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TESTING WEAK-FORM EFFICIENCY FOR THE SAUDI PARALLEL MARKET (NOMU)

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A B S T R A C T

Market efficiency is essential for a thriving stock exchange and has a substantial impact on capital investments, particularly in emerging markets. This article examines the weak-form efficiency of Nomu, the Saudi Arabian parallel stock exchange. The study employed various statistical tests on the collected closing values of the Nomu index from May 1, 2019, to May 31, 2023. The return normality and stationarity were investigated using the Jarque-Bera, Augmented Dickey-Fuller (ADF), and Phillips-Perron (PP) tests. The Variance Ratio (VR) test was used to assess autocorrelation, while the Wald-Wolfowitz Runs (WWR) test was utilized to examine random walk behavior. While the Runs test indicated some randomness, all other tests rejected their null hypotheses, indicating that the Nomu market is inefficient according to the weak-form model. This inefficiency suggests that historical trading data may predict future prices, which could discourage foreign capital inflows, thereby limiting Nomu's growth and investment appeal. The significance of these findings for regulators and policymakers in formulating market regulations and policies aimed at enhancing Nomu's efficiency and investor appeal cannot be overstated. This paper, with its robust methodology, is believed to be the first to evaluate the Nomu market's weak-form efficiency since its inception, contributing to a better understanding of market dynamics in emerging stock exchanges.

INTRODUCTION

An efficient stock market empowers investors to make better-informed investment choices and guarantees that stock prices faithfully mirror the entirety of accessible information. When stock prices incorporate all publicly available information about a company, including its financial performance, future prospects, and industry trends, a market is considered efficient.

Efficient stock markets play a vital role in encouraging corporate transparency and accountability by motivating companies to disclose relevant information promptly and accurately to investors. In such markets, companies face greater policies, leading to a reduction in fraudulent activities and other forms of corporate misconduct.

Saudi Vision 2030, a strategic initiative aimed at diversifying the Saudi economy and reducing its dependency on oil, partly relies on the primary and parallel stock markets. The successful achievement of various Vision 2030 goals hinges on the efficiency of these stock markets. Vision 2030 aims to draw in foreign investments and promote the development of small and medium-sized enterprises (SMEs) within the boundaries of Saudi Arabia. An efficient stock market is a critical enabler of these objectives. By providing transparent information and adhering to robust regulations, an efficient stock market instils confidence in foreign investors, thereby attracting greater foreign capital inflow. Moreover, the market's support for SMEs, including the parallel market known as Nomu, empowers these enterprises to access capital for expansion, ultimately contributing to economic diversification and job creation. Thus, an efficient stock market promotes transparency, accountability, and competition, thereby fostering a dynamic and innovative financial sector in accordance with the Vision 2030 objectives.

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Nomu, a stock exchange that has been operating since 2017, has limited empirical research on its weak market efficiency. Therefore, this study delves into examining the Nomu stock market's weak-form efficiency. Specifically, we explore whether any anomalies or inefficiencies can be detected by applying statistical methods that determine whether the data follows the random walk, is stationary, is normally distributed, and has serial correlation. In order to give investors, regulators, and policymakers useful knowledge about how this market is efficient, our research aims to shed light on the weak-form efficiency of the Nomu stock market.

The forthcoming segments of this paper are organized in the subsequent manner: In Section 2, we give an overview of the research that has been published and concentrates on the techniques for evaluating the weak-form efficiency of the Saudi stock market (SSM). The theoretical underpinnings of weak-form efficiency testing are succinctly described in Section 3. Section 4 showcases the findings derived from the examination of the collected data. Finally, in Section 5, we engage in a discussion on the conclusions drawn from this research, along with the encountered limitations and potential directions for future research.

LITERATURE REVIEW

In the discipline of financial economics, the Efficient Market Hypothesis (EMH) notion has been extensively examined, especially in its weak form. The weak-form EMH theory states that all information that can be learned from past market prices is included in the current market prices. Consequently, analyzing historical data is futile for predicting future price changes (Fama, 1970). Different methods, including traditional statistical tools, trading strategies, forecast-based procedures, and, more recently, cutting-edge machine learning methodology, have been used to evaluate weak-form efficiency across multiple markets. Various methodologies that have been applied to test the SSM will be reviewed hereafter.

Traditional Statistical Methods

Various methodologies have been used to evaluate the weak-form efficiency of the SSM, each with their own strengths and limitations. Some studies employ conventional statistical methods such as the Runs test, the Augmented Dickey-Fuller (ADF) test, and the Jarque-Bera test, while others use more specialized techniques such as the Detrended cross-correlation analysis (DCCA) and the Detrended fluctuation analysis (DFA).

Elmokadem and Abdelnabi used the Run test, Jarque-Bera test, and ADF test to examine the randomness, normality, and stationarity of index values (Elmokadem & Abdelnabi, 2023). Popular and relatively simple, these tests rely on certain assumptions and may not be sensitive enough to capture complex market dynamics. They discovered a lack of weak-form efficiency in the SSM during the COVID-19 pandemic, a time of high global economic unpredictability that may have affected the results.

On the other hand, Almuqren and Almogbel utilized three unit root tests: the ADF test, the Phillips-Perron (PP) test, and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test (Almuqren & Almogbel, 2023). These tests are more robust than the Run and Jarque-Bera tests, allowing for a more comprehensive analysis of stationarity. In contrast to Elmokadem and Abdelnabi's conclusions, they discovered evidence supporting the weak-form efficiency of the SSM. The discrepancy may be attributable to the distinct evaluation periods and methodologies utilized.

Another study utilized intraday data and the DCCA and DFA techniques (Zebende, Santos Dias, & De Aguiar, 2022). Innovative and capable of capturing persistent correlations in time series, these methods provide a unique perspective on market efficiency. Nevertheless, their application is more complicated, and the results may be harder to interpret. The SSM was discovered to be inefficient in its weakest form.

One published research employed a number of methodologies, such as the Runs test, the calculation of Hurst exponents, and the single, multiple, and variance-ratio-based WALD tests (Al-Faryan & Dockery, 2020). This comprehensive method permits a more rigorous examination of market efficiency, but it may be hampered by methodological complication and overfitting. Their research revealed indicators of predictability in stock prices, indicating a degree of inefficiency. Nonetheless, they also discovered that the adoption of the Saudi corporate governance code enhanced the SSM's efficiency to some degree, demonstrating the influence of regulatory changes on market efficiency.

Several studies discovered evidence of inefficiency in the SSM utilizing a variety of techniques, including unit root tests, autocorrelation assessments, runs tests, and variance decomposition examinations (Asiri & Alzeera, 2013; Chaker & Sabah, 2018; Hokroh, 2013; Khoj & Akeel, 2020; Shaalan, 2019). Despite the diversity of methodologies employed, these studies consistently found inefficiency, suggesting that stock prices may be predictable. This consistency across various methodologies lends credibility to their findings.

Earlier research utilized tests that accounted for the impact of limited trading activity and the Multiple Variance Ratio (MVR) test, respectively (AlKhazali, 2011; El-Temtamy & Chaudhry, 2009). During their respective research periods, these studies discovered that the SSM followed a random walk pattern and exhibited a weak-form efficiency. However, these methodologies are contingent upon their underlying assumptions, and the results may not be applicable to other time periods or market conditions.

In 2004, a published research utilized the non-parametric one sample Runs test and the parametric Mean Square Successive Differences (MSSD) test to examine randomness and independence, respectively (Onour, 2004). These techniques are straightforward and straightforward to implement, but they may lack sensitivity and robustness. During the testing period, the SSM was inefficient according to the study.

In summary, the traditional statistical methods used to assess the weak-form efficiency of the SSM differ considerably in complexity, robustness, and sensitivity. The discrepancies in findings can be attributed not only to these methodological differences, but also to differences in study periods, the specific sectors or indices examined, and the influence of major events such as the implementation of the Saudi corporate governance code or the COVID-19 pandemic. The inconsistent results highlight the need for careful method selection and application in such investigations.

Trading Strategies and Filter Rules

While formal inference techniques form the basis of statistical methods, trading rule tests do not rely on such techniques. Instead, they focus on the profitability of different trading strategies. The filter rules are methods where buy and sell signals are generated based on specific percentage price movements. Similarly, techniques rooted in technical analysis or momentum strategy tests provide alternative ways to test for weak-form efficiency. If these strategies can consistently generate abnormal profits, it would imply a violation of the weak-form EMH.

A published research study employed two distinct trading strategies, namely the filter rule test and the moving average strategy, exploring the weak-form efficiency of the SSM (Al–Abdulqader, Hannah, & Power, 2007). The research made use of weekly data spanning the years 1990 to 2000, collected from 45 different companies. Results indicated some degree of predictability but stronger support to EMH than previous studies at the time.

More than 25 years ago, in his thesis, Al-Razeen has tested the SSM weak-form efficiency using traditional statistical tests and the Filter Rule tests (Al-Razeen, 1997). Average weekly prices were collected, from January 1992 to December 1995 on 28 individual stocks, to calculate weekly returns. The findings suggested that during that timeframe, the market did not exhibit weak-form informational efficiency.

Forecasting-Based Methods

When assessing the weak-form efficiency of stock markets, numerous forecasting-based approaches have been utilized. The backbone of these techniques lies in the examination of past trading data to predict future price movements. The ARIMA and GARCH models are commonly used for this purpose, providing robust frameworks for time series analysis. ARIMA models integrate autoregressive, differencing, and moving average components to analyse and predict financial data, investigating the potential of past prices to anticipate future ones. In contrast, GARCH models estimate the volatility of returns or prices, testing for volatility clustering. If future prices or volatility can be significantly predicted using these models, it suggests a deviation from weak-form efficiency.

A variety of forecasting-based techniques were used in a study on the weak-form efficiency of the SSM to analyse the Tadawul All Share Index (TASI), three of its indexes, and individual stock prices from 2000 to 2010 (Al Ashikh, 2012). The primary objectives of this study are to evaluate SSM performance and investigate any potential effects brought on by the day of the week. Modifications to the GARCH model were utilized to look into volatility trends in asset returns. The results show that the SSM does not adhere to the weak form of the EMH, and that the day of the week has a large impact on return rates and volatility.

Machine Learning Methods

Machine learning techniques have made it possible to test weak-form market efficiency using yet another tool. These algorithms might be violating the weak-form EMH if they can predict prices more accurately than chance alone.

A recent study employed machine learning algorithms to forecast future pricing based on historical data (Alturki & Aldughaiyem, 2020). With the help of a long short-term memory layer, this study attempted to build a multivariate recurrent neural network that can predict trading signals for SSM shares for the following day. This study, which runs from June 2018 to August 2019, is divided into three main sections: an analysis of the SSM weak-form efficiency, the creation of a neural network to produce trading signals, and a critique of the suggested technique. The outcomes reveal that the recommended RNN model is capable of producing next-day trading signals with an accuracy rate of 55% and achieving a 23% return on investment. The study concluded that the suggested approach and trading agent might help historical values forecast trade signals and beat the buy-and-hold method.

While trading rules, forecasting-based methods, and machine learning techniques offer valuable insights, the traditional statistical methods remain critical in testing for weak-form efficiency. Their objectivity, ease of interpretation, universal applicability, lesser data demands, and robustness make them an indispensable tool in the study of market efficiency. Moreover, with various methods, around 80% of the reviewed literature above confirmed weak-form inefficiency for the main SSM, Tadawul, during various ranges of time, which is summarized in Table 1. The observation that the Tadawul exchange lacks weak-form efficiency does not automatically imply the same for the parallel market, Nomu. This study's objective is to robustly assess Nomu, the Saudi parallel stock market, using traditional statistical techniques.

The study develops the following set of hypotheses in order to fulfil this objective:

Hypothesis 1: The index returns series of Nomu is normally distributed.
Hypothesis 2: The index returns series Nomu has a unit root or is non-stationary.
Hypothesis 3: The index returns series of Nomu is serially correlated.
Hypothesis 4: The index returns series of Nomu follows a random walk.

The comprehensive approach used here, integrating the Jarque-Bera test, ADF and PP tests, Variance Ratio Test, and Runs test, provides a robust analysis of the Nomu's weak-form market efficiency. This method simultaneously examines data normality, stationarity, autocorrelation, and randomness to test the weak-form efficiency hypothesis. This offers a more holistic view of weak-form market efficiency than previous studies that focused on one or two aspects. To account for different market condition, the approach also will consider volatility analysis, which previous studies lacked. This addition, along with the combination of tests, overcomes the limitations of any single test, improving results reliability.

Table 1. Literature review summary of testing weak-form efficiency for Tadawul

Authors	Year	Data Type[1]	Period	Methodology	Weak-Form
Elmokadem and Abdelnabi	2023	D, S	2020-2022	Jarque-Bera, Runs, and ADF.	Inefficient
Almuqren and Almogbel	2023	D	2020-2023	ADF, PP, and KPSS.	Efficient
Al-Faryan and Dockery	2020	D, W, M	1994-2016	Single, multiple, and variance-ratio-based WALD tests, Runs, and Hurst exponents.	Inefficient
Khoj and Akeel	2020	D	2012-2019	Unit root, Autocorrelation, Runs, and Variance Decomposition.	Inefficient
Zebende et al.	2020	H	2019-2020	DFA and DCCA.	Inefficient
Alturki and Aldughaiyem	2020	D	2018-2019	Machine Learning	Inefficient
Tharwah Shaalan	2019	D, S	2002- 2010	Shapiro Wilk, Box-Ljung, ADF, PP, and Runs.	Inefficient
Chaker and Sabah	2018	D	2013-2017	ADF, PP, Runs, and Variance Ratio.	Inefficient
Batool Asiri and Hamad Alzeera	2013	D, S	2006-2012	Dickey-Fuller unit root, Correlation, Durbin-Watson, and Runs.	Efficient
Mohammed Hokroh	2013	D	2007	Autocorrelation and Runs tests.	Inefficient[2]
Abdullah Al-Ashikh	2012	D, S, I	2000-2010	Autocorrelation Function, Ljung-Box Q-Statistic, Runs, and GARCH models.	Inefficient
Osamah AlKhazali	2011	W	1995-2007	Wright's rank and Sign Variance Ratio.	Inefficient[3]
El-Temtamy and Chaudhry	2009	D, W	2003-2008	Runs and Multiple Variance Ratio.	Efficient
Al–Abdulqader, Hannah et al.	2007	I	1990-2000	Filter Rule and the Moving Average Strategy.	Inefficient[4]
Ibrahim Onour	2004	D, S, I	2003-2004	Runs and MSSD tests.	Inefficient
Abdullah Al-Razeen	1997	I	1992-1995	Autocorrelation Analysis, Box-Pierce, Runs, and Filter Rule.	Inefficient

1: Regarding data type, please use the following codes: H for Hourly, D for Daily, W for Weekly, M for Monthly, S for Sector Indices, and I for Individual Stocks.
2: The author has recommended studying underreaction and overreaction split to make a conclusive decision on efficiency.
3: The author has reported weak-form inefficiency unless data are corrected for thin trading.
4: The authors have reported weak-form inefficiency but pointed out that there was significant efficiency improvement.

MATERIALS AND METHODS

Data

The research data was obtained from *investing.com*, and the Nomu market was chosen for testing efficiency. The sample period was from May 2019 to May 2023 (inclusive) and was taken on a daily basis. The data was converted into daily returns by subtracting the price logarithms of two consecutive periods. After plotting the daily returns series, presented in Figure 1, it was evident that there were two distinctive periods, high volatility period and low volatility period. Thus, it was decided to split and add those two periods to the full period so that we investigate the effect, if any, of volatility on our results.

Hence, we have named each period accordingly: full period (May 2019-May 2023) as *Period F*, high volatility period (May 2019-May 2021) as *Period H*, and low volatility period (June 2021-May 2023) as *Period L*.

The normality test, unit root, and autocorrelation tests were calculated using *EViews* software, while the random walk test was performed using *SPSS*. Description of each test is presented hereafter.

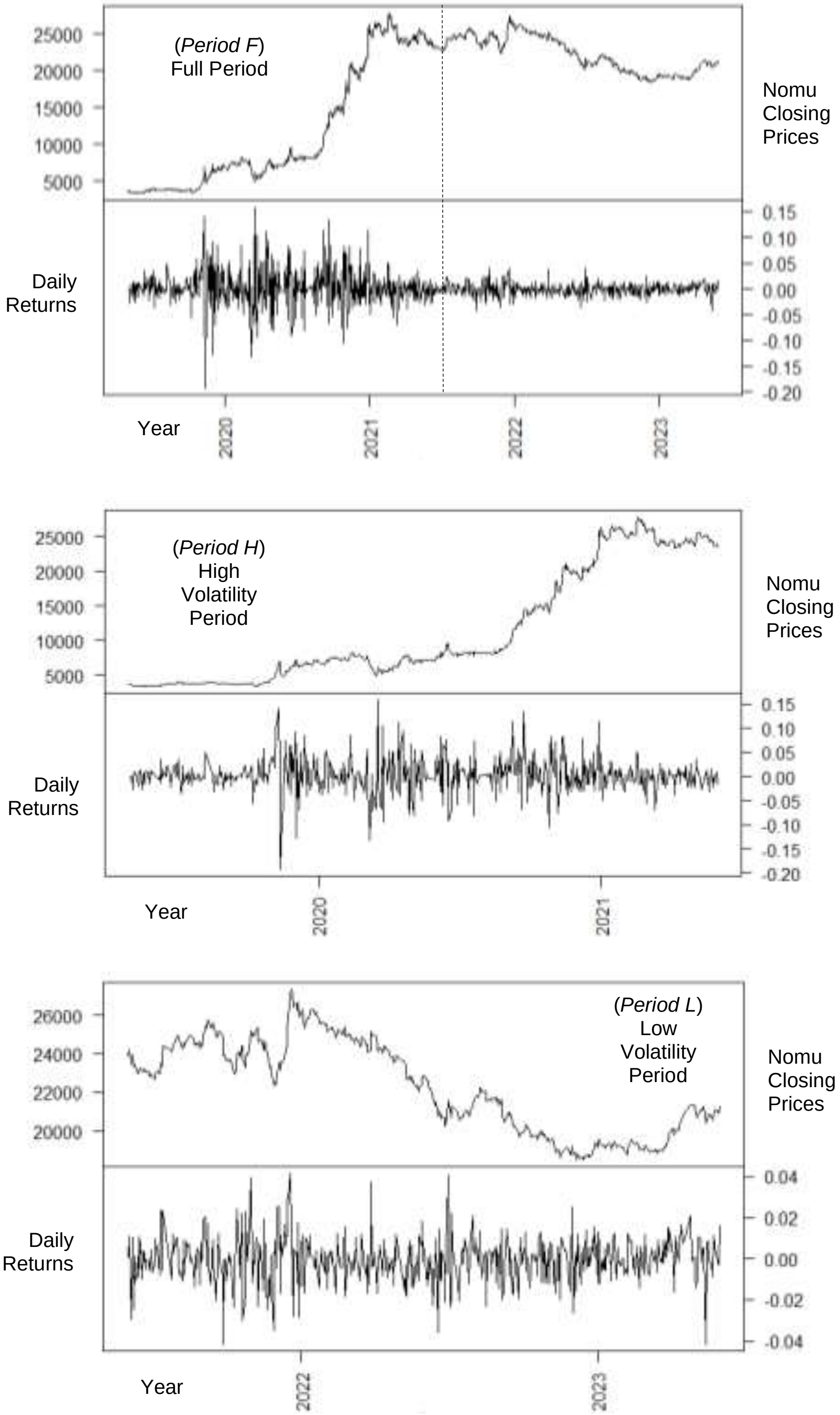

Figure 1. Index closing prices and daily returns for each identified period.

Normality Test

The statistical test selected to assess whether our returns time series adheres to a normal distribution is the Jarque-Bera test. In the context of weak-form efficiency, this test serves the purpose of gauging the dependability of statistical models and predictions that hinge on the presumption that the returns data adheres to a normal distribution. The Jarque-Bera test assesses the skewness and kurtosis of return data and compares them to what would be anticipated in a normal distribution. When skewness and kurtosis exhibit substantial deviations from their expected values, it indicates that the return data doesn't conform to a normal distribution. Non-normal distributions may indicate the presence of outliers or other irregularities that could affect the reliability of statistical models and predictions. Among the various tests for normality found in the literature, the Jarque-Bera test distinguishes itself by its enhanced capacity to identify deviations from normality in symmetric distributions with medium to long tails, as well as in distributions exhibiting modest skewness along with long tails (Thadewald & Büning, 2007).

Unit Root Test

The ADF and PP tests are employed as statistical tools to ascertain whether our return series exhibits characteristics of a random walk or displays stationarity with a unit root. A random walk means that future values are unpredictable and past values do not contain any useful information, while a stationary process means that future values can be predicted based on past values. Both the ADF and PP tests involve performing regressions of the time series against its prior lagged values and then evaluating the significance of the resulting coefficients. The PP test addresses serial correlation using a corrective strategy, whereas the ADF test integrates additional lagged differences of the time series. There are many other unit root tests, but the analyst's subjective judgment is primarily responsible for selecting an appropriate one (Arltová & Fedorová, 2016).

Autocorrelation Test

To determine whether there is serial correlation existing in our returns time series, Lo and MacKinlay first proposed the variance ratio test in 1989 (Lo & MacKinlay, 1989). In the context of weak-form efficiency, this test gauges whether past returns hold predictive information for future returns. The test's primary objective is to ascertain whether a given series is serially uncorrelated, achieved by computing the ratio of return variances over various time intervals. When a series of returns exhibits serial correlation, the variance of returns over extended intervals may deviate from the expected values, either increasing or decreasing. The subject of variance-ratio tests for the random walk hypothesis has seen significant advancements and research (Charles & Darné, 2009). Among the several approaches explored in the literature review section, the Variance Ratio test suggested by Lo and MacKinlay has gained widespread popularity and usage.

Random Walk Test

To determine whether our returns time series follows a random walk pattern, we use the Runs test, also known as the Wald-Wolfowitz Runs test, a non-parametric statistical technique. Within the context of weak-form efficiency, this test aims to investigate whether previous returns carry predictive information regarding future returns. The process involves counting the occurrences of positive and negative return sequences within the series and then comparing this count to the expected number of such sequences in a random walk scenario. Notably, the Runs test does not necessitate that return distributions conform to normality or possess identical characteristics, a condition often unmet in stock return data. Simultaneously, it mitigates the influence of outlier values, which are frequently encountered in return datasets.

RESULTS

Jarque-Bera Test for Normality

We applied the non-parametric Runs test, commonly known as the Wald-Wolfowitz Runs test, to see if our returns time series exhibits a random walk pattern. Skewness in the distribution measures its asymmetry, where a skewness value of 0 signifies a completely symmetrical distribution. Conversely, when the skewness value is positive, as observed in our results (e.g., 0.55, 0.29, and 0.02), It signifies a distribution with a slight rightward skewness, implying an extended tail on the right side. Kurtosis compares tail thickness and peakness to a normal distribution. A distribution with 11.10, 6.65, and 4.77 kurtosis for each of our returns data respectively has heavier tails and a higher peak than a normal distribution. This suggests that the data has more extreme positive and negative deviations than a normal distribution. In fact, the Jarque-Bera test clearly indicates that we must reject the null hypothesis of normality when it produces a probability value of 0 for each period, exceeding the significance level of 0.05. As a result, it is evident that the returns data does not exhibit a normal distribution during any of the time periods mentioned.

Also, observe how on the QQ-plot, in Figure 3, the over-dispersed returns data appears as a flipped S shape, which deviates from the straight line for all periods for both the large and small quantiles of the normal distribution. Consider the smallest and largest observations (the left and right sides of the QQ-plot, respectively) to begin to comprehend this pattern: The smallest observations are smaller than would be predicted by a normal distribution (i.e., the points on the QQ-plot are below the line). This suggests that the data distribution's lower tail is extended beyond what would be expected in a normal distribution. The largest observations are larger than expected from a normal distribution (i.e., the points on the QQ-plot are located above the line). This indicates that the distribution of the data has a longer upper tail than a normal distribution. Hence, the daily returns clearly have much fatter tails than the normal distribution.

Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) Tests for Unit Root

In order to determine whether a unit root existed, the ADF and PP tests were run. The findings are shown in Table 2. These tests were applied to the return data series. In both cases, the obtained p-value is 0, which falls below the critical values of 1%, 5%, and 10%. Additionally, the t-statistics from both tests for all time periods are significantly lower than the MacKinnon critical values. Consequently, it can be inferred that the data exhibits stationarity and lacks a unit root. Simply put, we can rule out the unit root null hypothesis. We conclude that the Nomu market lacks weak-form efficiency and does not exhibit a random walk pattern because all of our series exhibit stationarity, as shown by the unit root test.

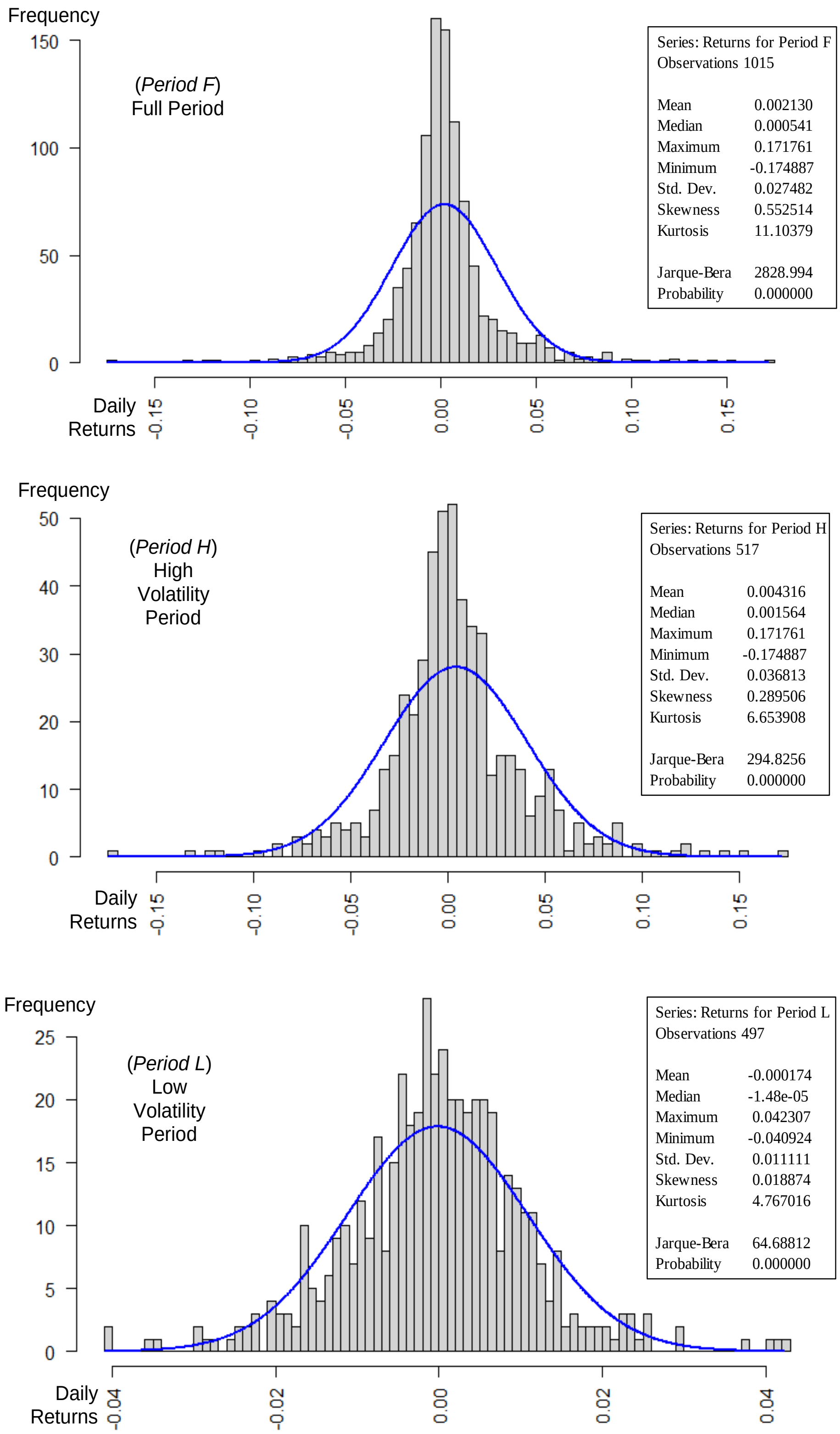

Figure 2. Jarque-Bera test of normality results for each period.

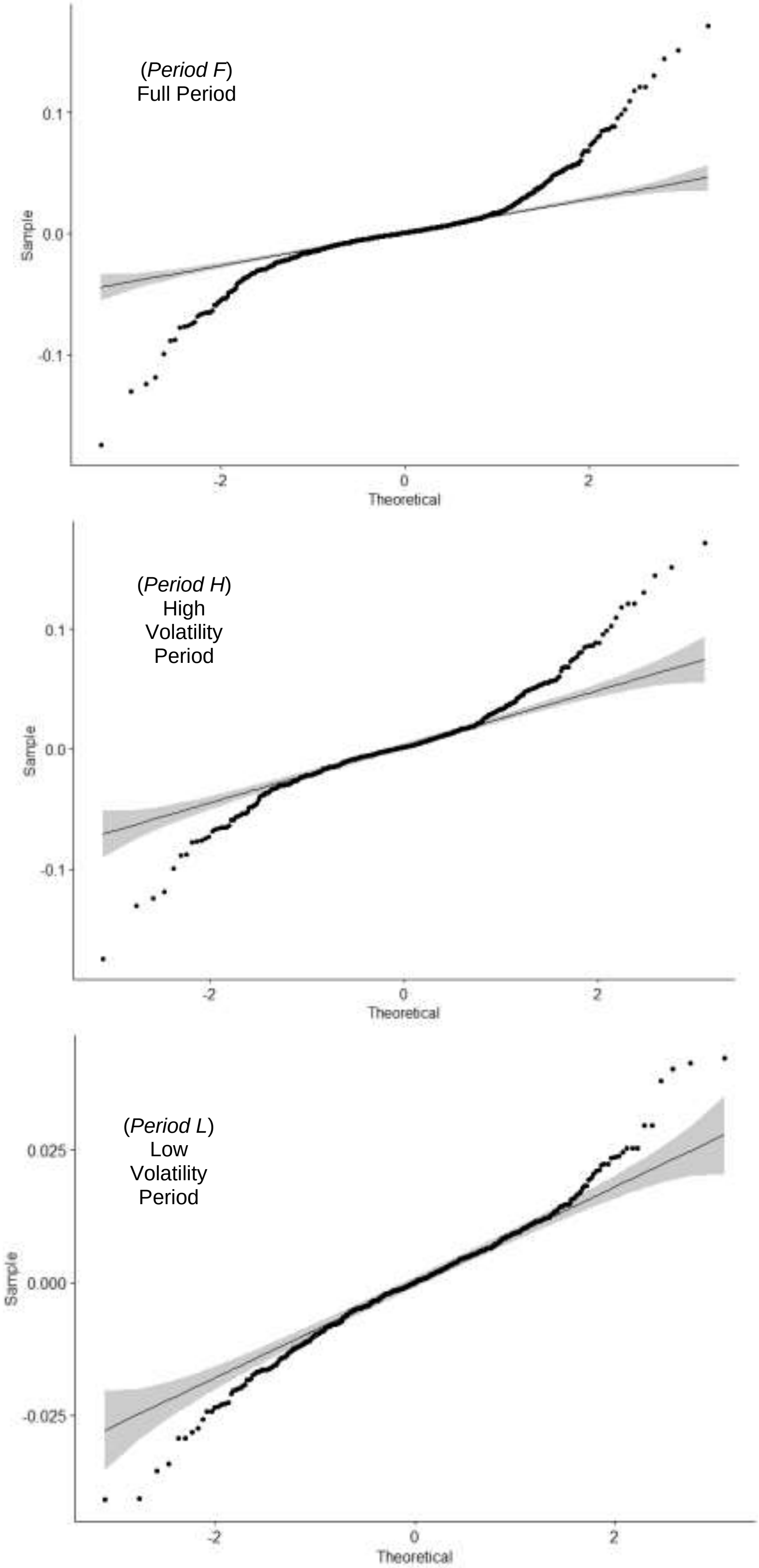

Figure 3. QQ-plot for returns series for each period.

Table 2. Augmented Dickey-Fuller and Phillips-Perron test results

Period	Augmented Dickey-Fuller t-Statistic	Phillips-Perron t-statistic	Probability[1]
Period F	-30.46464	-30.43500	0.0000
Period H	-21.84570	-21.86754	0.0000
Period L	-21.34503	-21.34470	0.0000
Test Critical Values	**1% Level**	**5% Level**	**10% Level**
	-3.44	-2.86	-2.57

1 MacKinnon (1996) one-sided p-values.

Variance Ratio Test for Autocorrelation

Table 3 displays the variance ratio calculated from the daily return data across all time periods. The probabilities in this study are consistently zero, and none of the z-Statistics fall inside the range of +1.96 to -1.96. The outcomes of the variance ratio test consistently yield values below one. This result suggests that the return data deviates from the characteristics of a random walk and forces us to reject the null hypothesis of serial correlation. As a result, employing the Variance Ratio test, we can ascertain that the Nomu market exhibits weak-form inefficiency and does not possess the characteristics of a random walk.

Table 3. Variance Ratio test results for all periods.

