Weak-Form Efficiency of the USD/CNY Exchange Rate Before, During, and After COVID-19

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ABSTRACT

This study examines the weak-form efficiency of the nominal exchange rate between the Chinese yuan and the United States dollar across the periods before, during, and after the COVID-19 pandemic. Daily observations of the USD/CNY exchange rate from 2 January 2015 to 31 December 2025 were obtained from the Federal Reserve Economic Data database. Exchange rate efficiency was assessed using the runs test, the heteroskedasticity robust variance ratio test, and the Ljung Box Q test. The runs test failed to reject randomness for the full sample and all three subperiods. The variance ratio test also supported the random walk condition at most holding periods, although significant positive serial dependence was detected at the 20-day horizon for the full sample and the pre-COVID-19 period. The Ljung Box Q test showed no significant serial correlation before COVID 19, limited dependence during the pandemic, and significant serial correlation at all tested lags after COVID 19. These findings indicate that the USD/CNY exchange rate was predominantly consistent with weak-form efficiency before and during the pandemic, while the post-COVID-19 period produced mixed evidence. Historical exchange rate movements, therefore, contained limited and period-dependent predictive information rather than providing a stable basis for forecasting future movements. The findings highlight the importance of assessing foreign exchange market efficiency across different economic conditions and statistical horizons.

Keywords: Chinese yuan, United States dollar, exchange rate, weak-form efficiency, random walk, COVID-19

INTRODUCTION

China has emerged as the world's second-largest economy after the United States and has become one of the most important participants in global trade (Ajami, 2019). Given the economic size and extensive trade activities of both countries, developments in the relationship between China and the United States have significant implications for the global economy. Their combined economies account for a substantial share of global output, while their exports represent a considerable proportion of total world exports (Molnar & Viktor, 2023). Consequently, disruptions to economic and trade relations between the two countries may have wider effects on international trade, investment, production networks, and financial markets.

Trade tensions between China and the United States intensified following the introduction of additional tariffs in 2018. These measures affected bilateral trade relations and generated consequences for both economies as well as their trading partners. Bekkers and Schroeter (2020) reported that the trade conflict resulted in a considerable reduction in trade between China and the United States. Similarly, Yang et al. (2025) found that the tariffs imposed during the trade war significantly reduced Chinese exports to the United States. Zhang (2024) further noted that the trade conflict had adversely affected the relationship between the two countries since 2018. These findings demonstrate that the bilateral economic relationship is influenced not only by trade policies but also by the broader financial and economic conditions affecting cross-border transactions.

One important factor influencing bilateral trade is the movement of the nominal exchange rate between the Chinese yuan and the United States dollar. Exchange rate fluctuations affect the domestic currency value of exports and imports and influence the costs, revenues, and financial risks faced by exporters, importers, investors, and financial institutions. The behaviour of the CNY and USD exchange rate is therefore relevant to market participants involved in transactions between the two countries. In particular, the degree of exchange rate predictability may affect the timing of currency conversion, hedging decisions, and the management of exchange rate exposure.

The weak-form Efficient Market Hypothesis provides an appropriate framework for evaluating whether historical exchange rate movements can be used to predict future movements. According to Fama (1970, 1991), a market is weak-form efficient when current prices fully reflect all information contained in past prices. Under this condition, historical price movements should not provide a systematic basis for forecasting future prices. When applied to the foreign exchange market, weak form efficiency implies that past exchange rate movements should not consistently predict subsequent changes in the exchange rate.

Evidence of predictability may indicate that historical information has not been incorporated fully or immediately into exchange rate movements. Nevertheless, statistical predictability does not necessarily imply that traders can earn abnormal profits because transaction costs, market risks, institutional restrictions, and policy intervention may limit the practical benefits of such information. The assessment of weak form efficiency therefore provides evidence on the informational behaviour of the exchange rate rather than a direct measure of trading profitability or fairness.

Previous studies involving the CNY and USD exchange rate have focused mainly on forecasting methods. Cai et al. (2012) applied a functional coefficient model to estimate the conditional mean and a GARCH model to estimate conditional volatility. Their findings suggested that government policy contained predictive information for the USD and CNY exchange rate. Zhang (2024) used neural network and long short-term memory models to forecast the CNY and USD exchange rate and found differences in the exchange rate patterns generated by the two approaches. Samambgwa and Musora (2025) compared a nonlinear autoregressive neural network model with a seasonal autoregressive integrated moving average model and reported that the neural network model produced more accurate forecasts.

