

Forecasting USD/VND Exchange Rate – An Approach from SARIMA Model

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Abstract—This paper applies the Seasonal Autoregressive Integrated Moving Average (SARIMA) model to forecast the USD/VND exchange rate using daily observations from 1 January 2021 to 31 January 2025. Exchange rate forecasting is critical for monetary stability, international trade, and risk management in emerging economies. The SARIMA approach, by incorporating both autoregressive and seasonal components, effectively captures volatility and temporal dependencies inherent in high-frequency financial data. After systematic model identification and diagnostic testing, the forecasting accuracy was assessed through out-of-sample evaluation. Results show that the experimental prediction for February 2025 achieved strong performance, with a maximum error of only 1.9%. These findings underscore the model's robustness and highlight its potential to support financial decision-making, hedging strategies, and short-term policy adjustments. More broadly, the study confirms that carefully specified univariate time-series models can yield valuable insights into exchange rate dynamics, offering both theoretical relevance and practical implications for Vietnam's macro-financial context.

Keywords—Exchange rate, USD/VND, SARIMA, forecast, macro-financial context..

I. INTRODUCTION

Exchange rates occupy a central position in macroeconomic analysis and international finance, functioning as a nexus through which monetary policy, trade competitiveness, and capital movements are mutually transmitted. As the relative price of one currency expressed in terms of another, the exchange rate affects import and export prices, terms of trade, and the domestic price level; consequently, it is routinely monitored by policymakers, market participants, and multinational firms. It has been widely argued that, in open economies, exchange rate variability can materially alter macroeconomic outcomes by modifying inflationary pressures, reallocating production incentives, and reshaping external debt burdens. Against this backdrop, the accurate short-term forecasting of exchange rates is indispensable for effective macroeconomic management and corporate risk mitigation.

The theoretical literature on exchange rate determination is both deep and diverse. Classical approaches such as Purchasing Power Parity (PPP) and Interest Rate Parity (IRP) provide long-run anchors, whereas asset-pricing and portfolio-balance frameworks emphasize the role of expectations, risk premia, and international capital flows. Empirical investigations have further documented that exchange rate dynamics are frequently characterized by persistence, heteroskedasticity, and episodic regime shifts induced by global shocks or policy interventions. Such stylized facts imply that practical forecasting must reconcile structural economic theory with flexible, data-driven techniques capable of capturing short-run irregularities and seasonal patterns.

A broad array of methodological paradigms has therefore been advanced for exchange rate prediction. Structural macroeconomic models-rooted in fundamental relationships-offer interpretability but may underperform when transient market sentiment or high-frequency noise dominates. Reduced-form econometric methods, including vector

autoregressions and univariate time-series models, trade theoretical structure for empirical adaptability and have been shown to yield competitive short-horizon forecasts. More recently, machine learning and non-linear methods (for example, random forests and recurrent neural networks) have been deployed to exploit complex, non-linear dependencies, albeit sometimes at the expense of interpretability and robustness in small samples.

Within this methodological spectrum, Seasonal Autoregressive Integrated Moving Average (SARIMA) models stand out as particularly well-suited for high-frequency exchange rate data that exhibit recurrent seasonal patterns and serial dependence. The SARIMA framework extends the classic ARIMA specification by incorporating seasonal autoregressive and moving-average components, thereby enabling the model to account for calendar-driven effects (such as end-of-week, end-of-month, or holiday-related adjustments) that commonly appear in daily foreign-exchange series. Model specification typically involves stationarity assessment, appropriate differencing to remove unit roots, and the rigorous examination of autocorrelation and partial-autocorrelation functions; thereafter, parsimonious orders are selected using information criteria such as AIC or BIC and validated through residual diagnostics.

Despite its advantages, the SARIMA approach is not without limitations. Being univariate in its canonical form, it does not directly incorporate observable exogenous drivers—such as interest differentials, commodity price shocks, or macroprudential policy changes—unless extended to ARIMAX formulations. Moreover, its forecasting performance may be compromised in the presence of structural breaks or persistent regime shifts, which require either intervention analysis, time-varying parameterizations, or regime-switching augmentations. Hence, while SARIMA offers computational simplicity and interpretive clarity, careful pre-testing and robustness checks are indispensable.

The present study applies SARIMA modeling to daily USD/VND exchange-rate observations from 1 January 2021 through 31 January 2025, delivering an out-of-sample forecast for February 2025. The USD/VND pair commands particular policy relevance given the dominant role of the US dollar in global transactions and the sensitivity of Vietnam's export-led growth to exchange-rate movements. By demonstrating that a well-specified SARIMA model can achieve high short-term forecasting accuracy-exemplified by a maximum forecast deviation of 1.9% in the experimental window-this research seeks to bridge methodological rigor and policy relevance.

From a policy perspective, reliable short-term exchange-rate forecasts can meaningfully enhance the timing and calibration of foreign-exchange interventions, refine monetary-policy pass-through assessments, and improve corporate hedging strategies. By furnishing empirically grounded, operationally tractable forecasts, the study aspires to support central banks, treasury desks, and exporters in tempering currency-induced uncertainty. In sum, the investigation contributes both to the methodological literature on time-series forecasting in emerging markets and to the pragmatic toolkit available for macro-financial policy formulation.

The paper is structured as follows. The introduction is followed by the literature review of related studies, then the data collection and research methods. The next part of the study is the empirical results together with discussions and the final part is to propose some policy implications towards macro-financial sustainable development in Vietnam in the next time.

II. LITERATURE REVIEW

Pahlavani & