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How Strong is the Evidence of the Weak Form of Efficient Market Hypothesis-EMH?

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Market efficiency plays a critical role in the success of investment decisions made by individual and institutional investors. Pakistan Stock Exchange is a modern market with several characteristics of a developed market. Considering the significance of EMH for investors and other stakeholders, this study aims to test the weak form of EMH in the Pakistan stock exchange using daily data for 2018-2023. This study employs unit root test, autocorrelation, and run test to test the efficient market hypothesis. The study's findings indicate that index returns do not follow a random walk; therefore, PSX for the selected period is inefficient. Based on the study's findings, it can be inferred that returns at PSX are predictable based on historical information. The study has implications for various stakeholders.

Keywords: Efficient Market Hypothesis (EMH), Weak Form of EMH, Random Walk Theory, Unit Root, Stationarity, Abnormal Returns

Introduction

Information plays a key role in the working and efficiency of the capital markets. Various market players depend on information availability to make optimal decisions, considering that markets are efficient and stock prices fully reflect whole information (Aktan et al., 2018; Omar et al., 2013; 2024, الدفتار). Therefore, market efficiency is a much-desired trait by various stakeholders linked with stock markets. Based on the efficient market hypothesis (EMH), most stock markets are efficient in either semi-strong form or weak form or inefficient in both forms (Azad et al., 2014; Cooray & Wickremasinghe, 2007; Degutis & Novickytė, 2014; Dias et al., 2020). Market efficiency makes investors expect a risk-adjusted return (Fakhry, 2016). The EMH assumes that in an efficient market, stock returns are random, and investors cannot earn excess returns because of the availability of information in an unbiased manner to all stakeholders (Hamid et al., 2017; Kelikume et al., 2020; Ullah & Asghar, 2023). Therefore, a true reflection of all information in share prices is expected.

For many decades, researchers have been testing EMH. However, the results are inconsistent regarding accepting and rejecting three forms of the EMH hypothesis (Strong, semi-strong, and weak) in different global stock markets. Moreover, the researchers documented a point of consensus in research on EMH that in the presence of market efficiency, investors cannot earn abnormal returns (Khan et al., 2023; Khan & Khan, 2016; Kiran, 2019; Kulikova et al., 2024; Latif et al., 2011). In addition, it has also been observed that there are many situations where EMH fails, which motivated researchers to test the three forms of EMH repeatedly.

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Hence, it becomes critical to test stock markets for three forms of EMH because inefficiency leads to higher risk-weighted returns for the investors.

EMH is considered an important tool for the investment decisions attached to capital markets; this tool becomes more critical for stock markets of developing and emerging economies, which are highly volatile and attract large investors expecting higher returns (Aktan et al., 2018; Khan & Khan, 2016). Furthermore, information about market efficiency or inefficiency helps investors adopt trading strategies for investment decisions accordingly (Adnan et al., 2023; Kelikume et al., 2020; Mehmood et al., 2012; Zebende et al., 2022; 2024, الدفتار). Therefore, a comprehensive understanding of market efficiency is important for various stakeholders, including investors, corporate executives, stock market regulators, operators, and many more (Elangovan et al., 2022; Mishra, 2012).

Considering the significance of EMH, this study aims to test the weak market efficiency in the Pakistan Stock Exchange (PSX). Literature on testing EMH in developing and emerging provides mixed results. Few studies have rejected the weak and semi-strong EMH, while few have reported the presence of market efficiency in the weak form. Similarly, researchers have also tested weak and semi-strong forms of EMH for PSX and reported mixed results; this accentuates the need to test the EMH in PSX for the current period. The study has selected recent years for testing weak form at PSX because, during these six years (2018-2023), Pakistan's economy has faced various events, including a major pandemic and political changes. Investors' trust is shaken because of such events, and they need useful information to make better investment decisions in such situations. Moreover, literature signifies the need of conducting such studies time to time to identify whether change in market mechanics over the time periods impact market efficiency or not. Similarly, investment decisions are largely dependent upon information, and they need to understand how markets react and adjust information to optimize their investment decisions. Testing market efficiency is also important because market conditions change over the time resulting into market deviations from efficiency, indicating a time-varying feature of informational efficiency (Adnan et al., 2023; Said et al., 2022). Hence, it is important to guide investors by testing weak-form in PSX so that they can use the findings to predict prices and make informed decisions.

The next section of the paper presents a literature review on EMH, its forms, and the research on EMH in the Pakistan Stock Exchange. The third section covers research methodology, explaining data, data sources, research tools, and the analysis techniques which have also been discussed in detail. The fourth section covers detailed results whereas, the last section highlights the findings, recommendations, and directions for future research.

Literature Review

Capital markets are usually unstable in developing and emerging markets, increasing the sensitivity of stock returns in response to economic changes (Kaur & Chaudhary, 2022). Furthermore, like various macroeconomic factors, capital markets are sensitive to information that travels from different sources and adjusts in capital markets through prices. Therefore, market efficiency concerning information availability is crucial and a question of interest for investors (Elangovan et al., 2022; Kulikova et al., 2024; Smerkolj & Jeran, 2023; 2024, الدفتار).

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EMH provides the answer to this question, which states that stock prices that prevail in stock markets at any time should fully reflect the currently available information. There is a consistency between returns and perceived risk of the investors (Naseer & Bin Tariq, 2015; Zebende et al., 2022).

The efficient market hypothesis takes three forms, including weak-form, semi-strong, and strong forms of efficiency (Fama, 1970). These forms are named based on the availability of various types of information. A weak form of market efficiency states that past prices and trends cannot predict future prices; that is, stock prices follow a random walk; therefore, investors cannot beat the market. Weak form leads to the random walk hypothesis. The semi-strong form postulates that stock prices fully reflect historical prices and publicly available information; hence, investors return attached with any publicly available information. The strong form of market efficiency states that stock prices reflect all public and insider information. Therefore, private or inside information is useless and cannot help investors earn extra returns.

In 1900, the random walk concept laid the theoretical foundations of EMH (MacKenzie, 2008), and EMH takes the central proposition in finance. Random walk states that market information comes randomly and unpredictably; therefore, price changes are also expected to be unpredictable and random. Furthermore, EMH built its strong theoretical and empirical evidence by the mid-1970s. Fama (1970), for the first time, used the term EMH and argued that stock prices follow a random walk in an efficient market and investors cannot earn excess returns. Moreover, in an efficient market, the prices of the shares must reflect all available information important for the evaluation of a company's future performance. Therefore, any new information affecting the company's future profitability should be immediately reflected in the share price (Ehiedu & Toria, 2022). Although numerous researchers tested the three market efficiency forms in different economies, mixed evidence was reported. Inconclusive results of EMH make it a paradox, the concept highlighted by Grossman (1976) arguing that greater investors' belief in market efficiency leads towards a less efficient market.

Numerous studies have been conducted to test EMH in developed, developing, and emerging economies and found that results are ambiguous. Few studies supported the hypothesis, while others have reported few anomalies, i.e., the deviation from EMH (Fakhry, 2016; Hamid et al., 2017; Khan & Khan, 2016; Nisar & Hanif, 2012; Rossi & Gunardi, 2018). More specifically, the US and UK equity markets and the New York Stock Exchange were found efficient in the weak form of market efficiency (Kim et al., 2011; Milionis & Papanagiotou, 2011; Worthington & Higgs, 2003). While markets of the Athens Stock Exchange, UK mutual fund market, Istanbul Stock Exchange, Vienna Stock Exchange, and stock markets of Austria, Belgium, Denmark, Finland, and France are inefficient in weak form (Kapusuzoglu, 2013; Milionis & Papanagiotou, 2011; Worthington & Higgs, 2003)

Compared to developed economies, Asian economies have also been the point of focus to test EMH because of their volatile nature and prominence. Past studies have used various objectives, methodologies, and analysis techniques, but similar to developed economies, consensus on the results of EMH is also lacking (Yaya et al., 2021). Researchers documented that Asia Pacific is not fully efficient and that prices on their stock markets do not follow a random walk (Aktan et al., 2018; Azad et al., 2014; Hamid et al., 2017). Some Asian markets are

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efficient in either weak form or semi-strong form, while some are inefficient. Most of the studies conducted in the Asian region have tested weak forms of market efficiency and reported mixed results (Aktan et al., 2018). Similarly, studies conducted to test the weak form of EMH in Pakistan have also used various techniques, periods, and data sets and presented varied results. Results from Pakistan varied from inefficient weak and semi-strong forms to inefficiency in both forms of any one form depending upon the data frequency used (Khan & Khan, 2016; Phiri, 2015; Zahid et al., 2012).

