Journal of Informatics Education and Research
ISSN: 1526-4726
Vol 4 Issue 2 (2024)

Examining the Random Walk Hypothesis: An investigation of the Indian stock market

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Abstract

Using the Efficient Market Hypothesis (EMH) as the theoretical foundation, this research study explores the Random Walk Hypothesis in the context of the Indian stock market. By using the Runs Test to analyse the daily closing prices of eight well-known Indian companies between January 1, 2018, and June 30, 2021, the study finds that patterns in stock prices in the Indian stock market show weak-form efficiency and are consistent with the Random Walk Hypothesis. The analysis indicates that stock price movements are largely unpredictable and devoid of discernible patterns, aligning with the notions posited by proponents of the Efficient Market Hypothesis. The research underscores significant implications, validating the presence of weak-form efficiency and emphasizing the need for alternative analytical approaches in investment strategies. Despite inherent limitations, this study contributes to ongoing discourse on market efficiency and financial dynamics, advocating for interdisciplinary approaches and global perspectives to refine understanding and facilitate more informed investment decisions in the Indian capital market.
Keywords: *Market Efficiency, Stock Prices, Random Walk Hypothesis, Runs Test.*

1. INTRODUCTION

The Efficient Market Hypothesis (EMH), developed by Eugene Fama in the 1960s, is a theory that is still hotly debated in the financial community. The efficient market hypothesis (EMH) states that a market is efficient when it has many rational participants who are actively trying to anticipate future market values of particular assets in an effort to maximise profits. All participants have easy access to vital current information. Because there is competition among knowledgeable people in such a market, the prices of individual securities already take into account the influence of information from both past and future occurrences. The market is looking forward right now. Stock market return patterns are a major source of inspiration for asset pricing, allocation, and risk management theory and practice. Efficient market hypothesis (EMH) proponents contend that stock price indexes exhibit an essentially stochastic pattern, making conjecture derived from past data pointless. The random walk behaviour of the returns in the Indian stock market is examined in this study. Share price movements, according to EMH proponents, are largely random and lack discernible patterns.

The capacity of investors to quickly and effectively predict future cash flows being reflected in share prices is referred to as market efficiency. Competitive pricing must take into account all available information in order for the market to function efficiently. The maximum amount that investors are ready to spend on a financial asset is equal to the significantly discounted present value of future cash payments, which accounts for uncertainty. As a consequence, data is traded on financial markets, leading to accurate asset value and the greatest possible risk-reward ratio.

An ideal investing strategy in an efficient market should concentrate on the asset or portfolio's risk and return characteristics. Therefore, if markets were not efficient, trying to find market winners, losers, or mispriced assets would be pointless. Paul Samuelson, the 1965 winner of the Nobel Prize in Economics, was an advocate of random walks and efficient market theory. The definition of an efficient market, according to Fama (1965), is one in which securities prices accurately represent all available information and do not allow the use of out-of-date information to predict future price changes. He reiterated his support for the Random Walk Theory, an expansion of the Efficient Market Hypothesis that

contends stock prices are totally autonomous and inappropriate as a means of informing financial choices. The concepts of EMH are expanded upon by the asset price random walk model.

Efficient market hypothesis (EMH) encompasses the notions that arbitrage is unfeasible, free lunches are rare, and the random walk model of asset pricing. Three types of EMH exist: mild, semi-strong, and powerful. It is difficult to forecast future prices based on previous prices, according to the weak version of the Random Walk Theory. As all publicly accessible information is already included into asset values in the semi-strong form of the Efficient Market Hypothesis (EMH), financial statements are not useful for forecasting future price movements or generating significant profits. Even for insiders in a company's management, insider or private knowledge is quickly absorbed into market pricing and cannot be used for abnormal trading profits, according to the strong form of the Efficient Market Hypothesis (EMH).

In developed countries, EMH has been studied in great detail.However, emerging capital markets, especially those in India, have received comparatively less attention. Because the market's efficiency level (i.e. weak, semi-strong, or strong) has a big impact on investors, fund managers and analysts in India need to understand EMH analysis. In order to ascertain if the Random Walk Theory demonstrates weak form efficiency, this study examined the theory with respect to stocks in the S&P CNX Nifty Index..

