiency can be seen in the non-parametric Run Test. The test of normality failed to depict approximately normal distribution through Skewness, Kurtosis and Kolmogrov-Smirnov Test. This deviation from normality leads to non-parametric test to examine Random Walk Hypotheses. The non-parametric Kolmogrov-Smirnov Test and Run Test represented contradictory result. The Kolmogrov-Smirnov Test is found statistically significant in measure of efficiency whereas Run Test portrayed statistical insignificance thereby retaining null hypotheses. As the Run Test is the strongest test of randomness in Random Walk Model the result of Run test is considered in the test of pricing efficiency. Thus in this study The Indian Stock Market is found efficient in weak form.

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