Holding Period	Variance Ratio			z-Statistic			Probability
	Period F	*Period H*	*Period L*	*Period F*	*Period H*	*Period L*	
2	0.53936	0.53929	0.55754	-6.74951	-6.22000	-7.22793	0.000
4	0.26543	0.26819	0.25190	-6.21831	-5.70858	-6.92563	0.000
8	0.13293	0.13540	0.12105	-5.00911	-4.60299	-5.52057	0.000
16	0.06725	0.06885	0.07138	-3.89111	-3.58017	-4.158734	0.000

Runs Test for Randomness

Table 4 incorporates the Runs test conducted using SPSS software, with the mean (K) serving as the threshold. The obtained results indicate that the z-value is positively significant at the 1% level, corroborated by the fact that the observed numbers of runs are greater than what would be expected by chance. This suggests that we do not have enough data to rule out the randomness null hypothesis. Consequently, the returns data does display a certain level of randomness.

Table 4. Runs test results for full period

Runs Test	*Period F*	*Period H*	*Period L*
Test Value (K): mean as Cutoff	0.00212996	0.00431582	-0.00017426
Number of Cases Less than K	563	286	245
Number of Cases Greater than or Equal to K	452	231	252
Total Cases	1015	517	497
Number of Actual Runs	518	273	253
Expected Runs	502.43	256.57	249.45
Z value	0.990	1.463	0.319
Asymptotic Significance (2-tailed) p-value	0.322	0.144	0.750

DISCUSSIONS

The empirical analysis of the index returns suggests several significant findings relevant to the evaluation of weak-form market efficiency for Nomu. The Jarque-Bera test result demonstrates non-normal distribution of the returns, implying potential exploitable patterns in the returns. The finding of a unit root in the index returns by the ADF and PP tests implies the presence of non-stationarity and some degree of predictability. This notion of predictability is further corroborated by the Variance Ratio test, which detects serial correlation in the index returns. However, the Runs test does not reject the null hypothesis, hinting at a degree of randomness in the index returns which, on its own, does not conclusively confirm weak-form efficiency. Notably, both high and low volatility periods manifested non-normality, stationarity, autocorrelation, and randomness patterns in the return series, although the magnitudes varied. These findings collectively suggest that while some degree of randomness is present, the evidence of non-normality, non-stationarity, and serial correlation potentially challenge the hypothesis of the market's weak-form efficiency.

This paper's methodology and approach have two major advantages over comparable research, which will be discussed below.

First, the exclusive use of a single test, such as the Runs test, in comparable studies could lead to an erroneous conclusion regarding market efficiency. In the context of the Nomu stock market, the Runs test fails to reject the null hypothesis, indicating that the index returns are random. When regarded in isolation, this result may be interpreted as weak-form efficiency. The results of the Jarque-Bera test, the ADF and PP tests, and the Variance Ratio test contradict this assumption, however. These tests disclose non-normal distribution, non-stationarity, and serial correlation, all of which suggest potential predictability in the returns, thereby challenging the weak-form efficiency hypothesis. Consequently, relying solely on only one or two tests could provide an insufficient and potentially deceptive picture of market efficiency.

Second, the inclusion of two distinct periods of high and low volatility in the analysis is a significant asset of the study, adding a layer of credibility by capturing the impact of varying market conditions on weak-form efficiency. This aspect is frequently overlooked in previous research, which may have weakened the validity of their findings. Market efficiency can be affected under varying volatility conditions due to various economic events. By analyzing both periods of high and low volatility, the study provides a more nuanced understanding of the behaviour of the market.

CONCLUSIONS

All other tests resulted in the null hypothesis being rejected, with the exception of the Wald-Wolfowitz Runs test. This indicates that a random walk pattern is not followed by the index returns. In accordance with the idea of weak-form market efficiency, it is impossible to anticipate future stock prices merely based on past prices or returns because they have all already been taken into account by present stock prices. In summary, the outcomes of empirical analysis indicate that the Nomu market might not conform to weak-form efficiency since there appears to be some predictability in index returns.

Irrespective of the underlying reasons for these inefficiencies, it is advisable for regulators to contemplate implementing measures aimed at bolstering the efficiency of the Nomu market. This could encompass enhancing transparency and reducing information disparities. Such measures might entail mandating companies to provide more comprehensive disclosures regarding their activities and financial performance, imposing stricter disclosure standards on market participants, and elevating the standards of financial reporting.

It is imperative to inform investors about the inefficiencies present in the Nomu market so they can make well-informed investment decisions. Regulators might contemplate issuing alerts or guidance to investors, highlighting the potential risks associated with investing in a market that lacks weak-form efficiency and encouraging them to exercise caution in their investment choices.

Moreover, additional research may be necessary to pinpoint the precise factors or underlying causes that contribute to the Nomu market's inefficiency. Such insights could prove invaluable for regulators in devising more tailored strategies to enhance market efficiency. Consequently, these stock markets are essential to any country's efforts to create a more diversified and sustainable economy for the future.

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