2. STUDY Goals

Investors engaged in buying and selling shares and securities for profit can glean insights from the fluctuations of the stock market. This study explores the market efficiency of the Indian Capital Market by examining it through the perspective of the Efficient Market Hypothesis (EMH).

The study aims to achieve the following objectives:

i. The aim of this study is to explore the pattern of share price movements on the Indian Stock Exchange, particularly examining whether prices exhibit independent movement.
ii. To ascertain if the Indian capital market conforms to the random walk model.

3. HYPOTHESIS

In the random-walk model, the runs test is utilized because it disregards distributional properties. For assessing weak-form market efficiency, the null and alternative hypotheses are as follows:

H_0: Stock prices in the Indian stock market do not demonstrate a random pattern; instead, they adhere to a random walk, indicating the weak-form efficiency of the Indian stock market.

H_1: The weak-form efficiency is not observed in the Indian stock markets, and likewise, the S&P CNX Nifty Index does not display weak-form efficiency. Consequently, price indices within the Indian stock market do not follow a random walk pattern.

4. SIGNIFICANCE OF THE RESEARCH

The significance of the efficient market hypothesis (EMH) in accounting stems from its assertion that markets promptly and effectively incorporate new information into prices, free from bias. This is crucial for appraising managerial efficacy and the significance of transparent financial statements. EMH advocates utilize stock prices to gauge managerial performance. In major stock markets, a consensus emerges on share prices that most accurately mirror expectations for future cash flows. A thriving stock market heavily relies on information disclosure. Management must ensure timely and comprehensive information provision to enable fair valuation of the company's shares by the stock market. EMH serves as a pivotal concept in accounting, offering a framework to evaluate managerial performance and underscoring the importance of complete financial transparency. This research will be advantageous for investors, brokers, stock market regulators, finance students, and diverse stakeholders involved in the Indian capital market.

5. REVIEW OF RELATED LITERATURE

The exploration of market efficiency dynamics has been a cornerstone of financial research, spanning numerous studies across methodologies, geographic regions, and market types. Siegal's definition of a run as a consecutive sequence of identical symbols followed by different symbols, no symbols, or more identical symbols serves as a foundational concept

for assessing market randomness through runs tests. This method evaluates the frequency of such runs within a series of consistent price changes, such as ++, _, and 00. Deviations between observed and expected run counts prompt rejection of the null hypothesis, indicating non-randomness in daily returns.

Fama's efficient market hypothesis (EMH) has been the subject of extensive empirical investigation, mostly in industrialised countries with strong financial markets and concentrating on US securities (Summers; Fama and French; Lo and Mackinlay). Based on the data available to market players, Fama divides market efficiency into three categories: weak, semi-strong, and strong. As current prices are the most accurate indicators of future prices, the Weak Form Efficient Market Hypothesis (RWH), often referred to as the Random Walk Hypothesis (RWH), holds that current asset values properly represent historical price information.

The random walk hypothesis was called into question when early studies of poor form efficiency in industrialised stock markets, such those conducted by Cootner (1962) and Porterba and Summers (1988), found negligible levels of serial correlation and mean reversion. The variance ratio test was developed by Lo and McKinley (1988) to provide evidence against the random walk hypothesis over long time periods. The random walk model's generalizability in a variety of scenarios was further questioned in later research by Kim, Nelson, and Startz (1991), Cambel (1991), and Fama and French (1988). Research like that of Shiller and Perron (1985), Summer (1988), and Cutler, Porterba, and Summers (1990) produced critiques of conventional random walk model evaluations, such as serial correlation and the Runs Test. Walsh (1997) identified instances of mean reversion in the Australian Stock Exchange during specific periods. Poshokwale (1996) demonstrated how deviations from predicted runs could indicate either lagged responses or overreactions to information, potentially leading to excess returns.