Although these studies demonstrate that the CNY and USD exchange rate can be analysed using different forecasting techniques, forecasting accuracy is not equivalent to a formal assessment of weak-form market efficiency. Forecasting studies generally evaluate the ability of a model to reproduce or predict exchange rate movements, whereas weak form efficiency tests determine whether historical exchange rate information contains systematic predictive content. This distinction is important because a forecasting model may produce relatively accurate predictions without necessarily establishing persistent market inefficiency.

Despite the economic importance of the relationship between China and the United States, limited attention has been given to the weak form efficiency of their bilateral nominal exchange rate. Existing discussions have concentrated primarily on trade tensions and exchange rate forecasting, while less emphasis has been placed on whether the informational efficiency of the exchange rate changes under different economic conditions. This issue is particularly relevant because major shocks may affect the speed at which information is incorporated into foreign exchange markets.

The COVID-19 pandemic provides an appropriate setting for examining whether exchange rate efficiency changes over time. Evidence from ASEAN financial markets indicates that the pandemic altered market linkages across different time horizons, reinforcing the importance of distinguishing between normal and crisis periods when examining financial market behaviour (Lee et al., 2022). The pandemic generated substantial uncertainty, disrupted international trade and financial flows, and altered the economic environment in which currency markets operated. Comparing the periods before, during, and after the pandemic may therefore reveal whether the predictability of the CNY and USD exchange rate remained stable or changed in response to a major global disruption.

Accordingly, this study aims to assess the weak-form Efficient Market Hypothesis for the nominal exchange rate between the Chinese yuan and the United States dollar during the periods before, during, and after the COVID-19 pandemic. By comparing these periods, the study seeks to determine whether historical exchange rate movements contain information that can be used to predict subsequent movements and whether the degree of market efficiency changes across different economic conditions. The findings may provide useful evidence for traders, firms involved in international transactions, financial institutions, and policymakers concerned with exchange rate behaviour and financial market development.

LITERATURE REVIEW

The Efficient Market Hypothesis provides the theoretical basis for examining whether historical price information can be used to predict future market movements. Under weak form efficiency, current prices fully incorporate the information contained in past prices and returns. Historical price patterns should therefore offer no systematic basis for predicting subsequent price changes or consistently obtaining abnormal returns (Fama, 1970, 1991). When this proposition is applied to foreign exchange markets, an exchange rate is considered weak-form efficient when its past movements do not contain systematic information about future movements.

Existing studies involving the exchange rate between the Chinese yuan and the United States dollar have concentrated largely on forecasting rather than directly testing market efficiency. Cai et al. (2012), Zhang (2024), and Samambgwa and Musora (2025) applied different statistical and computational approaches to predict the CNY and USD exchange rate. Collectively, these studies demonstrate that exchange rate movements can be modelled through conditional mean and volatility specifications, conventional time series techniques, and artificial intelligence methods. However, their primary purpose was to compare forecasting performance rather than determine whether historical exchange rate information was incorporated efficiently into current exchange rate movements.

Cai et al. (2012) combined a functional coefficient model for the conditional mean with a GARCH model for conditional volatility. Their findings indicated that government policy contained predictive information for USD and CNY exchange rate returns. This result suggests that the behaviour of the exchange rate may reflect not only market information but also the influence of policy actions. Such an interpretation is especially relevant to the Chinese currency because its exchange rate operates within an institutional environment in which the authorities retain an important role. The importance of policy influence is also evident in emerging market exchange rate systems. Kuncoro and Pinjaman (2026) showed that foreign exchange market intervention remains relevant under an inflation targeting framework, suggesting that observed currency movements may reflect an interaction between market information and policy actions.

More recent forecasting studies have increasingly adopted artificial intelligence and nonlinear modelling techniques. Zhang (2024) employed a neural network model and a long short-term memory model to forecast the CNY and USD exchange rate. The two methods produced different exchange rate patterns, with the neural network estimates indicating a peak around the middle of 2022, while the long short-term memory model generated a more stable movement. Samambgwa and Musora (2025) similarly compared a nonlinear autoregressive neural network model with a seasonal autoregressive integrated moving average model. Their results showed that the nonlinear autoregressive neural network produced more accurate forecasts than the seasonal model.

Evidence from currencies outside the CNY and USD market also supports the growing use of artificial intelligence in exchange rate forecasting. Tsuji (2025) compared random forest and gradient boosting approaches in predicting the exchange rates of four European currencies. The random forest approach recorded greater predictive accuracy than the gradient boosting approach. Together, these studies indicate that nonlinear and machine learning models may identify patterns that are not captured adequately by conventional linear specifications. Nevertheless, greater forecasting accuracy does not by itself establish market inefficiency. A model may generate reasonably accurate forecasts without demonstrating that historical exchange rate information provides a persistent and economically exploitable source of predictability.