Pakistan's economy has also been the focus for researchers to test the forms of EMH because of its volatile nature and economic changes. There are several studies conducted in the context of Pakistan, but few are reported here. Studies including Haque et al. (2011), Akber and Muhammad (2013), Haroon (2012), Rabbani et al. (2013), Ali et al. (2021), Rehman and Qamar (2014), Rehman et al. (2012), Seth and Sharma (2015), Khan and Khan (2016), and Azad et al. (2014) reported inefficiency in weak-form for PSX. Meanwhile, Khan and Khan (2016) documented PSX as a weak form of efficiency for the monthly data set, similarly Adnan et al. (2023) also reported PSX as weak form efficient and adheres to adaptive market hypothesis. Moreover, a comparison of traditional and Sharia compliant stocks in PSX also revealed that both stocks are weak-form inefficient (Munir & Chishti, 2021). Another study on Sharia compliant stock also revealed the similar results i.e. weak-form inefficiency for KMI30 indices in Pakistan(ul Hassan et al., 2020). Few researchers have also tested PSX for strong and semi-strong form of market efficiency, Bashir et al. (2020) reported informational inefficiency of PSX for weak and strong form while semi-strong form sustained and showed efficiency.

Summarizing the findings of various studies conducted at PSX to test EMH, PSX, most of the time, showed inefficiency towards weak and semi-strong forms and provided opportunities for investors to earn abnormal returns. The studies also concluded that the inefficiency of the PSX is because of many macroeconomic variables, which provides a basis for conducting this study. This study also aims to test the weak form of EMH at PSX for the most recent period, during which the economy of Pakistan has experienced many changes, specifically political changes. It is important to test PSX for EMH for the recent period to guide investors in making optimal and rational decisions. It is also important to conduct the study in current scenarios where investors' trust is shaken and are reluctant to invest. The findings of the study will guide investors about the behavior of PSX in the period of political change which can help them in predicting the stock market performance in the future.

The study aims to empirically demonstrate whether or not the Pakistan Stock Exchange is weak-form efficient. For this purpose, the study examined whether or not the series of PSX returns is stationary. Furthermore, the study has also tested whether PSX follows a normal distribution. The following are the hypotheses for this study:

H_1: The return series of PSX are normally distributed.

H_2: There is no stationarity in the return series PSX.

H_3: PSX follows a random walk.

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Methodology

Stock markets are considered weak form efficient if stock returns follow a random walk, meaning current prices fully reflect the market information and are not predicted through past trends. Literature has identified various techniques to test weak forms of market efficiency, among which autocorrelation test, unit root tests (Augmented Dickey-Fuller, 1979; Phillips-Perron, 1988; and the Kwiatkowski, Phillips, Schmidt and Shin, 1992), Run test (Bradley, 1968), Variance Ratio tests (conventional single variance ratio of Lo and MacKinlay, 1988 and 1989) and variance ratio based on sign and ranks (Wright, 2000) are the most commonly used techniques.

This study also aims to test whether or not the Pakistan Stock Exchange is a weak form efficient stock market. For this purpose, daily data has been collected from Refinitiv DataStream from 2018 to 2023. The daily data for the recent period, which the researchers have not yet considered, has been selected for the analysis. The selected period is crucial concerning political and economic changes in Pakistan; hence, it is significant to observe the behavior of the stock market during the period with uncertain political and economic changes (Rahman et al., 2018). Daily open, high, low, and closing prices of PSX indices have been collected (1259 observations), and log returns have been calculated using closing price data. To address the key objectives and hypothesis of the study, descriptive statistics (mean returns, maximum, minimum, standard deviation, Skewness, Kurtosis, and Jarque-Bera Test), unit root test (to check the stationarity of time series data, ADF and PP tests), autocorrelation (Ljung and Box 1978) to test whether the observations vary around a constant mean or not) have been used. Various researchers have used these analysis techniques for testing weak-form of EMH in emerging markets, developing markets, Asian markets, and specifically for the stock market of Pakistan (Akber & Muhammad, 2013; Aktan et al., 2018; Cooray & Wickremasinghe, 2007; Elangovan et al., 2022; Hamid et al., 2017; Haque et al., 2011; Khan & Khan, 2016; Kiran, 2019; Rabbani et al., 2013) Furthermore, the study has used STATA software to analyze the data and results have been presented in the next section.

Results and Discussion

This section presents the analysis results to test the study's hypothesis. Descriptive statistics address the first hypothesis, i.e., whether data is normally distributed. Table 1 presents descriptive statistics of PSX's market index returns for 2018-2023. Log returns have been calculated using the closing price of the market index.

