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RESEARCH ARTICLE

Random Walk Model for Stock Market Trend Analysis of Nepal

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Abstract: This study examines the applicability of the random walk hypothesis in the Nepal Stock Exchange (NEPSE), an emerging market marked by inefficiencies such as low liquidity, limited technological infrastructure, and external economic influences. Advanced stochastic models, including Markov chains, martingale techniques, and the Chapman-Kolmogorov equation, are employed to assess NEPSE's weak-form market efficiency. Analysing daily closing price data from 242 listed companies over five weeks, the study reveals significant inefficiencies. Transition matrices demonstrate a high likelihood of price states revisiting specific trends, with stationary vectors [0.4472, 0.5228, 0.0300] reflecting the probabilities of "High," "Low," and "Same" states, respectively. Variance ratio test further confirms deviations from randomness, highlighting inefficiencies such as serial correlation and non-random price fluctuations. These findings indicate that historical prices influence future movements, contradicting the random walk hypothesis. The results stress the need for improved infrastructure, enhanced regulatory frameworks, and investor education to increase market efficiency. By integrating specific numerical findings and inefficiencies, this study provides actionable insights for policymakers and investors while contributing to the academic discourse on emerging markets.

Keywords*: Emerging Markets, Financial Modelling, Market Efficiency, Markov Chains, Martingale Techniques, NEPSE Index, Stochastic Processes*

Introduction

The concept of random walk theory has been foundational in understanding stock market behavior, tracing back to Bachelier's seminal work in 1900. His application of the random walk model proposed that speculative prices evolve in a manner that renders future prices unpredictable based solely on past information. Decades later, Fama, (2017) significantly expanded the theory by articulating the Efficient Market Hypothesis (EMH), suggesting that asset prices fully reflect all available information. This study examines the random walk hypothesis within the context of the Nepal Stock Exchange (NEPSE), an emerging market with unique characteristics that make it ideal for such an investigation.

Nepal's stock market, although relatively nascent, has undergone significant development since the establishment of NEPSE in 1993. The NEPSE index, reflecting the performance of its 242 listed companies, plays a pivotal role in capital mobilization within Nepal's growing economy. Unlike developed markets, NEPSE exhibits inefficiencies due to limited technological infrastructure, low trading volumes, and external influences like political and economic instability (Rana, 2020, Risal and Koju, 2021). These inefficiencies offer a fertile ground for evaluating the applicability of the random walk model in an underdeveloped financial ecosystem.

Previous studies, including Charles and Darné, (2009) and (Dias *et al.*, 2022) have demonstrated varying degrees of market efficiency across emerging and developed markets. However, research specific to Nepal is sparse, with existing literature primarily focused on broader economic indices or employing conventional statistical tools. This study seeks to address this gap by applying the random walk hypothesis using advanced statistical models,

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including the Markov chain and transition matrices, to analyze NEPSE's stock price behavior.

Stock markets are critical indicators of economic health, yet their efficiency remains a contentious subject, especially in emerging markets. The random walk hypothesis, which posits that stock prices evolve randomly and unpredictably, has been extensively debated in developed markets (Fama, 1995, Andrew, 1997). However, the application and validation of this hypothesis in underdeveloped and emerging markets, such as Nepal, are relatively underexplored (Risal and Koju, 2021). Nepal's stock market, represented by the Nepal Stock Exchange (NEPSE), is in its infancy, characterized by limited technological advancements, low liquidity, and susceptibility to external shocks (Bhatta, 2010, Dias *et al.*, 2022). Empirical evidence suggests that these factors contribute to market inefficiencies, creating opportunities for speculative practices and unfair pricing mechanisms (GC, 2010, Dangol, 2012). While studies like those of Rana (2020) and Gaire (2017) have examined NEPSE using traditional econometric models, there is limited research employing advanced stochastic approaches such as Markov chains and transition matrices (Dshalalow and White, 2021, Walter, 2021). Furthermore, comparative analyses of Nepal's stock market with other emerging markets are scarce, leaving policymakers and investors with insufficient insights into the broader implications of inefficiencies (Charles and Darné, 2009, Sarkar, 2019). This gap is particularly significant given the increasing role of global economic integration, where even small markets like NEPSE are influenced by international trends (Hamid *et al.*, 2017, Okorie and Lin, 2021). Thus, there is a pressing need to investigate whether NEPSE conforms to the random walk hypothesis and to evaluate its efficiency in comparison with regional and global markets, utilizing robust statistical techniques to address these critical gaps (Malafeyev *et al.*, 2017, Ananzeh, 2021). This research aims to fill this void by providing a comprehensive analysis of NEPSE's efficiency using advanced models, offering actionable insights for improving market integrity and investor confidence.