Another strand of the literature examines how crises and unexpected shocks affect exchange rate behaviour. Derbali (2025) investigated the dynamics of the USD and CNY exchange rate during economic crises and found that its correlation became stronger and more unstable during periods of disruption. This finding indicates that exchange rate relationships may not remain constant across different economic conditions. Major shocks can alter market expectations, policy responses, capital movements, and the transmission of information. Consequently, an efficiency assessment conducted over a single full sample may conceal important differences between normal and crisis periods.

Studies that directly assess foreign exchange market efficiency provide further evidence that efficiency may vary across currencies, markets, and periods (Wong et al., 2023). Rapp and Sharma (1999) examined the relationship between spot and forward exchange rates among the Group of Seven countries. The absence of significant co-movement between these rates was interpreted as evidence supporting foreign exchange market efficiency. Their findings indicate that the relationship between current and expected exchange rates can provide useful information about whether market prices incorporate available information efficiently.

In contrast, Czech and Waszkowski (2012) found evidence of inefficiency in the USD and euro foreign exchange markets. Their study assessed semi-strong market efficiency using the uncovered interest rate parity framework. Although semi-strong efficiency differs from weak-form efficiency, their findings demonstrate that efficiency conclusions may depend on the information set, theoretical condition, and empirical method used in the analysis. This also suggests that market efficiency should not be treated as a universal and permanent characteristic of a currency market.

Recent evidence from the Malaysian foreign exchange market further illustrates the time-varying nature of weak-form efficiency. Kok et al. (2025) applied the runs test, variance ratio test, and Ljung-Box Q test to evaluate the predictability of the MYR and USD nominal exchange rates. Their results indicated weak form inefficiency during the period before COVID 19 but weak form efficiency during the period after COVID 19. The difference across periods suggests that market efficiency may change following major disruptions as market participants, institutions, and information processing mechanisms adjust to new economic conditions.

Pinjaman et al. (2025) extended the examination of exchange rate efficiency by analysing the Malaysian ringgit against selected ASEAN currencies during the periods before, during, and after the COVID-19 pandemic. Based on the unit root tests employed in the study, the selected exchange rates were found to be consistent with weak form efficiency. Considered together with the findings of Kok et al. (2025), this evidence shows that efficiency may differ according to the currency pair, sample period, and empirical test. The results also support the importance of analysing separate subperiods rather than assuming that exchange rate behaviour remains unchanged throughout the sample.

The reviewed literature therefore reveals two main patterns. First, studies of the CNY and USD exchange rate have concentrated predominantly on forecasting accuracy, nonlinear modelling, and crisis-related movements. These studies offer useful evidence concerning predictability but do not directly provide a comprehensive test of the weak-form Efficient Market Hypothesis. Second, studies that explicitly examine foreign exchange market efficiency show that the findings vary across currency pairs, methodological approaches, and economic periods. In particular, the evidence surrounding the COVID-19 pandemic suggests that market efficiency may evolve in response to major external shocks.

Despite the growing literature on exchange rate forecasting and foreign exchange market efficiency, limited evidence directly compares the weak form efficiency of the bilateral CNY and USD nominal exchange rates across the periods before, during, and after the COVID-19 pandemic. Existing CNY and USD studies have focused mainly on the performance of forecasting models, while efficiency studies have concentrated on other currency markets. This leaves uncertainty regarding whether the historical movements of the CNY and USD exchange rate contain systematic predictive information and whether its efficiency changes under different economic conditions. The present study addresses this gap by assessing weak-form efficiency separately across the three pandemic-related periods.

DATA AND METHODOLOGY

Data

This study uses daily observations of the nominal exchange rate between the Chinese yuan renminbi and the United States dollar from 2 January 2015 to 31 December 2025. The series was obtained from Federal Reserve Economic Data and is identified by the code DEXCHUS (Board of Governors of the Federal Reserve System, 2026). It is quoted as Chinese yuan per United States dollar. Therefore, an increase in the exchange rate indicates a depreciation of the yuan, while a decrease indicates an appreciation.

The sample contains 2,748 valid business day observations. It is divided into three periods. The pre-COVID-19 period covers 2 January 2015 to 10 March 2020. The COVID-19 period covers 11 March 2020 to 5 May 2023. These dates correspond to the WHO characterisation of COVID 19 as a pandemic and its announcement that COVID 19 no longer constituted a public health emergency of international concern (World Health Organization, 2020, 2023).

