# Adaptive Vs Efficient: A Comparative Analysis of Stock and Foreign Exchange Markets in Pakistan

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## *Abstract*

*The objective of this study is to evaluate the applicability of the Adaptive Market Hypothesis (AMH) to the Pakistan Stock Exchange (PSX) and the Foreign Exchange Market (FOREX). The study utilizes daily exchange rate data for the US Dollar, Euro, and British Pound against the Pakistani Rupee to analyze the dynamics of the FOREX market in Pakistan. In stock parallel, the study employs daily return data from the PSX. The dataset spans from January 2009 to December 2022. The methodology adopted in this study uses a rolling window analysis technique, which involves the division of the dataset into 350 windows. Subsequently, the researcher applied Augmented Dickey-Fuller (ADF) and Portmanteau tests (PT). The results obtained from the ADF test indicate the absence of a unit root in both the PSX and FOREX markets. It implies that the time series data is stationary, aligning with the Random Walk Hypothesis (RWH). Consequently, the findings suggest that market efficiency is predominantly upheld in the PSX and FOREX markets. Furthermore, the PT results reveal no evidence of autocorrelation between the PSX and US Dollar exchange rates. In summary, this study concludes that the financial markets, represented by the PSX and FOREX in Pakistan, exhibit a time-varying nature regarding efficiency, affirming support for the Adaptive Market Hypothesis (AMH). These findings suggest that, over time, market conditions change, and the market deviates from efficiency. Individual and corporate investors can utilize these insights to achieve better market returns, whereas these findings can aid practitioners and policymakers in devising effective frameworks to achieve desired outcomes.*


**Keywords:** Adaptive Market Hypothesis, Efficient Market Hypothesis, Random Walk Hypothesis, Pakistan Stock Exchange

## Introduction

The debate surrounding the Efficient Market Hypothesis (EMH) still needs to be settled in contemporary financial discourse. Various studies have scrutinized the EMH in light of insights from behavioral finance. In their work, Rasheed et al. (2018) and Shiller (2006) contend that the EMH represents an idealized financial world but fails to depict the reality of financial markets accurately. Malkiel (2003) and Thaler (2015) noted that if $100 bills were left unattended in the world's stock exchanges, they would only remain unclaimed for a short time, a humorous allegory

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illustrating the EMH's perceived shortcomings. The rationale for the ongoing EMH debate can be attributed to several factors.

Another variable contributing to the ongoing debate is the diversity of strategies employed. Over the past six decades, numerous approaches have been developed. On one hand, conventional efficiency tests have produced mixed, often inconclusive results. On the other hand, alternative methodologies have been formulated to account for the dynamic nature of efficiency over time. Nevertheless, how researchers implement these methods has added complexity to the debate, as identical methodologies sometimes yield inconsistent results. In this research, we delve deeper into the significance of ways in the efficiency debate, considering various systematic approaches and assessing two standard traditional efficiency tests and an alternative robustness test. The findings are analyzed in the context of our empirical examination of Lo's (2004) AMH, enabling us to elucidate historical examples and patterns that may contribute to settling the debate.

Investors traditionally utilize the EMH as a benchmark to gauge market efficiency. However, in a country like Pakistan, the society is predominantly collectivist and excessively prone to behavioral anomalies (Rasheed et al., 2018) the evidence regarding EMH in practice is inconclusive. Some researchers argue in favor of the Pakistan Stock Exchange (PSX) being efficient (Khan & Khan, 2016; Rehman & Said, 2019), while others claim it is inefficient (Arshed et al., 2019; Rasheed, Gul et al., 2021)**.** These mixed results present a complex interplay of financial market behavior to elaborate by any of the two extremist views of finance, i.e., traditionalist and behaviorist. Therefore, this study seeks to add to the current understanding of this conflict by investigating the adaptive behavior of the PSX and FOREX markets through a rolling window analysis.

Another study contribution is the comparative incorporation of stock and foreign exchange markets. As stated by Linden (2009), the FOREX market is the world's preeminent financial market where currencies from various nations are exchanged and traded. Transactions occur online with modern technology, making it convenient for investors to trade in currency. In both financial markets, investors employ two primary types of analysis to forecast future prices. Technical analysis is rooted in patterns, while fundamental analysis relies on economic data, news, and other information. In stock markets, brokers facilitate securities trading and earn profits, relying on the expertise of intermediaries. It contrasts with the FOREX market, with no exchange fees (Jagerson & Hansen, 2011)**.** PSX operates from Monday to Friday between 9:00 a.m. and 5:00 p.m., limiting investors to these trading hours.

In contrast, the FOREX market is accessible 24 hours a day, seven days a week, allowing traders to buy or sell currencies anytime. Furthermore, the FOREX market is known for its high liquidity, surpassing traditional financial markets (Jagerson & Hansen, 2011; Linden, 2009). Hence, it can provide a better understanding of actual market behavior. Meanwhile, comparing these markets will uncover and shed light on any contextual differences between the stock market and the global forex market.

The study will add to the existing literature as one of the primary challenges pertains to the absence of an alternative theoretical framework. Critiquing an existing theory is relatively straightforward, as theories involve simplifying real-world complexities. However, formulating a new and superior theory to supplant the EMH is more formidable. Behavioral finance proponents have yet to devise a comprehensive framework that defines the behavioral efficiency of financial markets. Lo (2004, 2005) and Lo and MacKinlay (2011) addressed this challenge by introducing the Adaptive Market Hypothesis (AMH), which leverages concepts from evolutionary theory to reconcile opposing views on efficiency.

Nonetheless, even with this contribution, the AMH has not conclusively displaced the EMH as the prevailing theory of financial market efficiency. This study will provide empirical evidence to understand better this inconclusive avenue concerning a collectivist economy like Pakistan. The existing literature on the topic predominantly focuses on developed and Western economies. This study will also fill this literature gap. In order to accomplish the objectives, the study is subsequently divided into the literature review, research methodology, results, and conclusion sections, respectively.

## Literature Review

The foundations of conventional finance can be traced back to Von Neumann. At the same time, Neumann and Morgenstern (1947) introduced the expected utility theory, and Friedman and Savage (1948) put forward the subjective utility theory. These theories serve as fundamental frameworks for decision-making under risk and uncertainty. In conventional finance, rationality prevails, signifying that investor, upon receiving information, updates their thinking by Bayesian and probabilistic principles. Essentially, rationality entails maximizing utility, with rational investors consistently seeking to maximize their utility. It is the premise for the emergence of the Efficient Market Hypothesis (EMH), a concept first introduced by Fama (1970).

EMH posits that market prices accurately and fully reflect all available information. It comes in three forms: weak, semi-strong, and strong. The weak form of EMH holds that past prices are already incorporated into available information and are thus used by investors to predict future prices. The semi-strong form extends this to the belief that all public information is accessible to investors, while the strong form encompasses both public and private information. In a potent form of EMH, investors incorporate all information, both technical and non-technical, for investment analysis, rendering the market highly efficient.

On the contrary, behavioral finance delves into the role of individual and collective behavior in the financial market, especially under conditions of risk and uncertainty (Malkiel, 2003). This approach examines market behavior through psychological principles and delves into behavioral psychology to understand how human behavior influences decision-making and the broader economic landscape. Behavioral finance draws heavily on concepts such as Prospect Theory by Kahneman and Tversky (1979) and later Cumulative Prospect Theory by Tversky and Kahneman (1992). It acknowledges that individuals often operate under cognitive constraints, preferring heuristics in decision-making.

In this debate between traditionalists and behavioralists, Lo (2004) introduced the Adaptive Market Hypothesis (AMH), which posits that individuals act in self-interest but learn from past mistakes during decision-making in a competitive and innovative environment. Under AMH, securities exchanges can exhibit efficiencies and inefficiencies because investors are neither entirely rational nor irrational; instead, they adapt and learn from their previous transactions. Empirical studies of AMH reveal that the volatility and consistency of stock returns can vary under different market conditions, such as bear and bull markets, equity market bubbles, and busts (Ito & Sugiyama, 2009). AMH also acknowledges the presence of cognitive biases attributed to heuristics, which may extend beyond financial contexts (Lo, 2005). When market participants and investors make decisions, they formulate different hypotheses for themselves, exhibiting bounded rationality, which may ultimately lead to optimal decisions grounded in rational assumptions (Simon, 1955). The latest research highlights the significance of investor personality traits and contextual factors, critical considerations in AMH, in integrating new information into prices and shaping investor behavior towards market anomalies (Akhtar et al., 2018; Rasheed et al., 2021; Urquhart &

McGroarty, 2014). Unlike traditional market efficiency theories that treat all markets similarly (Lo, 2002, 2005), AMH recognizes that variations in stock market behavior in different market conditions depart from market efficiency.

## Pakistan's FOREX Market

The practical implications of the Adaptive Market Hypothesis (AMH) regarding its capacity to capture and generate efficiency have significant repercussions, as noted by Campbell et al. (1997). It motivates us to illustrate the concept of efficiency within the Pakistani Foreign Exchange (FOREX) market. The choice to focus on the Pakistani FOREX and Pakistan Stock Exchange (PSX) stems from various compelling reasons. Pakistan experiences a substantial influx of foreign exchange due to its controlled floating exchange rate system, resulting in an increasing daily turnover in the FOREX market, positioning it 81st worldwide in terms of daily turnover (Lo, 2004). In a controlled floating exchange rate system, policymakers employ strategic instruments to manage currency volatility stemming from specific shocks and ensure economic stability. The efficiency and macroeconomic stability of the FOREX market have fostered short- and long-term foreign investment growth. Foreign Direct Investment (FDI) in Pakistan has surged due to fundamental policy reforms. The importance of the Pakistani FOREX market is underscored by the country's financial sector transformations, escalating imports and exports, and macroeconomic fluctuations.

Data distribution within emerging market sectors must align with established market norms, ensuring equitable access to information and preventing information disparities that favor better-informed traders who might capitalize on abnormal returns. Additionally, emerging markets (EMs) are susceptible to economic shocks due to their inherently volatile economic conditions. However, EMs are not homogeneous; Pakistan exhibits distinct characteristics that set it apart. Despite the financial market reforms implemented since the mid-1990s, concerns persist regarding the informational efficiency of Pakistan's FOREX market. Consequently, the pursuit of efficiency is highly relevant (Aghion et al., 2009), and a country-specific study promises unique insights into the Pakistani market. Therefore, this study contributes to the body of knowledge by proposing that:

H1: The Pakistan Stock Exchange (PSX) follows the Adaptive market hypothesis (AMH).

H2: The FOREX market in Pakistan follows the Adaptive market hypothesis (AMH).

## Research Methodology

### Data

The researcher discussed the top developed market countries' currencies, Dollar (USD), German (Euro), and UK (Pound), concerning the Pakistan FOREX and PSX Market (Table 1). The nature of this study is quantitative, and the researcher used the PSX Market and FOREX Market as univariate. The sample is from January 2009 to December 2022 (time series data). The researcher used the daily return of the PSX Market and the daily exchange rate for FOREX and utilized the rolling window technique to run the test, which is better quality and uses 350 rolling windows. The data is taken from Yahoo Finance in both markets. All the interpretations are made through the STATA software. The return is calculated from the methodology utilized by Khuntia et al. (2018).

**Table 1: Sample**

| Markets | Index/Currency |
|---|---|
| **Stock Market** | |
| (PSX) | (KSE-100) |
| **FOREX** | |
| US | $ |
| UK | £ |
| Germany | € |

Compounded Return (R) for the exchange rate (E) and Sock Index (KSE-100) at the time (t) are estimated as:

$$R_t = Ln\left(P_t / P_{t-1}\right)$$

## Measurement of Efficiency

### Random Walk Hypothesis

The Random Walk Hypothesis (RWH) test serves as a method to assess the informational efficiency in the weak form of the Efficient Market Hypothesis (EMH). While it is not a direct test of the EMH, its results can provide valuable insights. If the RWH is accepted, market prices follow a random walk pattern, suggesting that all historical information is already incorporated into current prices. This acceptance of the RWH would suggest that the market is operating efficiently in its weak form. On the other hand, if the RWH is rejected, it indicates that the market does not adhere to a random walk pattern and that historical information does not entirely account for current prices. In this scenario, the market is considered inefficient in the weak form. Primarily, the RWH is used as a tool for technical analysis, which involves analyzing historical price and volume data to make investment decisions. However, it is essential to note that there have been relatively fewer studies conducted on Asian markets in this context, as noted by Todea et al. (2009). It suggests that there may be opportunities for further research and analysis in Asian markets to understand better their adherence to the principles of the RWH and the broader implications for market efficiency in the weak form of the EMH.

## Econometrics Analysis

### Rolling Windows

The rolling window approach is a valuable method to identify significant historical events and assess the weak form efficiency in financial markets. For instance, Alvarez-Ramirez et al. (2008) applied the rolling window analysis to test the weak form efficiency of the Dow Jones in 1971 when the Bretton Wood system was terminated. This approach is closely related to sub-period analysis and is primarily employed to evaluate weak form efficiency. Researchers like Cajueiro and Tabak (2005) have conducted numerous studies on weak form efficiency across various markets. Although there is a degree of consensus on the window size, as noted by Charles et al. (2011), it is essential to occasionally adjust the window size to ensure that there is a sufficient number of observations to maintain statistical power and size attributes while detecting short-term patterns and trends, as pointed out by Hiremath and Kumari (2014). Moreover, the rolling window technique overcomes the challenge of randomly dividing an entire sample into subsamples, as highlighted by Hiremath and Narayan (2016).

In this study, the researcher opted for a rolling test window comprising 350 observations, following the findings of Charles et al. (2011) and Hiremath and Narayan (2016). The rolling window is advanced by one point in each iteration, removing the initial observation and adding the closing

estimate of the subsequent test measurements. This study employs rolling window lengths 350 to calculate the test statistics, ensuring robust and comprehensive analysis of the weak form efficiency in the financial market.

**Portmanteau test**

The portmanteau test is much of the time used to check if H0: j=0 for each j=1, ... p. Lobato et al. (2001) recommend a robustness portmanteau test measurement of the accompanying kind where the stock return is delicate to obscure sorts of restrictive heteroscedasticity:

Q p ¼ T ∑ p i¼1 ρ˜ 2 i

Where ρ˜ 2 i ¼ γˆ 2 i = τ2 i ;γˆ 2 i is the assessment for the auto covariance of stock returns of request I and 2 I is the auto covariance of squared stock returns. Escanciano and Lobato (2009) offer a mechanized test in which the best worth of p is picked utilizing a method that is information subordinate. Coming up next is an illustration of a test:

AQ≡Q p˜ ¼ T ∑ p˜ i¼1 ρ˜ 2 I; ð4Þ

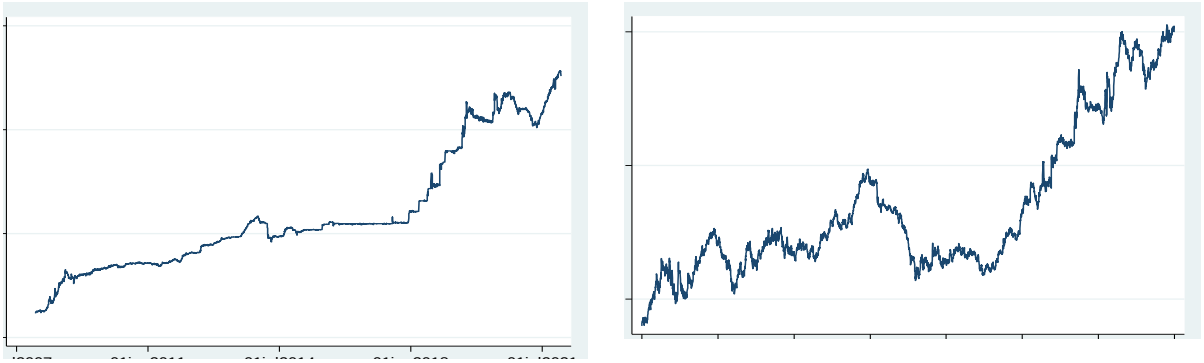
Where p is the ideal slack request to be picked by a compromise among Akaike's and Bayesian data measures, with one level of opportunity, the AQ measurement asymptotically follows the chi-squared appropriation. Assuming the worth of AQ is more significant than 3.84, the invalid speculation of no return autocorrelation is dismissed at the 5% degree of importance.

## Results

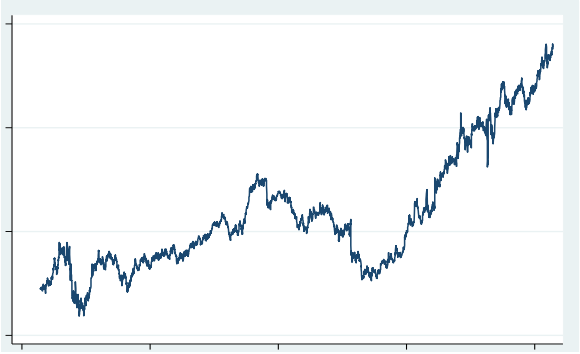
In this study, the researcher uses the daily prices of the FOREX market and PSX from January 1st, 2009, to December 31st, 2022, downloaded from yahoo finance for both markets and convert the prices into return by using the return formula. All values shown an incremental increase from 2009 to 2022 with fluctuations.

**Figure 1: Trend of PSX and FOREX Prices**

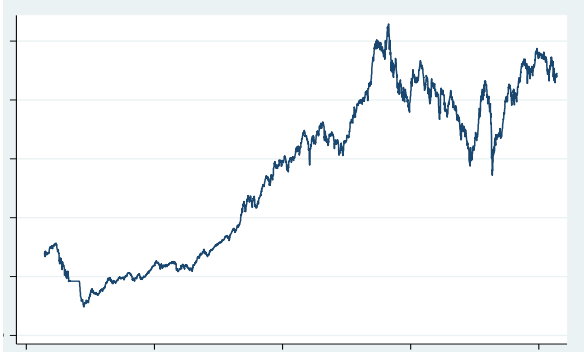
**Dollar** **Euro**



**Pound**



**PSX**



These values are raw prices indicates that there is no significant trend in prices. All values fluctuate from day one to the end.

**Table 2: Descriptive Statistics**

| Statistics | PSX | PKR-US | PKR-EURO | PKR-GBP |
|---|---|---|---|---|
| Mean | .0003996 | .0002772 | 0.0002441 | .0002097 |
| Maximum | .0860496 | .082853 | 0.827069 | .0873163 |
| Minimum | -.0685607 | -.0526582 | -.0487127 | -.0801499 |
| SD | .0115918 | .003983 | .0071618 | .0074617 |
| Skewness | -.2801061 | 2.7969995 | 0.7961032 | .2216282 |

The descriptive statistics tables show the positive mean and standard deviation (table 2). The PSX mean is at an all-time high compared to the FOREX market. In the count noun meaning, a descriptive statistic is a summary statistic that quantitatively characterizes or summarizes characteristics from a data collection. Descriptive statistics (in the mass noun sense) applies and analyzes such statistics. Descriptive statistics differ from inferential statistics (or inductive statistics) in that they seek to summarize a sample rather than learn about the population the sample of data is assumed to represent (Kaur et al., 2018). In the above table, the maximum value depicts that the maximum value is the highest in the data set. The maximum highest value is .0873163 GBP. The maximum value of PSX is .0860496, the second highest value in maximum.

On the other hand, the minimum value is the value which is the lowest value in the dataset. The PSX and FOREX have negative values, showing the data's minimum value. Return standard deviation is a measure of volatility or risk—the greater the standard deviation of returns, the greater the return variation. The SD of PSX is 0.115918, the highest SD against FOREX, which means the PSX is more volatile than FOREX. In the forex market, the highest risky currency is GBP .0074617. The GBP is the highest SD value of the Dollar and Euro. The PSX skewness value is negative, meaning there are more negative returns. The PSX-only value is negative, meaning their return values are more harmful. On the other hand, the FOREX skewness values are all positive, but the dollar is highly positive, which shows that the dollar price increases over time in Pakistan.

**Estimate stationery**

The data, mostly in time series, are assumed to be nonstationary. Every researcher prefers their time series data must-have stationery because the result is more accessible to interpret than if the

time series is nonstationary. The time series comprises three things—first, constant expected value; second, constant variance; and last, constant covariance.

On the other hand, the nonstationary provides spurious results. This study first finds that this time series is stationary or nonstationary. So, the researcher used the most standard augmented Dickey-Fuller test (ADF) in the market of PSX and FOREX. The primary purpose of this test is to check whether a unit root exists in the time series (Dickey & Fuller, 1979). The ADF checks the null hypothesis (H0) that elaborates that the time series has a unit root, but the data is non-stationary.

**Table 3: ADF Result**

| Statistics | PSX | PKR-US | PKR-EURO | PKR-GBP | $H_0$ Hypothesis |
|---|---|---|---|---|---|
| **Test Statistics** | -50.778 | -67.816 | -55.124 | -53.926 | Rejected |
| **Critical Value (5%)** | -2.860 | -2.860 | -2.860 | -2.860 | Rejected |
| **Probability Value** | 0.0000 | 0.0000 | 0.0000 | 0.0000 | - |

The result of the ADF is presented in Table 3. The table reported no sign of a unit root in the PSX and FOREX markets. Both markets' test statistics values are less than 5%. So, both markets rejected the null hypothesis of non-stationary time series. Hence, the PSX and FOREX market series do not have a unit root, but the data is stationary.

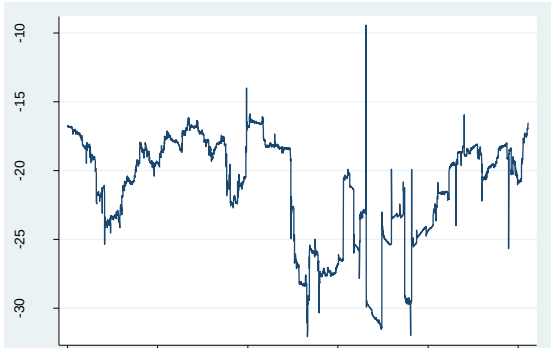
**Table 4: Portmanteau test**

| Statistics | PSX | PKR-US | PKR-EURO | PKR-GBP |
|---|---|---|---|---|
| **Q Statistics** | 133.9552 | 118.4020 | 25.7442 | 42.9854 |
| **Probability Value** | 0.0000 | 0.0000 | 0.9607 | 0.3446 |

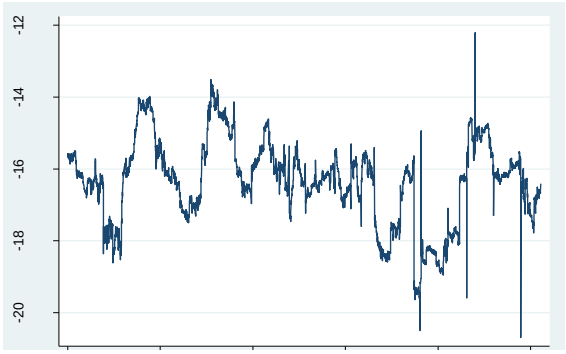
The above table shows the Portmanteau test for white noise tested on both PSX and FOREX markets. The PSX's Q value is more than the p-value, which means the PSX is not following the white noise process and the null hypothesis. The PSX and US Dollar have autocorrelation. The same is true with the US dollar not following the white noise. On the other hand, the Euro and GBP follow the white noise and reject the null hypothesis. Therefore, the GBP and Euro have no autocorrelation.

**Figure 2: Rolling ADF**

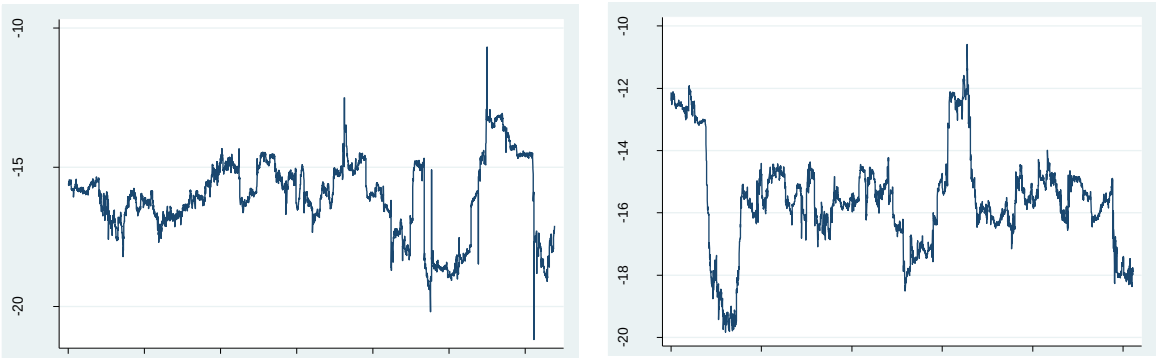
**) Dollar**




**) Euro**



**Pound** **(d) PSX**

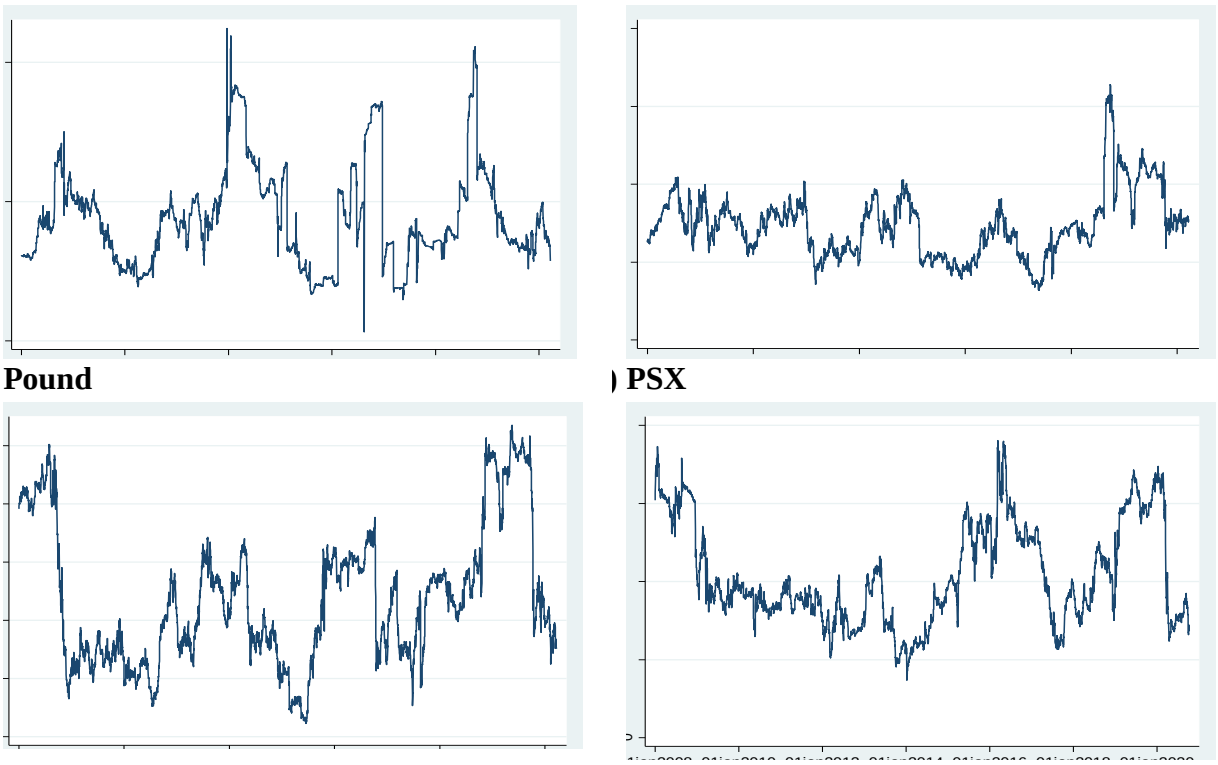



The PSX-100 index and FOREX above values show the ADF test, which is interpreted through the rolling window analysis. On the X-axis is the value showing the time frame, and on Y-Axis is the Z value of ADF.

**Figure 3: Rolling Portmanteau test**

**Dollar** **Euro**

**Pound** **PSX**



The PSX-100 index and FOREX above values show the Portmanteau test, which is interpreted through the rolling window analysis. On the X-axis, the value shows the time frame; on Y-Axis is the Q value.