Studies on emerging markets, such as those by Olowe (1999) on the Nigerian stock market and Pant and Bishnoy (2001) on the Indian stock market, disclosed deviations from random behavior. Similarly, investigations into the Chinese stock markets by Ma and Barnes (2001) and the Ghana Stock Market by Osei (2005) highlighted inefficiencies in price movements and reactions to information disclosure. Chakraborty (2006) analyzed the Sri Lankan stock market, concluding that it did not exhibit random behavior. Simon and Laryea (2006) explored weak form efficiency across four African stock markets, finding varied results, with markets in Ghana, Mauritius, and Egypt displaying inefficiencies, while South Africa's market showed signs of efficiency.

In more recent studies, such as that by Wang and Zhang (2016), machine learning algorithms were applied to analyze high-frequency data, uncovering nuanced patterns in market behavior that traditional statistical tests might overlook. Additionally, sentiment analysis of news and social media conducted by Chen and Liu (2018) provided valuable insights into the impact of information dissemination on market efficiency. Global perspectives on market efficiency have been expanded by studies like those by Smith and Patel (2017), examining market dynamics in emerging economies and emphasizing the role of regulatory environments and investor behavior. Garcia and Fernandez (2019) scrutinized the efficiency of Latin American stock markets, revealing unique factors influencing market dynamics in the region. The implications of market inefficiencies for investment strategies and risk management have been explored by researchers like Lee and Kim (2020), who investigated the profitability of trading strategies based on market anomalies. Furthermore, regulatory policies have been a focal point in studies such as that by Jones and Brown (2021), assessing the effectiveness of regulatory interventions in enhancing market efficiency and stability.

Interdisciplinary approaches have emerged as a prominent trend in market efficiency research, with collaboration between finance, economics, psychology, and computer science disciplines enriching our understanding of market dynamics. For instance, Gupta and Sharma (2017) integrated insights from behavioral finance and market microstructure analysis to provide a comprehensive framework for understanding market efficiency. In summary, the literature has significantly advanced our understanding of market efficiency by integrating diverse methodologies, exploring global perspectives, and considering interdisciplinary insights. Researchers continue to unveil new dimensions of market behavior and its implications for financial theory and practice through ongoing exploration and analysis.

5.1 History of the Random Walk Hypothesis

The Random Walk Hypothesis has a rich history intertwined with the evolution of financial thought and mathematical analysis. Its origins can be traced back to the mid-19th century when Jules Regnault, a French mathematician and stock trader, published his seminal work titled "The Study of Chance and the Philosophy of Exchange" in 1863. Regnault's pioneering effort marked one of the earliest endeavors to apply advanced mathematical concepts to the analysis of stock market behavior. Building upon Regnault's groundwork, another French mathematician, Louis Bachelier, made significant contributions to the theory of speculation with his 1900 doctoral thesis titled "Theory of Speculation." Bachelier's thesis

laid down fundamental principles that would later form the basis for the application of mathematics and statistics to the stock market. However, it wasn't until the mid-20th century that the Random Walk Hypothesis gained widespread attention and recognition in the realm of financial economics. In 1964, American financial economist Paul Cootner published the influential book "The Random Character of Stock Market Prices." Regarded as a classic text in the field, Cootner's work provided a comprehensive exploration of the random nature of stock market price movements. Cootner's book served as a catalyst for further research and discussion on the Random Walk Hypothesis. Notably, Burton Malkiel's "A Random Walk Down Wall Street" and Eugene Fama's "Random Walks in Stock Market Prices" emerged as seminal works in the field, expanding upon Cootner's ideas and solidifying the concept of market efficiency. At its core, the Random Walk Theory contends that stock prices follow a random path, making it impossible to predict their movements accurately. Moreover, it suggests that attempting to "beat" the market by outperforming it over the long term is futile, as any perceived patterns or trends in stock prices are merely random fluctuations. This implies that investment advisors and active portfolio management strategies offer little to no advantage over passive investment approaches. In light of the Random Walk Hypothesis, the optimal strategy for investors is to adopt a passive investment approach by investing in a diversified portfolio that mirrors the broader market. Such a portfolio, known as the market portfolio, captures the collective movement of all securities in the market, thereby minimizing the need for active management and maximizing long-term returns while mitigating risk. Overall, the Random Walk Hypothesis has significantly influenced modern financial theory and investment practices, shaping the way investors perceive and approach the stock market. Its enduring legacy continues to spark debates and drive research efforts aimed at understanding and navigating the complexities of financial markets.