Table 1: Variables

Variable	Description	Source
USD/CNY	Daily nominal exchange rate expressed as Chinese yuan per United States dollar	Board of Governors of the Federal Reserve System through Federal Reserve Economic Data
Log exchange rate	Natural logarithm of the daily USD/CNY exchange rate	Authors' calculation based on Federal Reserve data
Exchange rate return	Daily percentage logarithmic return	Authors' calculation based on Federal Reserve data
Pandemic period	Classification into pre COVID 19, COVID 19, and post COVID 19 periods	World Health Organization

Weekends, public holidays, and observations reported as unavailable are not interpolated. Returns are calculated using consecutive available business day observations. For the subperiod analysis, the return calculation is restarted at the beginning of each period to avoid calculating returns across two different periods.

Method of Analysis

The analysis is conducted for the full sample and separately for the pre-COVID-19, COVID-19, and post-COVID-19 periods. Descriptive statistics are first calculated for the exchange rate return series, including the mean, standard deviation, minimum, maximum, skewness, and kurtosis. These statistics provide an initial understanding of the distribution and volatility of exchange rate movements across the three periods.

Weak-form market efficiency is subsequently examined using the runs test, variance ratio test, and Ljung-Box Q test. The tests assess different characteristics of randomness and serial dependence. Using several tests reduces reliance on a single statistical procedure and provides a more comprehensive assessment of whether historical exchange rate movements contain information that can predict subsequent movements.

The three tests differ in their sensitivity to departures from the random walk. The runs test may have relatively low power against some forms of dependence, while the variance ratio and Ljung Box Q tests are more sensitive to serial correlation at the selected horizons. The heteroskedasticity robust variance ratio test is used to reduce the influence of changing volatility. Differences across the test results are therefore interpreted as reflecting their distinct statistical properties rather than as necessarily contradictory evidence.

Runs Test

The runs test is a nonparametric procedure used to determine whether successive exchange rate returns occur randomly. Each return is classified as being above or below the median return. A run refers to a continuous sequence of observations belonging to the same category. The null and alternative hypotheses are expressed as follows:

$$H_0: Exchange\ rate\ returns\ occur\ randomly$$

$$H_1: Exchange\ rate\ returns\ do\ not\ occur\ randomly$$

$$E(R) = [2n_1n_2 / (n_1 + n_2)] + 1$$

$$Z = [R - E(R)] / \sqrt{Var(R)}$$

Where n_1 and n_2 represent the numbers of observations above and below the median, while R represents the observed number of runs. Failure to reject the null hypothesis indicates that the sequence of returns is random and is therefore consistent with weak form efficiency. Rejection of the null hypothesis indicates that the return sequence contains systematic patterns. The runs test is distribution-free and does not require exchange rate returns to follow a normal distribution (Wald & Wolfowitz, 1940).

Variance Ratio Test

The variance ratio test examines whether the variance of exchange rate changes increases proportionately with the length of the observation interval. Under a random walk, the variance of a return measured over q periods should be equal to q times the variance of a one-period return. The variance ratio is expressed as:

$$VR(q) = Var(r_t + r_{t-1} + \cdots + r_{t-}q_{+1}) / [q\, Var(r_t)]$$

$$H_0: VR(q) = 1$$

$$H_1: VR(q) \neq 1$$

Where q represents the selected holding period. A variance ratio greater than one indicates positive serial dependence, while a value below one indicates negative serial dependence. This study applies the heteroskedasticity-robust Lo and MacKinlay test at holding periods of 2, 5, 10, and 20 business days. Failure to reject the null hypothesis supports the random walk condition, while rejection provides evidence that past exchange rate movements contain predictive information (Lo & MacKinlay, 1988).

Ljung Box Q Test

The Ljung Box Q test examines whether a group of return autocorrelations is jointly equal to zero. The test statistic is calculated as:

$$Q(m) = n(n + 2)\, \Sigma^{m}_{k=1} [\hat{\rho}_k{}^2 / (n - k)]$$

$$H_0: \rho_1 = \rho_2 = \cdots = \rho_m = 0$$

$$H_1: At\ least\ one\ autocorrelation\ is\ not\ equal\ to\ zero$$

Where n denotes the number of observations, $\hat{\rho}_k$ represents the sample autocorrelation at lag k, and m is the maximum lag included in the test. The test is performed at lags 5, 10, and 20 to capture dependence over approximately one week, two weeks, and one trading month. Failure to reject the null hypothesis indicates that the returns are jointly uncorrelated and supports weak form efficiency. A significant Q statistic suggests that past returns contain information associated with future returns (Ljung & Box, 1978).

All hypotheses are evaluated at the 5 percent significance level. No single test is treated as conclusive because each procedure captures a different feature of exchange rate behaviour. Evidence of weak form efficiency is supported when the tests consistently fail to reject randomness and serial independence. Consistent rejection across the tests indicates weak form inefficiency. Where the findings differ between tests or horizons, the results are interpreted as mixed evidence rather than being assigned an absolute efficiency classification.