Table 1

Descriptive Statistics

Descriptive	**Value**
Number of Observations	1259
Mean	0.0000406

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Standard Deviation	.0099406
Minimum	-.0510309
Maximum	.0579806
Kurtosis	6.948694
Skewness	.4847447
J-B Statistics	867
P-Value	0.0000*

NOTE: * P-Value is for J-B statistics to check the normality of data where null-hypothesis is the normality of stock returns

For the selected sample of the study, the maximum value of market index returns is 0.0579806, the minimum value is -0.0510309, and the standard deviation is 0.0099406.

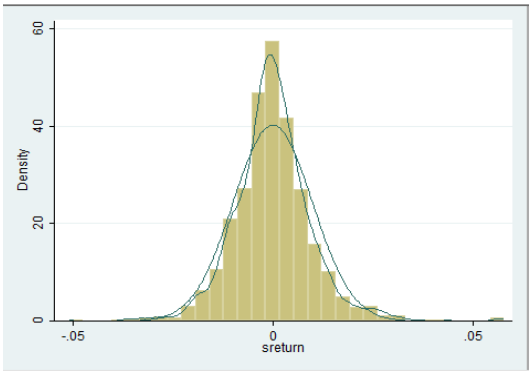

Figure1. Histogram-Index returns (Daily Index)

Skewness and Kurtosis must be 0 and 3 for normally distributed data, respectively. At the same time, values mentioned for Skewness and Kurtosis in Table 1 indicate positive Skewness in data and a leptokurtic distribution because the kurtosis value is greater than 3. The same can be observed through the histogram of returns represented in Figure 1. The skewness value, Kurtosis, indicates that data is not normally distributed, as verified by histogram. Furthermore, the p-value of J-B Statistics is significant, leading to the rejection of the null hypothesis that data is normally distributed. Therefore, the first hypothesis of the study has been rejected. Hence, data is not normal. In addition, the trends of closing index prices and index returns can be observed in Figures 2 and 3, respectively.

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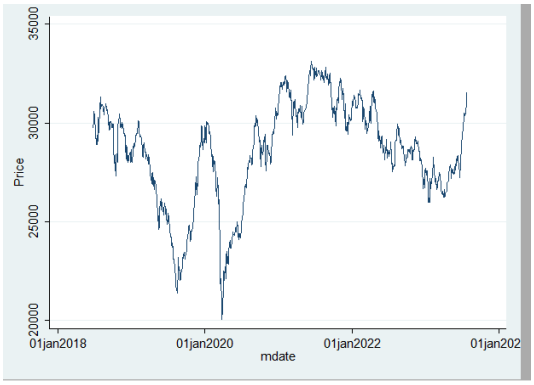

Figure 2: Closing price trend (Daily Index)

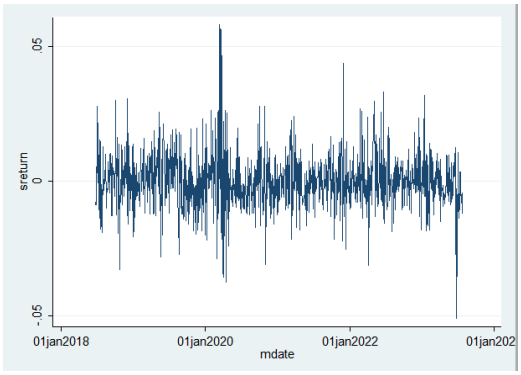

Figure 3: Stock Return trend (Daily Index)

The study's second hypothesis, *H_{02}: No stationarity in the return series of PSX*, has been tested through a unit root test. An eventual criterion to test a weak form of market efficiency is to examine the random walk hypothesis for the return series for which the unit root test has been performed. The successive stock prices are identically circulated and independent if the return series is random. Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) have been applied as largely accepted unit root tests for this study.

Table 2
ADF Test for Daily Index Returns

	t-statistics	**Probability**
Augmented Dickey-Fuller test statistic	-23.322	0.0000*
Critical Values		
1%	-3.430	
5%	-2.860	
10%	-2.570	

*MacKinnon approximate p-value

Table 2 presents the results of ADF, and the p-value is significant, which means H_o (the series has a level unit root) is rejected, and it is concluded that the return series is stationary. Furthermore, the Phillips-Perron Test results support ADF results as the p-value is significant at a 5% significance level.

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Table 3
Phillips-Perron Test for Daily Index Returns

	t-statistics	Probability
Phillips-Perron test statistic	-23.322	0.0000*
Critical Values		
1%	-3.430	
5%	-2.860	
10%	-2.570	

*MacKinnon approximate p-value

The results of both tests for unit root reject the presence of randomness in the return series and verify that series returns follow a specific pattern, which indicates that results are not leading toward acceptance of the weak form of EMH. Therefore, the second hypothesis of the study is also rejected.