The objectives of this research are twofold: (1) to evaluate the weak-form efficiency of NEPSE through a rigorous application of the random walk model and (2) to draw comparative insights from global emerging markets to contextualize Nepal's market behavior. Findings from this study not only contribute to the academic discourse on market efficiency but also provide practical implications for policymakers and investors in developing economies like Nepal. By examining NEPSE's market dynamics, this research enhances our understanding of how random walk principles manifest in small, underdeveloped capital markets. This study posits that understanding NEPSE's inefficiencies is crucial for fostering market development and enhancing investor confidence. The insights drawn may also serve as a reference for other emerging economies aiming to refine their financial markets and align them with global standards (Maiti, 2021, Walter, 2021).

The random walk hypothesis, introduced by Bachelier, (1990), asserts that stock prices evolve randomly, rendering future movements unpredictable based on historical data. This foundational concept was expanded by Fama, (2017) through the Efficient Market Hypothesis (EMH), which posits that market prices fully reflect all available information. While developed markets often exhibit strong-form efficiency, emerging markets tend to deviate due to structural, regulatory, and behavioral inefficiencies (Fama, 1995, Dias *et al.*, 2022). This study explores these deviations in the context of the Nepal Stock Exchange (NEPSE), addressing gaps in the literature with advanced stochastic methods.

Basics Norms of Random Walk Theory

a. The price of every security on the stock market is said to follow a random walk, based on the random walk hypothesis.

b. Walk theory further suggests that the price movement of one asset is unrelated to the price movement of another.

Global Perspectives on Random Walk Hypothesis

Studies on the random walk hypothesis have shown mixed results across global markets. In developed economies, such as the U.S. and Europe, markets largely conform to random walk assumptions due to robust infrastructure and regulatory frameworks (Worthington and Higgs, 2004, Charles and Darné, 2009). Advanced statistical methods, including Markov chains and variance ratio test, have been instrumental in validating market efficiency in these contexts (Tang, 1993, Avena *et al.*, 2016). For instance, West and Tinic, (1973) demonstrated the applicability of the random walk model in U.S. equity markets, while Andrew, (1997) critiqued its limitations in accounting for short-term anomalies.

Emerging markets, however, often deviate from the random walk model. Studies on African markets reveal inefficiencies driven by low liquidity, inadequate infrastructure, and external shocks, such as the COVID-19 pandemic (Dias and Santos, 2020, Okorie and Lin, 2021). Similar trends were observed in Asian markets, where calendar anomalies and behavioral biases undermine market efficiency (Poshakwale, 2002, Sarkar, 2019). For example, research on Chinese and Indian stock markets highlights deviations linked to investor sentiment and regulatory gaps (Malafeyev *et al.*, 2017, Dias *et al.*, 2022). These findings underscore the importance of advanced methodologies in capturing market inefficiencies.

Random Walk Hypothesis in Nepal's Stock Market

The Nepal Stock Exchange (NEPSE), established in 1993, serves as a pivotal financial institution in Nepal's nascent economy. However, inefficiencies such as low trading volumes, limited technological advancements, and external political influences have constrained its development (Bhatta, 2010, Risal and Koju, 2021). Existing studies primarily rely on traditional econometric tools, such as ARIMA and GARCH models, to analyze NEPSE's performance (Gaire, 2017). While these approaches provide valuable insights, they fail to account for the dynamic and stochastic nature of stock price movements.

Earlier research by GC, (2010) and Dangol, (2012) tested NEPSE's weak-form efficiency using historical price data, reporting deviations from randomness. Similarly, Rana, (2020) explored time-varying volatility in NEPSE, identifying patterns inconsistent with the random walk hypothesis. However, these studies lack the methodological rigor of advanced stochastic frameworks, such as transition matrices and martingale techniques, which have been applied successfully in other markets (Avena *et al.*, 2016, Walter, 2021).

Advanced Stochastic Methods: A Theoretical Basis

Advanced stochastic models offer robust tools for evaluating market efficiency. The Chapman-Kolmogorov equation, for instance, captures the probabilistic structure of stock price transitions, enabling the identification of stationary distributions and long-term trends (Tang, 1993, Satorra., 2016). Martingale techniques further assess whether stock prices adhere to fair market assumptions, where future prices equal their current values given historical data (Doob, 1953, Gerber, 1994).

These methods have been successfully applied in diverse markets. For instance, Avena *et al.*, (2016) demonstrated the efficacy of Markov processes in modeling European equity markets, while Charles and Darné, (2009) validated their applicability in Chinese markets. Dias *et al.*, (2022) extended these techniques to African markets, highlighting their adaptability across varied financial systems. Despite their potential, such methods remain underutilized in analyzing NEPSE, presenting a critical gap this study seeks to address.

Behavioral and Structural Factors in Emerging Markets

Behavioral finance offers an alternative perspective on market anomalies, emphasizing the role of investor psychology in driving inefficiencies. Ricciardi and Simon, (2000) argue that cognitive biases, such as overconfidence and herding, significantly influence market behaviors. These factors are particularly pronounced in emerging markets, where informational asymmetries and limited institutional support exacerbate inefficiencies (Chaudhuri and Wu, 2003, Gilmore and McManus, 2003). In the context of NEPSE, behavioral anomalies remain underexplored, despite evidence of speculative practices and irrational investor behavior (Risal and Koju, 2021).

Structural factors, including technological constraints and regulatory gaps, also play a pivotal role in shaping market efficiency. For example, Hamid *et al.*, (2017) identified infrastructure deficits as key drivers of inefficiencies in Asia-Pacific markets, a finding echoed in studies on African and South Asian economies (Dias and Santos, 2020, Ananzeh, 2021). These insights are relevant for NEPSE, where similar challenges persist, limiting its alignment with global market standards (Joshi and K.C, 2005, Rana, 2020).

Bridging Gaps in Literature

Despite extensive research on the random walk hypothesis, significant gaps remain, particularly in the context of Nepal. Previous studies have predominantly focused on traditional statistical tools, neglecting the potential of advanced stochastic models to capture dynamic market behaviors. Additionally, comparative analyses between NEPSE and other emerging markets are scarce, hindering a broader understanding of its unique inefficiencies (Bhatta, 2010, Dias and Santos, 2020).

This study addresses these gaps by employing transition matrices, variance ratio test, and martingale techniques to evaluate NEPSE's weak-form efficiency. By integrating insights from behavioral finance and stochastic modeling, it provides a comprehensive analysis of Nepal's stock market dynamics. The findings contribute to the academic discourse on market efficiency and offer actionable recommendations for policymakers and investors in transitional economies. The random walk hypothesis provides a valuable framework for assessing market efficiency, but its applicability varies across market contexts. While developed markets largely conform to its principles, emerging markets like Nepal exhibit significant deviations due to structural and behavioral factors. By leveraging advanced stochastic models, this study enhances the understanding of inefficiencies in NEPSE and provides a foundation for future research on emerging financial systems.

Materials and Methods

This section provides an in-depth overview of the dataset, its scope, and the methodologies employed to analyze stock price movements in the Nepal Stock Exchange (NEPSE). The study focuses on evaluating the weak-form efficiency of NEPSE by applying advanced stochastic and statistical models, with the Random Walk Model serving as the primary analytical framework.

Dataset Overview

The dataset comprises daily closing prices of 242 listed companies on NEPSE, covering a five-week period from September 18, 2023, to October 19, 2023. This dataset was selected to provide a detailed snapshot of short-term market trends and inefficiencies. Its daily frequency ensures high granularity, enabling the study to capture the dynamic behavior of stock prices within the chosen timeframe. Despite the short duration, the dataset represents the entire NEPSE index, ensuring comprehensive market coverage.

Scope of the Study

The study aims to examine NEPSE's stock price movements through the lens of the random walk hypothesis. By focusing on short-term trends, the research seeks to identify potential inefficiencies and deviations from randomness in an emerging and underdeveloped market. The selected timeframe provides practical insights into NEPSE's evolving market dynamics, serving as a foundation for future analyses with extended datasets.

Application of the Random Walk Model

The Random Walk Model is central to this study, offering a framework to assess whether NEPSE's stock price movements are independent and unpredictable. This model hypothesizes that stock price changes follow a stochastic process, rendering them memoryless and non-predictable based on historical data. Key statistical techniques used include:

Random Walk Model

Assume that the stock price on any given day t is represented by X_t. Every time unit that follows, X_t fluctuates in an unexpected way, causing the stock price to shift either one unit to the left or right, or stay in the same place. We suppose that the system can move to a new state (i+1) or stay in state i, and that each jump's random orientation is unrelated to all of the leaps that came before it (Agwuegbo *et al.*, 2010).

If S_n is stock prices at particular time n and

$$S_n = X_n + X_1 + X_2 + \cdots X_n \qquad (1)$$

where X_n are independent random variables. So,

$S_n = S_0 + \sum_{j=1}^{n} X_j$ (2)

S_0 = The initial position,

X_j is the product of independent, identically distributed random variables that have the same chance of occurring at zero (r), taking the value +1 (p), or taking the value -1 (q).

We determine the distribution of S_n for finite n,

$S_n = \sum_{j=1}^{n} X_j$ (3)

$S_1, S_2 \cdots\cdots, S_n$.

S_{n+1} defined by S_n, S_{n-1}, $\cdots\cdots$, S_0

$\mathrm{P}\{S_{n+1} = i_{n+1}/S_n = i_n,\}S_{n-1} = i_{n-1}, S_0 = i_0$ (4)

And if this Markov property is satisfied.

$\mathrm{P}\{S_{n+1} = i_{n+1} \backslash S_n = i_n\}$ (5)

The nearest neighbor property is another name for equation (5). Since there is no preferred direction of time in the concept of a closest neighbor system, we therefore simply take into consideration what occurs.

Martingale Technique

With this method, stock investors are presented with options for their next investment, some of which are based on historical stock price performance (Doob, 1953, Gerber, 1994).

The expected benefits after some time

$\mathrm{E}\ S_{n+1} = \frac{i_{n+1}}{S_n} = i_n, S_{n-1} =$
$i_{n-1}, \cdots\cdots S_i = i_1,\ S_0 = i_0$ (6)

If Equation (6) is equal to S_n, then investment is impartial. The conditions of impartial investment for all n are

$\mathrm{E}\{S_{n+1} = i_{n+1} \backslash S_n = i_n\} = S_n$ (7)

Equation (7) is a martingale system assessed conditionally on S_n value and sequence history. A super martingale is a theory by Doob, (1953) that represents an investor's partial investment, where the likelihood of justice increases or decreases.

$Z_n = S_n - S_{n-1}$ (8)

Z_n = Same distribution

S_0 = 0 for probability one.

The Equation (8) discover Markov property for recursive stochastic equation:

$S_n = S_{n-1} - Z_n$ (9)

Let $\{S_n\}$ be a martingale technique with increment defined in Equation (9) as:

$S_n = Z_1 + Z_2 + \cdots\cdots + Z_n$ (10)

For K^{th} transition, Z_{k+1} is defined as

$S_n = \sum_{k=1}^{n} Z_k$ (11)

S_n is referred to as a Markov chain additive functional. The transition matrix may be used to calculate the Markov chain's strength of dependency.

Equation for Chapman-Kolmogorov

A key idea in the theory of stochastic processes, especially regarding Markov processes, is the Chapman-Kolmogorov equation. It illustrates how a Markov process's transition probabilities change over time (Satorra., 2016).

A key idea in the theory of stochastic processes, especially as it relates to Markov processes, is the Chapman-Kolmogorov equation. It illustrates how a Markov process's transition probabilities change over time. With state space S and transition probabilities $P_{ij}(n)$ which represent the likelihood of changing from state i to state j in n steps, let's examine a discrete-time Markov chain. The equation

$P_{ij}(m+n) = \sum_{K \in S} P_{ik}(m).P_{kj}(n)$ (12)

is the Chapman-Kolmogorov equation? It is widely used in queueing theory, statistical mechanics, finance, and other domains. It is essential for comprehending the behavior of Markov processes over time (Williams, 1991).