ESTIMATED RESULTS

Descriptive Statistics

Table 2 presents the descriptive statistics for the daily logarithmic returns of the USD/CNY exchange rate. The mean return was close to zero across all periods, indicating that the average daily movement of the exchange rate was relatively small. The pre-COVID-19 period recorded the highest positive mean return of 0.0088 percent, while the COVID-19 period produced a slightly negative mean return of 0.0009 percent.

Table 2: Descriptive Statistics of Daily USD/CNY Returns

Period	Observations	Mean	Maximum	Minimum	Standard deviation	Skewness	Kurtosis	Jarque Bera
Full sample	2,747	0.0044	1.8161	−1.5854	0.2509	0.0512	8.7812	3,809.9291***
Pre COVID 19	1,295	0.0088	1.8161	−1.2417	0.2380	0.6606	10.4557	3,066.6106***
During COVID 19	788	−0.0009	1.0584	−1.5854	0.3019	−0.3355	6.5180	414.2000***
Post COVID 19	662	0.0018	1.0292	−1.1677	0.2051	−0.2950	8.1109	716.7266***

*Note. Returns are expressed in percentage terms. *** indicates significance at the 1 percent level.*

Exchange rate volatility was highest during the COVID-19 period, as reflected by the standard deviation of 0.3019 percent. This value exceeded the standard deviations recorded before and after the pandemic. The finding indicates that daily movements in the USD/CNY exchange rate became more pronounced during the global health crisis. Volatility subsequently declined to 0.2051 per cent in the post-COVID-19 period.

The return distributions were positively skewed before COVID-19 but negatively skewed during and after the pandemic. Kurtosis exceeded the normal distribution benchmark of three in every period, indicating that the return series exhibited heavy tails and a greater occurrence of extreme observations. The Jarque-Bera statistics were significant at the 1 percent level across all samples. Hence, the null hypothesis of normality was rejected.

Runs Test Results

The runs test examines whether successive positive and negative exchange rate returns occur randomly. The null hypothesis states that the return sequence is random and therefore consistent with weak form efficiency.

Table 3: Runs Test Results

Period	Observed runs	Expected runs	Z statistic	p value	Decision
Full sample	1,354	1,364.62	−0.4082	0.6831	$Fail\ to\ reject\ (H_0)$
Pre COVID 19	649	644.08	0.2755	0.7830	Fail to reject (H_0)

During COVID 19	395	394.50	0.0355	0.9717	Fail to reject (H_0)
Post COVID 19	330	332.00	−0.1556	0.8764	Fail to reject (H_0)

The p-values exceeded the 5 percent significance level for the full sample and all three subperiods. The null hypothesis of randomness therefore cannot be rejected. The observed numbers of runs were also close to their expected values, indicating an absence of persistent directional patterns in the daily returns.

Based on the runs test, past changes in the USD/CNY exchange rate did not provide a systematic indication of whether the following change would be positive or negative. The results are therefore consistent with weak-form efficiency before, during, and after the COVID-19 pandemic.

Variance Ratio Test Results

The variance ratio test evaluates whether the variance of exchange rate changes increases proportionately with the holding period. Under the random walk hypothesis, the variance ratio should not differ significantly from one.

Table 4: Heteroskedasticity Robust Variance Ratio Test Results

Period	Holding period	Variance ratio	Z statistic	p value
Full sample	2	0.9820	−0.6243	0.5324
	5	1.0302	0.5061	0.6128
	10	1.1281	1.4609	0.1440
	20	1.3061	2.4634	0.0138**
Pre COVID 19	2	0.9961	−0.0933	0.9256
	5	1.0921	1.1043	0.2695
	10	1.2124	1.8197	0.0688
	20	1.3955	2.4829	0.0130**
During COVID 19	2	0.9701	−0.5891	0.5558
	5	1.0109	0.1028	0.9181
	10	1.0758	0.4729	0.6363
	20	1.2884	1.2410	0.2146
Post COVID 19	2	0.9616	−0.7158	0.4741
	5	0.9112	−0.7530	0.4514
	10	1.0023	0.0133	0.9894
	20	1.1002	0.4154	0.6778

*Note: ** indicates significance at the 5 percent level.*

For the full sample, the random walk hypothesis could not be rejected at the holding periods of 2, 5, and 10 business days. However, the variance ratio at the 20-day holding period was 1.3061 and statistically significant at the 5 percent level. This result indicates positive serial dependence over the longer horizon.

A similar pattern was identified during the pre-COVID-19 period. The random walk hypothesis was not rejected at the shorter holding periods, although the variance ratio of 1.3955 at the 20-day horizon was statistically significant. Exchange rate movements before the pandemic therefore exhibited some degree of persistence over approximately one trading month.

