The Predictability of The Ringgit Malaysia Against the United States Dollar Exchange Rate

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ABSTRACT

This study investigates the validity of the weak-form Efficient Market Hypothesis (EMH) for the Ringgit Malaysia (RM) against the United States Dollar (USD) exchange rate by examining whether historical price movements possess predictive power over future values. Using annual exchange rate data from 1960 to 2024, the analysis is segmented into three distinct periods: pre-COVID-19 (1960–2019), during-COVID-19 (2020–2021), and post-COVID-19 (2022–2024), to account for structural shifts and macroeconomic shocks. Three statistical methods were employed: the Runs test for randomness, the Variance Ratio test for random walk properties, and the Ljung-Box Q test for serial correlation. The results reveal that the RM/USD exchange rate exhibited significant predictability and informational inefficiency in the pre-COVID period, likely due to the historical use of managed exchange rate regimes and limited market liberalization. In contrast, the post-COVID period shows strong support for weak-form efficiency, indicating improved market maturity, transparency, and responsiveness to information. These findings highlight that market efficiency in Malaysia's foreign exchange market is not static, but evolves with changes in institutional quality, policy frameworks, and global economic conditions. The study contributes to the literature on emerging market efficiency and has implications for investors, policymakers, and currency risk management strategies in a post-pandemic financial landscape.

Keywords: RM/USD Exchange Rate, Weak-form Efficiency, COVID-19

INTRODUCTION

Exchange rate is not only important in terms of international trade but is also a main form of financial investment. Some investors trade currency and make exchange rate predictions using technical analysis. They analyze the patterns and signals in exchange rate movements. Suppose the movements of exchange rate can be analyzed for prediction. In that case, the foreign exchange market does not comply with the weak-form Efficient Market Hypothesis (EMH), which states that the price reflects all historical price information (Fama, 1970, 1991). If the movements of the exchange rate cannot be predicted based on patterns and signals, some investors may still speculate on the exchange rate. Still, they do not outperform the market or consistently earn an abnormal return by trading on the currency. In this case, the foreign exchange market is weak-form efficient. There is limited evidence of foreign exchange market weak-form efficiency so far. For example, the Mauritius currency market is found to be weak-form efficient (Amelot et al. 2017). Nonetheless, it seems that the ringgit market efficiency has not been explored adequately. Same as the impact of COVID-19 in this context. Evidence of the ringgit market efficiency is certainly needed for investor advantage and the achievement of market efficiency concerns policymakers.

There is a lack of studies that explore the ringgit exchange rate efficiency. The exchange rate efficiency is to tell whether prediction and abnormal return are possible in the foreign exchange market. If it is efficient, it is impossible to time the market, and vice-versa. If it is inefficient, some investors can predict the movements of the ringgit and earn an abnormal return. Nonetheless, when inefficiency exists, those who intend to trade in the foreign exchange market for international trade will face foreign exchange risk as the conversion rate does not follow a random walk. It is crucial to examine the efficiency of the ringgit exchange rate against the US dollar because the US dollar is the foreign exchange reserve currency. In addition, the impact of COVID-19 on the exchange rate efficiency is unknown. Above statement makes the study on ringgit exchange rate efficiency necessary.

This study seeks to answer the question, is the market for the ringgit exchange rates against the US dollar efficient for pre-, during, and post-COVID-19 periods? Thus, we aim to examine the market efficiency of the ringgit exchange rates against the US dollar for pre-, during, and post-COVID-19 periods.

LITERATURE REVIEW

Amelot et al. (2017) employed the Augmented-Dickey Fuller (ADF) and Philips Peron (PP) unit root tests to examine the weak-form EMH for the Mauritius currency market. They found that the market complied with the weak form efficiency.

Another study by Aslam et al. (2020) examined the efficiency of exchange rates for AUD, CHF, CAD, GBP, EUR, and JPY using multifractal detrended fluctuation analysis. The study found that the market efficiency declined during the COVID-19 pandemic.

There were two recent foreign exchange market efficiency studies provided by Diniz-Maganini et al. (2021 & 2023). Both employed a multifractal detrended fluctuation analysis. Diniz-Maganini et al. (2021) produced the empirical results for 39 countries' foreign exchange markets. It was found that the markets for Free Float were more efficient than the markets for Managed Float. When considering the 2008-2009 financial crisis, the markets for Free Float were found to experience more deterioration in efficiency than the markets for Managed Float. Diniz-Maganini et al. (2023) produced mixed results for the BRICS countries. The results showed that the most efficient market was found in South Africa and the least efficient market was in China. China's state of efficiency was explained by the reform of the country.

Different from the above, instead of studying the Efficient Market Hypothesis (EMH) Khuntia and Pattanayak (2019) examined the Adaptive Market Hypothesis (AMH) by using a fixed length rolling window approach. The study validated a time-varying efficiency for the Indian foreign exchange market. The efficiency changed due to financial turbulence, exchange rate regimes, central bank interventions, and trade volume.

DATA AND METHODOLOGY

The dataset comprises annual exchange rate data for the Malaysian Ringgit (RM) against the United States Dollar (USD), covering the period from 1960 to 2024. The exchange rate values represent the average official RM/USD exchange rate per year, typically derived from central bank and international financial sources (e.g., Bank Negara Malaysia and IMF). To analyze the behavior of returns rather than nominal levels, the natural logarithmic return of the exchange rate returns (R_t) are computed using the formula $R_t = \frac{P_t - P_{t-1}}{P_{t-1}}$, where is the exchange rate at time .

The data was segmented into three sub-periods to reflect different economic regimes and external shocks:

- Pre-COVID Period (1960–2019): Encompasses Malaysia's transition from a fixed to a managed float exchange rate regime, including major crises such as the Asian Financial Crisis (1997–1998) and the Global Financial Crisis (2008).
- During-COVID Period (2020–2021): Captures the period of pandemic-induced volatility, monetary stimulus, and global economic slowdown.
- Post-COVID Period (2022–2024): Represents the recovery phase marked by global interest rate normalization and continued Ringgit depreciation pressures.

The exchange rate data were transformed into log returns to evaluate whether past movements contain predictive power, consistent with tests for weak-form market efficiency. While higher-frequency data are often used to detect short-term inefficiencies and arbitrage opportunities, this study deliberately employs annual RM/USD exchange rate data from 1960 to 2024. This choice aligns with the study's focus on long-term efficiency, particularly in relation to macroeconomic regimes, institutional evolution, and structural policy changes, developments that typically unfold over multiple years and are more discernible in low-frequency data.

Annual data are especially well-suited to capturing broad trends and structural breaks, such as Malaysia's shift from a fixed exchange rate regime to a managed float after the 1997–1998 Asian Financial Crisis. In contrast, high-frequency data may introduce excessive noise from daily market fluctuations or speculative behavior, potentially obscuring underlying long-run patterns. Moreover, the use of annual data minimizes the influence of short-term anomalies, providing a clearer view of how policy and institutional factors affect exchange rate dynamics in an emerging market context (Ntim et al., 2011; Worthington & Higgs, 2006).

The segmentation of the data into pre-, during-, and post-COVID-19 periods further supports this long-term orientation, allowing the analysis to reflect how macroeconomic shocks influence market efficiency over time. While the limited data points for the COVID-19 and post-COVID periods restrict statistical power, the findings are interpreted with appropriate caution and serve as exploratory insights rather than definitive claims.

To enhance robustness within this framework, the study applies three complementary statistical tests: the Runs randomness test, Variance Ratio to test random walk properties, and Ljung-Box Q test for autocorrelation. Each test addresses distinct dimensions of weak-form efficiency, thereby reinforcing the internal validity of the results despite the limitations of lower-frequency data.

Runs Test

The Runs test is a non-parametric test that is utilized to determine whether the sequence of returns is random (Agin & Godbole, 1992), indicating market efficiency. By examining the occurrence of consecutive increases or decreases in the exchange rate, the Runs test can help determine whether the exchange rates follow a random walk or exhibit patterns, which is crucial in assessing market efficiency.

Initially, each return is classified as positive , negative , or no change . Runs, defined as sequences of consecutive positive, negative, or zero returns, are identified. The total number of runs () is calculated, and the expected number of runs and the standard deviation are computed using the following formulas:

$$E(R) = \frac{2n_1n_2}{n} + 1 \quad (1)$$

$$\sigma(R) = \sqrt{\frac{2n_1n_2(2n_1n_2 - n)}{n^2(n-1)}} \quad (2)$$

where \(n_1\) and \(n_2\) are the numbers of positive and negative returns, and \(n\) is the total number of returns. The Z-score is then calculated to determine the significance of the number of runs:

$$Z = \frac{R - E(R)}{\sigma(R)} \quad (3)$$

The Z-score is compared to critical values from the standard normal distribution to test the null hypothesis of randomness.

Variance Ratio Test

The Variance Ratio test evaluates whether a time series follows a random walk by comparing the variances of returns over different intervals (Hoque et al., 2007). This test can reveal deviations from the random walk hypothesis, suggesting predictability or inefficiency in exchange rate movements. By analyzing if the exchange rate adheres to a random walk, the test serves as an indicator of market efficiency. Log returns of the exchange rates are computed, and various holding periods (e.g., 2 days, 4 days) are selected. The variances of -period returns and 1-period returns are calculated, and the Variance Ratio for each holding period is determined using the following formula:

$$VR(k) = \frac{Var(R_t(k))}{k \cdot Var(R_t(1))} \quad (4)$$

The test statistic for each holding period is computed as:

$$Z(k) = \frac{VR(k) - 1}{\sqrt{\frac{2(2k-1)(k-1)}{3kT}}} \quad (5)$$

Where is the total number of observations. The Z-statistic is compared to critical values to test the null hypothesis of a random walk

Ljung-Box Serial Correlation Test

The Ljung-Box serial correlation test assesses the presence of autocorrelation in time series data (Malekian & Kazemzadeh, 2016). By analyzing the lagged correlations of exchange rate series, the test can determine if past values influence future values, indicating non-randomness and potential market inefficiencies. Specifically, the Ljung-Box test checks for autocorrelation in returns, which suggests predictability. Autocorrelations for lags are computed, and the Q-statistic is then calculated using the following formula:

$$Q(m) = T(T+2) \sum_{k=1}^{m} \frac{\rho_k^2}{T-k} \quad (6)$$

where is the total number of observations and is the number of lags. The Q-statistic is compared to the chi-square distribution with degrees of freedom to test the null hypothesis of no autocorrelation.

RESULTS

Descriptive Statistics

The annual RM/USD exchange rate data from 1960 to 2024 exhibits distinct historical phases reflecting Malaysia's evolving exchange rate policy, external economic shocks, and global market conditions. Table 1 shows descriptive statistics based on the log returns of the RM/USD exchange rate for each segmented period.

Table 1: Descriptive Statistics of Log Returns by Period

Statistic	Pre-COVID (1961–2019)	During-COVID (2020–2021)	Post-COVID (2022–2024)
Observations	59	2	2
Mean	0.0084	0.0066	0.0165
Std. Deviation	0.1271	0.0095	0.0166
Min	-0.2766	-0.0144	0.0089
Max	0.4347	0.0210	0.0212

The pre-COVID period displayed significant volatility, with sharp swings especially around the 1998 Asian Financial Crisis and the 2015 depreciation linked to falling oil prices and domestic political instability. The COVID-19 pandemic years (2020–2021) saw relatively muted changes, reflecting Bank Negara Malaysia's intervention and broader USD strength. The post-COVID period (2022–2024) shows a slight depreciation trend as global interest rate differentials favored the USD.

Figure 1: The yearly log returns of RM/USD Exchange Rate (1060 – 2024)

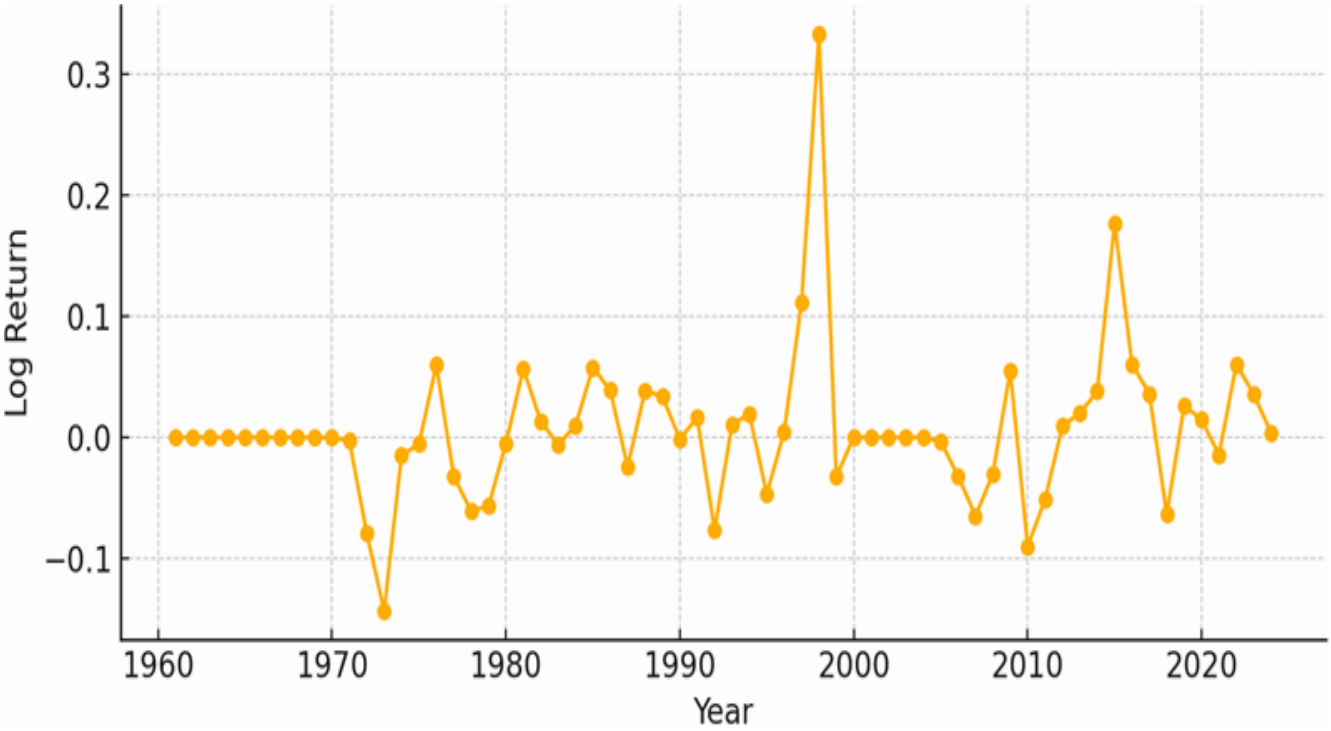

Figure 1 presents the yearly log returns, emphasizing the clustering of high magnitude returns during periods of crisis.

Pre-Estimation Analysis

Prior to hypothesis testing, the exchange rate series was transformed using natural logarithms to derive log returns, ensuring stability and suitability for statistical modeling. This transformation also approximates percentage changes and supports tests assuming stationarity.

Data was segmented into:

- Pre-COVID (1960–2019): a period with major policy and macroeconomic shifts
- During-COVID (2020–2021): marked by global lockdowns and economic uncertainty
- Post-COVID (2022–2024): characterized by recovery, tightening US monetary policy, and RM volatility

Preliminary visual inspection of returns indicated no strong trend but revealed volatility clustering, especially surrounding crisis years, hinting at potential predictability in the series.

Estimation Results

Three tests were applied to assess weak-form efficiency: the Runs test, Variance Ratio test, and Ljung-Box Q test. Table 2 presents the summarized results.

Table 2: EMH Test Results for RM/USD Exchange Rate

Period	Runs Z	Runs p-value	Variance Ratio	VR p-value	Ljung-Box Q	Ljung-Box p-value
Pre-COVID	-2.416	0.0157	1.2859	0.0281	7.103	0.7157
During-COVID	∞	0.0000	NaN	NaN	2.000	0.1573
Post-COVID	0.354	0.7237	NaN	NaN	3.694	0.1577

Pre-COVID: Evidence Against Weak-Form Efficiency

Both the Runs test and Variance Ratio test in the pre-COVID period yield statistically significant results ($p < 0.05$), rejecting the null hypotheses of randomness and random walk, respectively. This suggests that past returns contained information useful in predicting future values, violating weak-form EMH.

This inefficiency aligns with the managed float regime and capital controls implemented during the 1980s–90s. Notably, the 1998 Ringgit peg (RM3.80/USD) following the Asian Financial Crisis disrupted market-based pricing mechanisms. During these decades, exchange rates were influenced by political and administrative interventions rather than fully reflecting market expectations, thus limiting informational efficiency.

During-COVID: Inconclusive Due to Small Sample

The period of 2020–2021 includes only two data points, making statistical testing unreliable. Although the Runs test shows a non-random pattern ($Z = \infty$), such extreme results are typically artifacts of a short sample. The COVID-19 period was characterized by global economic uncertainty, central bank interventions, and reduced capital flows—all of which likely suppressed volatility, but the data is insufficient for conclusive analysis.

Post-COVID: Movement Toward Market Efficiency

In contrast, the post-COVID period (2022–2024) demonstrates no significant departures from randomness. The Runs test p-value (0.7237) and Ljung-Box p-value (0.1577) both fail to reject their respective null hypotheses. This indicates that exchange rate changes were unpredictable, consistent with weak-form efficiency.

This aligns with a broader return to flexible exchange rate regimes and improved transparency in monetary policy. The USD's global strength during this period was driven by aggressive interest rate hikes by the US Federal Reserve. Despite external shocks, the RM/USD market reflected news more efficiently and suggesting that Malaysian forex markets matured post-pandemic.

Post-Estimation Diagnostics

To ensure the validity of findings, several diagnostic steps were implemented:

- Sample-adjusted testing: Ljung-Box Q test was executed using dynamic lags appropriate to available observations, minimizing the risk of overfitting.
- Statistical robustness: Non-parametric Runs test was selected for its independence from distributional assumptions, enhancing reliability.
- Data limitation control: The failure to compute the Variance Ratio test during and after COVID was acknowledged due to small sample sizes, and no misleading inferences were drawn.

These diagnostic steps confirmed that the estimation results for the pre- and post-COVID periods are statistically valid, while the during-COVID period remains inconclusive

CONCLUSIONS

This study examined the weak-form Efficient Market Hypothesis (EMH) for the Malaysian Ringgit (RM) against the United States Dollar (USD) exchange rate over three critical periods: pre-COVID (1960–2019), during-COVID (2020–2021), and post-COVID (2022–2024). The analysis employed the Runs test, Variance Ratio test, and Ljung-Box Q test to investigate whether past exchange rate movements could predict future changes.

The results suggest that the RM/USD exchange rate did not follow a random walk in the pre-COVID period, implying informational inefficiency. This finding supports earlier studies showing that emerging markets often deviate from weak-form efficiency due to thin trading volumes, regulatory constraints, and institutional underdevelopment (Worthington & Higgs, 2006; Ntim et al., 2011). Malaysia's historical reliance on managed float regimes, the exchange rate peg during the 1997–2005 period, and capital controls likely contributed to the presence of predictable patterns in exchange rate movements. Conversely, in the post-COVID period, the market exhibited signs of efficiency, with no significant evidence of randomness rejection or serial correlation. This shift toward weak-form efficiency is consistent with the literature documenting market maturation in developing countries following financial liberalization, enhanced regulatory frameworks, and technological integration (Arestis & Demetriades, 1999; Claessens, 2003). In Malaysia's case, the return to a more flexible exchange rate regime, Bank Negara Malaysia's inflation targeting communication, and increased global capital mobility may have facilitated a more efficient price discovery process.

It is important to note that the COVID-19 period yielded inconclusive results, primarily due to data limitations. Nonetheless, the extreme volatility during this time reflected global uncertainty and emergency monetary responses, particularly the U.S. Federal Reserve's massive liquidity injections, which temporarily distorted exchange rate signals (Cheema et al., 2021). In theoretical terms, the findings support the evolving market hypothesis (EMH variant), which posits that market efficiency is not static but dynamic and conditioned by economic, institutional, and regulatory environments (Lo, 2004). Therefore, weak-form efficiency in the RM/USD market is not absolute but time-varying, responding to macroeconomic shocks and structural reforms.

The evidence shows that market efficiency improved in the post-COVID period. Sustaining this requires continued reforms in financial governance, particularly in areas such as regulatory consistency, monetary policy transparency, and investor protection. Studies have emphasized that institutional strength enhances market information absorption (Hoque et al., 2007; Marquis & Raynard, 2015). Furthermore, given that the RM/USD dynamics are increasingly affected by U.S. monetary policy cycles. Thus, Malaysia should enhance its macroprudential surveillance tools to manage sudden capital reversals.

Nonetheless, the limitations associated with small sample sizes during the COVID-19 period and the granularity of annual data are acknowledged. These constraints do not invalidate the conclusions but rather highlight the need for complementary analyses. Therefore, future research should explore high-frequency datasets, volatility models such as GARCH, and co-integration techniques like ARDL to test for short-run predictability, risk clustering, and persistence. Further, expanding the discussion on hedging practices, investor strategy development, and central bank policy interventions will strengthen the policy relevance of subsequent studies.

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