We demand the n-step transition probabilities of lower order to examine the Chapman-Kolmogorov equation.

$P_{i,j}^{(n)} = \mathrm{P}\ \{S_n = j \backslash S_0 = i\}$

$= \sum_k P\left\{S_n = \frac{j}{S_{n-1}} = K, \cdots\cdots, S_0 = i\right\}$

$= \sum_k P\{S_n = j \backslash S_n = K,\} P\{S_{n-1} = K / S_n = i\}$

$= \sum_k P_{k,j} P_{i,k}^{(n-1)}$

$= P_{i,j}^{(n)} = \sum P_{i,k}^{n-1} P_{k,j}$ (13)

The Probability of state for n times are defined as

$P_J^{(n)}$ = P$\{S_n = j\}$ (14)

$P^{(0)}$ = P$\{S_0 = i\}$ (15)

For n-steps transition matrix as

$P_j^{(n)}$ = P$\{S_n = j\}$ = $\sum_k \{S_n = j \backslash = i\}$ P$\{S_n = I\}$

=$\sum P_{i,j}^{(n)} P_i^{(0)}$ so

$P_j^{(n)} = \sum P_i^{(0)} P_{i,j}^{(n)}$ (16)

Transition matrix P and inauguration conditions $P^{(0)}$ are completely stated in (16). It demonstrates that, vector; we may observe the system's behavior over a short time. After enough time, the system reaches equilibrium, and the state probabilities are free from the original conditions. We curb investigation in stationery, so that the starting state $P_i^{(0)}$ becomes less significant to the n-step probability as n produces.

Lim P$[S_n = j/S_0 = i]$ = P$[S_n - j]$ = πj (17)

Stationery or time invariant is the limiting value. This invariance quality of π_j is related to the concept of ergodicity.

π_j = Lim $\pi_j^{(n)}$ (18)

The probability function,

$\sum_{j=1}^{n} \pi_{i,j}$ =1 (19)

The limit value of the distribution in Equation (16) satisfies the equation,

$\pi_{i,j} = \pi_i P_{i,j}$ (20)

π= πP (21)

and it's equivalence,

π (1-p) = 0 (22)

Time of expected return

The anticipated return time to state i, j∈ I for a finite irreducible Markov chain may be obtained by calculating the reciprocal of the limiting probability $P_{i,j}^{(n)}$.

Data Limitations and Justification

The dataset's five-week duration presents limitations in capturing long-term market dynamics and seasonal variations, which are crucial for understanding broader patterns in NEPSE's behavior. While effective for analyzing short-term trends, this timeframe may not reflect responses to cyclical economic shifts or structural changes, potentially constraining the study's insights to immediate market conditions (Dias and Santos, 2020, Maiti, 2021). Moreover, the limited scope affects the generalizability of the findings, as they may not fully apply to periods marked by significant economic or political events. This restricts the ability to draw comprehensive conclusions about NEPSE's overall market efficiency across different contexts (Hamid *et al.*, 2017, Okorie and Lin, 2021). Future research should consider longer datasets to validate these findings and provide a more robust understanding of NEPSE's efficiency in diverse scenarios.

The study's five-week timeframe is justified by its focus on capturing rapid market trends and inefficiencies, which are particularly relevant for a nascent market like NEPSE. Short-term observations are critical for identifying immediate patterns and behaviors that reflect market inefficiencies, providing actionable insights in a developing financial system (Dias and Santos, 2020, Risal and Koju, 2021). Furthermore, the dataset's duration aligns with the practicalities of analyzing a market undergoing structural evolution, enabling timely interventions to address inefficiencies. While the limited timeframe may constrain long-term generalizability, the use of advanced statistical techniques, such as Markov chains and the variance ratio test, ensures robust and reliable findings by accurately modeling stock price behaviors and transitions (Avena *et al.*, 2016, Maiti, 2021). This approach balances the need for immediate relevance with methodological rigor, making the study's conclusions meaningful within its defined scope.

Results and Discussion

This study uses the daily stock results of 242 NEPSE-quoted businesses. From September 18, 2023 to

October 19, 2023, the chain examined the market's behavior for two days in a row, for a total of five weeks or twenty days, with each day being classified as either a high or low point or as staying the same, as detailed in Table 1.

Table 1. Daily NEPSE Trends Data*

High	Low	Same	High	Low	Same
298	124	30	48	172	12
182	36	10	16	213	4
217	11	2	66	158	10
62	166	3	31	193	9
92	129	10	137	85	12
190	39	3	22	214	3
34	193	3	173	57	7
26	189	4	223	10	3
10	220	2	80	150	6
163	64	6			

* The daily NEPSE index trends from September 18, 2023 to 19, 0ctober 2023

State distribution in the initial state is given by Kumar and Narendra, (2023),

P^0= [0.4472   0.5228   0.0300]

$$P=\begin{bmatrix} 0.4 & 0.5 & 0.1 \\ 0.38 & 0.45 & 0.17 \\ 0.46 & 0.18 & 0.36 \end{bmatrix}$$

The state distribution has been revealed in Table 2.

Table 2. State Distribution (High, Low, and Same)

S.N.	$P_1^{(n)}$	$P_2^{(n)}$	$P_3^{(n)}$
1.	0.4472	0.52280	0.030
2.	0.448	0.5200	0.032
3.	0.448	0.5200	0.032
4.	0.448	0.5200	0.032
5.	0.448	0.5200	0.032
6.	0.448	0.5200	0.032
7.	0.448	0.5200	0.032
8.	0.448	0.5200	0.032
9.	0.448	0.5200	0.032
10	0.448	0.5200	0.032

P is a probability vector that changes stock prices over two consecutive days. Irrespective of the initial state distribution $P^{(0)}$, state distribution $P^{(n)}$ has the same limiting vector i. State distribution at one is given as:

P^1 = [0.4472   0.5228   0.0300]   (23)

The chain is stationary at n = 2, as the table describes the same vector from time 2 to 10. This suggests that *n* need not be very big before the state distributions in our analysis resemble the fixed vector. According to Table 2, a random walk model may accurately describe the movement of stock prices since the distribution is stationary at the starting difference. The transition diagram of NEPSE index is shown in Figure 1.

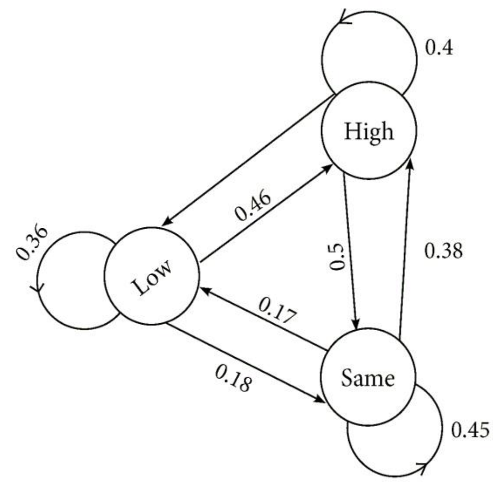

Figure 1. State Diagram (High, Low, and Same) of NEPSE Index

The state diagram in Figure 1 represents the transitions of the NEPSE Index among three states: High, Low, and Same. Each state corresponds to a specific condition of the stock index, with directed arrows indicating the probabilities of transitioning from one state to another. For instance, the transition from "Low" to "High" occurs with a probability of 0.46, while staying in the "Low" state has a probability of 0.36. Similarly, transitions from "High" to "Same" and "High" back to "High" occur with probabilities of 0.5 and 0.4, respectively. These transition probabilities form a Markov chain, capturing the dynamics of the NEPSE Index's state changes over time, illustrating how likely the index is to remain stable, increase, or decrease.

The results of this study showed that individual stocks often satisfy the random walk hypothesis. Furthermore, because price generation is believed to be a stochastic process, this study established that the Nepal Stock Exchange (NEPSE) is inefficient even in its weakest configuration. The investing strategies based on NEPSE historical data may not necessarily provide higher results.