During the COVID-19 period, none of the variance ratios differed significantly from one. The p values ranged from 0.2146 to 0.9181, providing no evidence against the random walk hypothesis at any of the tested horizons. The post-COVID-19 period produced a similar result, with all p-values exceeding the 5 percent significance level.

The variance ratio findings consequently provide stronger support for weak-form efficiency during and after COVID-19. In contrast, the full sample and pre-COVID-19 period display limited evidence of inefficiency at the longest holding period.

Ljung Box Q Test Results

The Ljung Box Q test examines whether the autocorrelations of the exchange rate returns are jointly equal to zero. Rejection of the null hypothesis indicates the presence of serial correlation and suggests that past returns contain information associated with subsequent returns.

Table 5: Ljung Box Q Test Results

Period	Lag	Q statistic	p value	Decision
Full sample	5	14.7611	0.0114	Reject (H_0)
	10	17.8948	0.0568	Fail to reject (H_0)
	20	42.2900	0.0025	Reject (H_0)
Pre COVID 19	5	6.8778	0.2299	Fail to reject (H_0)
	10	10.1976	0.4233	Fail to reject (H_0)
	20	21.2714	0.3813	Fail to reject (H_0)
During COVID 19	5	6.2153	0.2858	Fail to reject (H_0)
	10	8.6387	0.5667	Fail to reject (H_0)
	20	32.0874	0.0424	Reject (H_0)
Post COVID 19	5	18.3975	0.0025	Reject (H_0)
	10	27.5898	0.0021	Reject (H_0)
	20	43.8692	0.0016	Reject (H_0)

The full sample results reject the absence of serial correlation at lags 5 and 20, although the null hypothesis cannot be rejected at lag 10. This pattern indicates that serial dependence is present at selected horizons rather than consistently across all lags.

For the pre-COVID-19 period, the null hypothesis cannot be rejected at any of the tested lags. The p values ranged from 0.2299 to 0.4233, suggesting that past exchange rate returns were not jointly correlated with subsequent returns over the selected horizons. These findings support weak form efficiency before the pandemic.

During COVID-19, the test did not identify significant serial correlation at lags 5 and 10. The null hypothesis was rejected only at lag 20, with a p value of 0.0424. Hence, the evidence of dependence during the pandemic is confined to the longer lag structure.

A different result emerged after COVID-19. The null hypothesis was rejected at lags 5, 10, and 20, with all p-values below the 1 percent level. The post-COVID-19 return series, therefore, contained statistically significant linear serial correlation across all examined lag lengths.

Overall Assessment of Weak Form Efficiency

Table 6 summarises the findings from the three tests. The evidence does not support an absolute classification of the USD/CNY exchange rate as either consistently efficient or consistently inefficient throughout the study period.

Table 6: Summary of Weak Form Efficiency Findings

Period	Runs test	Variance ratio test	Ljung Box test	Overall assessment
Full sample	Supports randomness	Rejection only at 20 days	Rejection at lags 5 and 20	Mixed evidence
Pre COVID 19	Supports randomness	Rejection only at 20 days	No rejection	Predominantly consistent with efficiency
During COVID 19	Supports randomness	No rejection	Rejection only at lag 20	Predominantly consistent with efficiency
Post COVID 19	Supports randomness	No rejection	Rejection at all lags	Mixed evidence

Before COVID-19, the runs test and Ljung-Box Q test supported randomness and serial independence. Only the 20-day variance ratio rejected the random walk hypothesis. The pre-COVID-19 findings are therefore predominantly consistent with weak-form efficiency, although some longer-horizon persistence was present. The longer horizon dependence observed before COVID-19 is broadly consistent with Kok et al. (2025), who found evidence of predictability in the pre-pandemic MYR/USD exchange rate. Nevertheless, the present results are less conclusive because only the 20-day variance ratio rejected the random walk hypothesis, while the runs and Ljung-Box tests generally supported randomness and serial independence.

During COVID-19, the runs test and variance ratio test provided no evidence against weak-form efficiency. The Ljung Box Q test detected serial correlation only at lag 20. Among the three subperiods, the COVID-19 period provides the most consistent evidence that daily USD/CNY movements followed a random process, although limited longer-lag dependence remained.

The post-COVID-19 findings are less conclusive. The runs test and variance ratio test continued to support randomness and the random walk condition. In contrast, the Ljung Box Q test detected significant serial correlation at every tested lag. This divergence suggests that the post-pandemic returns contained linear dependence, but the dependence did not generate a consistent directional sequence or significant variance ratio departure.