## Discussion and Future Directions

(i) The decision to use 13-year total sample periods for the initial three observational sections was made based on data availability and the study's objective of examining the Adaptive Market Hypothesis (AMH) over time. While different subsample sizes could have been chosen, the 13-year samples provided an adequate number of observations to explore behavior over time while ensuring the tests yielded statistically robust results and also excluded the impact of the abnormal financial crisis in 2008. Many studies on the AMH have indeed utilized rolling window analysis, which has its limitations. Therefore, this study offers a different perspective on the AMH.

(ii) The total length of the sample period spans 13 years, from 2008 to 2021. Due to variations in data availability, the sample durations for different markets are not uniform in length. Each data period was considered practical and feasible, providing an accurate representation of how returns have evolved. If the data for the Pakistan Stock Exchange (PSX) markets had started in 1991, when the PSX was established, there would have been no data available for the PSX or FOREX markets. Using shorter data periods would have provided less information than the available sample time frames.

(iii) The AMH being a relatively new model, there is ample room for future research and exploration, as various testing techniques can be employed to investigate it further. Examining markets across multiple sample periods or using rolling sample windows could yield additional insights into the behavior of stock exchange returns, contingent upon data availability. More extended sample periods may be more advantageous in analyzing the AMH for these financial markets as more data becomes available, although this could necessitate several years. Different market sectors, such as individual stocks, Forex, and bond markets, may also be explored to understand the AMH better.

In conclusion, future research could focus on how the COVID-19 pandemic has impacted Pakistan's financial markets. The exploration can seek to uncover the challenges that investors face in terms of investing in stock exchanges and profiting from the Pakistani FOREX and PSX markets during the pandemic. It would shed light on the specific issues and dynamics in these markets during times of crisis.

## Conclusion

This study aimed to assess the applicability of the Adaptive Market Hypothesis (AMH) in the Pakistan Stock Exchange (PSX) and the Foreign Exchange (FOREX) markets. Daily return data from the PSX and daily exchange rate data from the FOREX market were utilized, covering the period from 2008 to 2021. The study employed the Augmented Dickey-Fuller (ADF) test to determine whether the time series data in both markets exhibited stationarity or non-stationarity. The findings revealed stationarity in both the PSX and FOREX markets, aligning with the principles of the AMH. As per Lo's theory, a market is considered adaptive when it is efficient and exhibits stationary time-series data. Consequently, the study concludes that the PSX and FOREX markets adhere to the Adaptive Market Hypothesis.

Additionally, the study conducted descriptive statistics, revealing that the PSX market in Pakistan is comparatively riskier than the FOREX market. The ADF test confirmed the absence of a unit root in both markets while affirming the presence of stationarity. Furthermore, the Portmanteau test indicated no white noise in the PSX data, implying no autocorrelation between the PSX and the US market. Conversely, autocorrelation was detected in the Euro and British Pound markets. It is noted that market efficiency can vary based on prevailing conditions. Financial turmoil, institutional structure, policy changes, macroeconomic volatility, central bank actions, and

political instability influence market efficiency. It underscores the time-dependent nature of market efficiency, and the AMH framework offers a deeper understanding of the intricacies of efficiency in developing stock markets like Pakistan.

The implications of this research are significant on multiple fronts. The remarkable consistency observed over time suggests that currency traders should exercise caution, avoiding herding behavior, as this consistency can indicate potential future opportunities. Since market efficiency evolves, FOREX and PSX investors are encouraged to adapt their investment strategies, recognizing that what works well in specific market conditions may perform poorly in others. Thus, dynamic financial planning strategies are better suited to adjust to shifting market circumstances.

Furthermore, the variation in the level of consistency of the Pakistani Rupee (PKR) against significant currencies implies that diversifying currency pairings may be advisable to safeguard against unexpected movements. For policymakers, proving efficiency in the FOREX and PSX markets necessitates appropriate central bank intervention to restore confidence and mitigate speculative attacks. This research underscores the dynamic and complex nature of financial markets and provides valuable insights for investors, traders, and policymakers in Pakistan.

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