This study examined the Nepal Stock Exchange (NEPSE) using advanced stochastic models, particularly Markov chains, to assess its adherence to the random walk hypothesis and evaluate its weak-form market efficiency. The findings reveal significant inefficiencies in NEPSE, which manifest in predictable stock price transitions. The state diagram (Figure 1) illustrates the dynamics among three states—High, Low, and Same—indicating specific probabilities of transitioning between states. For instance, the probability of transitioning from Low to High is 0.46, while the probability of remaining in the Low state is 0.36. Similarly, High states transition to Same states with a probability of 0.5, highlighting a cyclical behavior rather than a truly random movement.

These observed transition patterns, supported by the stationary distribution [0.4472, 0.5228, 0.0300], indicate that NEPSE's price movements are influenced by historical states, challenging the assumption of randomness posited by the random walk hypothesis. Such findings are consistent with previous studies on emerging markets like China and India, where inefficiencies were linked to structural constraints, such as low trading volumes and limited technological infrastructure, and behavioral biases (Charles and Darné, 2009, Malafeyev *et al.*, 2017). The variance ratio test further corroborates these inefficiencies by highlighting serial correlation in stock price movements, similar to trends observed in African markets where infrastructural deficits exacerbate inefficiencies (Okorie and Lin, 2021, Dias *et al.*, 2022).

The application of advanced stochastic methods, including Markov chains and the Chapman-Kolmogorov equation, offers a nuanced understanding of NEPSE's inefficiencies. Compared to developed markets, such as those in the U.S. and Europe, which conform more closely to the random walk hypothesis due to robust technological infrastructure and regulatory frameworks, NEPSE exhibits clear deviations. These deviations underscore the need for structural reforms, such as enhanced technological infrastructure, better regulatory policies, and investor education, to improve market efficiency and investor confidence (Bhatta, 2010, Risal and Koju, 2021).

In conclusion, the state transitions represented in Figure 1 reinforce the conclusion that NEPSE is not fully efficient, as stock price movements are influenced by prior states, providing opportunities for informed trading strategies. This aligns with broader research on emerging markets, where such inefficiencies are common due to structural and behavioral challenges. Future studies should consider longer timeframes and more comprehensive datasets to validate these findings and provide further insights into NEPSE's market dynamics. These efforts can guide policymakers and investors toward actionable reforms that align Nepal's stock market with global standards.

Conclusion

This study analyzed the Nepal Stock Exchange (NEPSE) through the lens of the Random Walk Model to evaluate its weak-form market efficiency. The findings reveal significant deviations from the random walk hypothesis, indicating that NEPSE's stock price movements are not entirely random but rather influenced by historical states. Transition probabilities, as illustrated in Figure 1, demonstrate a clear pattern of price transitions, with certain states, such as Low and High, showing a higher likelihood of recurrence. The stationary distribution further supports these findings, highlighting the predictable nature of price movements within NEPSE.

The inefficiencies observed in NEPSE align with those commonly found in emerging markets, where structural limitations, such as low liquidity, limited technological advancements, and inadequate regulatory frameworks, exacerbate deviations from randomness. These inefficiencies suggest opportunities for informed trading strategies while also exposing the vulnerabilities of the market. By incorporating advanced stochastic models, including Markov chains and the Chapman-Kolmogorov equation, this study provides a more robust and detailed understanding of NEPSE's market dynamics compared to traditional statistical approaches.

The implications of these findings are significant for policymakers, investors, and market participants.

Structural reforms, including investments in technological infrastructure, enhanced market transparency, and improved investor education, are essential to address the inefficiencies and move NEPSE toward greater market efficiency. Similar to trends observed in other emerging markets, such reforms could foster investor confidence, reduce information asymmetry, and promote fairer market practices.

Ultimately, this research contributes to the broader discourse on market efficiency in emerging economies and underscores the importance of using advanced analytical frameworks to uncover hidden inefficiencies. Future research should focus on longer-term datasets and consider the impact of evolving global economic dynamics on NEPSE to build a more comprehensive understanding of its market behavior and efficiency. These efforts are crucial for aligning NEPSE with global market standards and enhancing its role as a pivotal financial institution in Nepal's economic development.

Competing Interests

"The authors declare that there are no competing interests."

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