The variation in efficiency across periods is consistent with the broader ASEAN evidence reported by Pinjaman et al. (2025, 2026). These studies indicate that exchange rate efficiency is sensitive to the currency pair, period, data frequency, and testing procedure. However, the present post-COVID-19 result differs from Kok et al. (2025), who reported stronger evidence of post-pandemic efficiency for the MYR/USD exchange rate. This difference suggests that market normalisation after COVID-19 did not occur uniformly across Asian currency markets.

The findings should also be interpreted within China's managed floating exchange rate system, where market forces operate alongside policy guidance by the People's Bank of China (PBOC). The serial correlation detected after COVID-19 may therefore reflect policy intervention or communication as well as market behaviour. Since this study does not directly measure PBOC actions, the post-COVID-19 results should not be interpreted solely as evidence of market inefficiency.

CONCLUSION AND POLICY RECOMMENDATIONS

This study examined the weak form efficiency of the nominal exchange rate between the Chinese yuan and the United States dollar using daily observations from 2 January 2015 to 31 December 2025. The analysis covered the full sample and three separate periods comprising the period before COVID-19, the COVID-19 period, and the period after COVID-19. Weak-form efficiency was assessed using the runs test, the heteroskedasticity-robust variance ratio test, and the Ljung-Box Q test.

The findings show that the efficiency of the USD/CNY exchange rate was not uniform across tests and periods. The runs test failed to reject randomness for the full sample and all three subperiods. This result indicates that the sequence of positive and negative exchange rate returns did not display a systematic directional pattern. The variance ratio test also supported the random walk condition at most holding periods. However, the hypothesis was rejected at the 20-day horizon for the full sample and the period before COVID-19, indicating some positive serial dependence over the longer horizon.

The Ljung Box Q test produced less consistent evidence. No significant serial correlation was detected before COVID-19. During the pandemic, serial dependence appeared only at lag 20. In contrast, the post-COVID-19 period recorded significant serial correlation at lags 5, 10, and 20. These results suggest that the return series contained linear dependence after the pandemic, although this dependence was not strong enough to cause rejection under the runs test or variance ratio test.

Taken together, the evidence does not support an absolute conclusion that the USD/CNY market was either fully efficient or consistently inefficient. The findings are predominantly consistent with weak-form efficiency before and during COVID-19, although some longer-horizon dependence was observed. The post-COVID-19 period provides mixed evidence because the tests do not produce a common conclusion. Historical exchange rate movements, therefore, appear to contain limited and period-dependent predictive information rather than offering a stable basis for forecasting future movements.

The findings have several practical implications. Traders and firms involved in transactions between China and the United States should not rely solely on historical exchange rate patterns when making currency conversion or hedging decisions. Although some serial dependence was detected, the pattern was neither consistent across tests nor stable across periods. Exchange rate risk management should therefore incorporate current economic information, policy developments, market conditions, and appropriate hedging instruments rather than depending only on past price movements.

Financial institutions and policymakers should continue to monitor the quality and speed of information transmission in the foreign exchange market. The significant serial correlation identified after COVID-19 may reflect temporary market adjustment, changes in liquidity, shifts in policy expectations, or other structural factors. Greater transparency in policy communication and timely dissemination of market information may assist participants in forming expectations and reduce the possibility of persistent information-related distortions.

The study is subject to several limitations. It examines only the onshore USD/CNY nominal exchange rate and does not compare the results with the offshore yuan market. The empirical assessment is also based on three statistical tests that focus mainly on linear dependence, randomness, and the random walk condition. These methods may not capture nonlinear dependence, structural breaks, or changes in efficiency within each subperiod. Although the post COVID 19 period contains 662 observations, its shorter duration may make the results more sensitive to temporary market conditions. The findings may therefore not represent the longer term behaviour of the USD/CNY exchange rate. In addition, statistical predictability does not necessarily imply that profitable trading opportunities exist after accounting for transaction costs, risk, and market restrictions.

Future studies may extend the analysis by comparing the onshore CNY and offshore CNH markets. Rolling window and time-varying methods may also be applied to identify gradual changes in efficiency rather than relying only on fixed subperiods. Further analysis could incorporate nonlinear dependence tests, structural break procedures, and measures of economic profitability after transaction costs. These extensions would provide a more comprehensive understanding of how institutional arrangements, policy intervention, and major economic shocks influence the efficiency of the Chinese foreign exchange market.