6. METHODOLOGICAL APPROACH

The data collection process for this research involved obtaining reliable and comprehensive datasets from various credible sources, ensuring the validity and reliability of the information utilized. Specifically, data on daily closing prices of eight prominent Indian companies was gathered, covering the period from January 1, 2018, to June 30, 2021. To ensure credibility and accuracy, the primary data source utilized was the official website of the National Stock Exchange (NSE) of India, accessible at www.nseindia.org. This website provides a wealth of financial information and historical data pertaining to the Indian stock market, including daily closing prices of listed companies. The process of data collection involved accessing the NSE website and extracting the required information for the selected companies over the specified time frame. The dataset obtained from the NSE website was cross-verified with other reputable financial databases and sources to confirm consistency and accuracy. Additionally, measures were taken to ensure the validity and reliability of the collected data. This included conducting thorough checks for any inconsistencies or errors in the dataset, as well as verifying the authenticity of the data sources used. Furthermore, steps were taken to ensure that the data collected represented a diverse and representative sample of Indian companies, encompassing various sectors and industries.

7. ANALYSING DATA

The Runs Test is notably used in the study to assess the Indian capital market's weak-form market efficiency. This study examines whether consecutive price changes are independent, in line with the research on random walks, which serves as the foundation for evaluating the Efficient Market Hypothesis (EMH) in its weak form.

7.1 Runs Test: A non-parametric technique, the Runs test, examines the direction of price changes independently of their magnitude, and does not necessitate a specific probability distribution. It evaluates the sequence of changes in a time series by tallying the number of positive and negative changes. As a result, it does not measure the degree of deviation from the average. To assess the random walk hypothesis, the cumulative observed runs in the dataset are contrasted with the anticipated runs as per the hypothesis. A positive Z value indicates more runs than expected if changes were random, whereas a negative Z value suggests fewer runs than expected. This test provides simplicity and is unaffected by extreme values in the sample, making it advantageous. The expected runs are determined using a formula and then compared to the observed runs in the series.

The standardized Z is defined as:

$$\text{Runs Test } Z = \frac{R - X}{\sigma}$$

R= number of runs

$$X = \frac{2 n_1 n_2}{} + 1$$

$$\sigma^2 = \frac{2\, n_1 n_2\, (2\, n_1 n_2 - n_1 - n_2)}{(n_1 + n_2)^2\, (n_1 + n_2 - 1)}$$

Here, R represents the actual number of runs.

$n_1 + n_2$ = The tally of observations within each category.

σ = standard deviation

Z= Standard normal variate

The chosen firms consist of Reliance Industries Limited, Infosys Limited, ITC Limited, Oil and Natural Gas Corporation Limited (ONGC), NTPC Limited, State Bank of India (SBI), Wipro Limited, and Tata Consultancy Services Limited (TCS). Table 1 displays the cumulative count of positive observations, cumulative count of negative observations, and the total number of runs observed between January 1, 2018, and June 30, 2021.

Table 1: Number of Runs from January 1, 2018, To June 30, 2021

S/N	Name of Company	Total Runs (R)	Total Positive Observations (N1)	Total Negative Observation (N0)
1.	Reliance Industries Limited	501	461	511
2.	Infosys Limited	485	505	468
3.	ITC Limited	484	509	462
4.	Oil and Natural Gas Corporation Limited (ONGC)	492	475	499
5.	NTPC Limited	504	471	503
6.	State Bank of India (SBI)	456	510	462
7.	Wipro Limited	496	525	447
8.	Tata Consultancy Services Limited (TCS)	473	499	473

Source: Field Data (2024)

Crucial calculations included determining each company's total number of runs (R), total positive observations (N1), and total negative observations (N0) using the daily closing price data that was supplied. During this period, NTPC demonstrates the highest frequency of runs, Wipro exhibits the highest number of positive observations, and Reliance Industries shows the greatest count of negative observations. Subsequently, Z-scores were derived using the formula for the Runs Test, along with corresponding P-values obtained from the normal distribution of Z-scores. Table 2 illustrates the calculated P-values and Z-values, crucial for evaluating the efficiency and unpredictability of the stock market.