The third hypothesis tests whether the return series follows a random walk that has been tested by applying autocorrelation and run tests. Autocorrelation in a return series indicates that past values influence current values and can be predicted based on past values. Table 4 presents the results of autocorrelation and partial autocorrelation functions for the daily return series of PSX. The autocorrelation at lag 1 is 0.1003 (Q-stat = 12.701, p =0.004), rejecting the null hypothesis; correlation does not exist and indicates that the PSX return series does not follow a random walk. Moreover, autocorrelation values are positive for all lags.

Table 4
Autocorrelation (AC) and Partial Autocorrelation (PAC) Function for Index Returns (PSX-Daily)

Lags	ACF	PACF	Q-Stat	P-Value
1	0.1003	0.1591	12.701	0.0004
2	0.0132	0.0048	12.92	0.0016
3	0.0422	0.1330	15.166	0.0017
4	0.0305	-0.0606	16.346	0.0026
5	0.0021		16.351	0.0059

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Furthermore, to examine whether the observations vary around a constant mean, have constant variance, and are independent, a run test has been applied, a non-parametric test used to decide whether a data set is from a random process.

Table 5

Runs Test for the PSX for the Period 2018-2023

Runs and Tests	**Values**
Actual Runs	641
Negative Runs	629
Positive Runs	629
Total Observations	1258
Z-value	-3.27
P-value	0.002*

Results of the run test also verify the absence of randomness in the return series; therefore, this hypothesis is also rejected, showing that the PSX return series does not follow a random walk, and it can be concluded that PSX is inefficient in the weak form of EMH. The results are supported by previous studies conducted for Pakistan and South Asian economies(Adnan et al., 2023; Ali et al., 2021; Elangovan et al., 2022; Khan & Khan, 2016; Mehmood et al., 2012; Munir & Chishti, 2021; Omar et al., 2013; Rabbani et al., 2013; Said et al., 2022; Yaya et al., 2021).

Conclusion, Recommendations, and Future Directions

EMH has made tremendous contributions to finance in the past few decades. Among the three market efficiency forms, the weak form is probably the most tested (Chambino et al., 2024; Latif et al., 2011; Omar et al., 2013). A weak form of EMH states that investors cannot profit using information everyone knows. Moreover, under the assumptions of rationality, the prices should move automatically if all stakeholders have the same information regarding stock prices. Market efficiency is important for stakeholders, including analysts, investors' regulators of the stock exchange, and fund managers, to improve the flow of information that can help them make informed decisions.

Furthermore, investing strategies can be formulated better as per the availability of information. However, markets are inefficient, and traders are not always rational (Elangovan et al., 2022). Therefore, the investors may be reluctant to agree with EMH, and the literature is also divided on EMH.

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The presence of mixed results on EMH signifies the need to test forms of EMH repeatedly (Omar et al., 2013). This study is also an attempt to test weak form of EMH in Pakistan for the recent period, which other studies conducted for PSX have not yet covered. Daily index returns of PSX from 2018 to 2023 have been analyzed by applying different techniques. Descriptive statistics indicate that the data set used for the analysis is not normally distributed, and the index returns are positively skewed following a leptokurtic distribution. Moreover, the null hypothesis of the unit root test performed by applying ADF and P-P tests has been rejected, and the study also confirmed the presence of stationarity in the index returns of PSX. The randomness of index returns has been tested through autocorrelation and test, and both tests confirmed that PSX is inefficient in weal form and returns don't follow a random walk. Hence, investors can benefit from arbitrage opportunities based on past price trends in Pakistan.

Testing of market efficiency is inevitable for analysts, investors, and regulators for good governance and efficient information handling. The study's findings have implications for the stakeholders, especially the investors and analysts, who should carefully formulate investing strategies to avoid losses. The study's findings can guide investors in investment decisions rather than solely depending on agents. Other factors like risk appetite, financial literacy, and behavioral aspects are important considerations for investors.

Furthermore, the correct investment decisions largely depend upon the availability of the information. In the recent era, where information is readily available and it is assumed that it is accessible by investors, there are documented anomalies in the market, which also emphasizes the significance of the failure of EMH and the need to test market efficiency repeatedly. The findings can help investors to make effective investment decisions.

Future research can be conducted to test weak forms of EMH by using data for longer periods and other techniques to get more comprehensive results. Other factors, including behavioral factors, increased use of artificial intelligence (AI) in investing, financial literacy, and personal characteristics of the investors, can also be considered while testing EMH in stock markets.

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