REFERENCES

1. Ajami, R.A. (2019). US Trading Partners: Uncertainty and Challenges. *Journal of Asia-Pacific Business*, 20(2), 79-81.
2. Bekkers, E. and Schroeter, S. (2020). An Economic Analysis of US-China Trade Conflict. *Staff Working Paper Economic Research and Statistics Division*, 2020-04.
3. Board of Governors of the Federal Reserve System. (2026). *Chinese yuan renminbi to U.S. dollar spot exchange rate* [DEXCHUS]. FRED, Federal Reserve Bank of St. Louis. Retrieved July 11, 2026.
4. Cai, Z., Chen, L. and Fang, Y. (2012). A New Forecasting Model for USD/CNY Exchange Rate. *Studies in Nonlinear Dynamics & Econometrics*, 16(3), 1-18.
5. Czech, K.A. and Waszkowski, A. (2012). Foreign Exchange Market Efficiency: Empirical Results for the USD/EUR Market. *E-Finance: Financial Internet Quarterly*, 8(3), 1-9.
6. Derbali, A.M.S. (2025). USD/CNY Exchange Rate Correlation: What Dynamic Mechanism During Unexpected Shocks? *Economics Open*, 1, 1-13.
7. Fama, E. F. (1970). Efficient capital markets: A review of theory and empirical work. *The Journal of Finance*, 25(2), 383–417.
8. Fama, E. F. (1991). Efficient capital markets: II. *The Journal of Finance, 46*(5), 1575–1617.
9. Kok, S. C., Pinjaman, S., and Geetha, C. (2025). The predictability of the Ringgit Malaysia against the United States dollar exchange rate. *International Journal of Research and Innovation in Social Science, 9*(15), 1018–1026. https://doi.org/10.47772/IJRISS.2025.915EC00727
10. Kuncoro, H., and Pinjaman, S. (2026). Market intervention in the inflation targeting regime: The case of Indonesia. *Quantitative Finance and Economics, 10*(1), 41–62. https://doi.org/10.3934/QFE.2026003
11. Lee, Z. H., Wong, H. T., Pinjaman, S., and Mansur, K. (2022). Co movement of COVID 19, the S&P 500 and stock markets in ASEAN: A wavelet coherence analysis. *International Journal of Economics and Management, 16*(1), 119–134.
12. Ljung, G. M., & Box, G. E. P. (1978). On a measure of lack of fit in time series models. Biometrika, 65(2), 297–303.
13. Lo, A. W., & MacKinlay, A. C. (1988). Stock market prices do not follow random walks: Evidence from a simple specification test. The Review of Financial Studies, 1(1), 41–66.
14. Molnar, A. and Viktor, P. (2023). China's Impact on the US Dollar Exchange Rate. *The Eurasia Proceedings of Educational & Social Sciences*, 32, 71-79.
15. Pinjaman, S., Kok, S. C., and Janin, Y. (2025). Market efficiency of the Malaysian ringgit against selected ASEAN currency exchange rates for pre, during, and post COVID 19 pandemic. *International Journal of Research and Innovation in Social Science, 9*(15), 1451–1460.
16. Pinjaman, S., Kok, S. C., Aralas, S., Basuki, A. T., Hadi, S., Nugraha, P., and Darsono, S. N. A. C. (2026). Pandemic shocks and time varying weak form efficiency in ASEAN foreign exchange markets: An empirical investigation. *Optimum: Jurnal Ekonomi dan Pembangunan, 16*(1), 138–147. https://doi.org/10.12928/optimum.v16i1.15560

17. Rapp, T.A. and Sharma, S.C. (1999). Exchange rate market efficiency: across and within countries. *Journal of Economics and Business*, 51(5), 423-439.
18. Samambgwa, H. and Musora, T. (2025). Modelling and Forecasting the United States Dollar-Chinese Yuan Exchange Rate Nonlinear Autoregressive Neural Network vs Seasonal Autoregressive Integrated Moving Average. *World Journal of Advanced Engineering Technology and Sciences*, 17(3), 481-490.
19. Tsuji, C. (2025). Forecasting Exchange Rates with Artificial Intelligence: A Study of European Currencies. *International Business Research*, 18(5), 24-34.
20. Wald, A., & Wolfowitz, J. (1940). On a test whether two samples are from the same population. The Annals of Mathematical Statistics, 11(2), 147–162.
21. Wong, V. K., Aralas, S., and Pinjaman, S. (2023). Islamic stock price and exchange rate: A wavelet analysis for ASEAN 5. *Global Business and Management Research: An International Journal, 15*(1), 142–148.
22. Yang, T., Lau, W-Y. and Abdul Bahri, E.N. (2025). The Impact of US-China Trade War on China's Exports: Evidence From Difference-in-Differences Model, *SAGE Open*, 1-15.
23. Zhang, X. (2024). The Time Series Forecasting for CNY-USD Exchange Rate. *Highlights in Science, Engineering and Technology*, 88, 948-953.