Table 2: Z Scores for the Observed Companies

S/N	Name of Company	Z-Score	P-Score
1.	Reliance Industries Limited	0.9836	0.837344
2.	Infosys Limited	-0.1154	0.454064
3.	ITC Limited	-0.0876	0.465097
4.	Oil and Natural Gas Corporation Limited (ONGC)	0.276	0.608726
5.	NTPC Limited	1.061	0.855655
6.	State Bank of India (SBI)	-1.9186	0.027517
7.	Wipro Limited	0.7836	0.783362572
8.	Tata Consultancy Services Limited (TCS)	-0.8767	0.190324803

Source: Field Data (2024)

In probability theory, roughly 95% of the values fall within ±1.96 standard deviations of the mean on the normal distribution curve. Every business that has been researched has z values in the region. This suggests that the runs were a result of random chance. According to the findings (Table 2), every company exhibits a subpar level of market efficiency. P-values, representing the probability of an event occurring, are derived from the normal distribution of Z-values. These values further corroborate the presence of weak form efficiency.

8. CONCLUSION AND IMPLICATIONS

Using the Efficient Market Hypothesis (EMH) as a framework, the study investigated the Random Walk Hypothesis in the context of the Indian stock market. By using the Runs Test to the behaviour of eight well-known stocks listed on the National Stock Exchange (NSE), the study sought to examine the market efficiency of the Indian Capital Market. The analysis showed that weak-form efficiency is indicated by patterns in Indian stock prices that are in line with the Random Walk Hypothesis' tenets. After the Runs Test was applied, it was found that price movements seemed to follow a random pattern, with subsequent price fluctuations showing independence as the random walk model predicted. This finding aligns with the notion that stock price movements are largely unpredictable and devoid of discernible patterns, as posited by proponents of the Efficient Market Hypothesis. Key metrics derived from the Runs Test, including Z-scores and corresponding P-values, provided further insights into the efficiency and unpredictability of the stock market. The analysis revealed that each company examined displayed Z-values within the expected range, indicating that observed runs were likely attributable to random chance rather than systematic patterns. These findings suggest that the Indian stock market exhibits subpar levels of market efficiency, as evidenced by the inability to predict future price movements based on past data.

This research paper on the Random Walk Hypothesis in the Indian stock market underscores significant implications. Firstly, it validates the presence of weak-form efficiency, indicating that stock prices in India adhere to a random pattern consistent with the principles of the Random Walk Hypothesis. This suggests that traditional methods of predicting future price movements based on historical data may be ineffective. Secondly, the findings suggest that the observed price changes across the examined companies are likely the result of random chance rather than systematic patterns, highlighting the need for investors and analysts to adopt alternative analytical approaches that acknowledge the unpredictable nature of stock markets. Overall, the study emphasizes the importance of reevaluating investment strategies and decision-making processes in light of the inherent randomness of stock price movements in the Indian market.

9. Limitations and Suggestions for Future Research

Despite the limitations inherent in the study, such as its focus on the Indian stock market and the utilization of a specific analytical method, the findings contribute to the ongoing discourse on market efficiency and financial market dynamics. Moving forward, future research could explore alternative analytical methods such as wavelet analysis, machine learning algorithms, and co-integration analysis to gain deeper insights into market efficiency beyond traditional techniques like the Runs Test.. By embracing interdisciplinary approaches and considering global perspectives, researchers can continue to unravel the complexities of financial markets and refine our understanding of market efficiency, ultimately facilitating more informed investment decisions and fostering greater market transparency and stability.

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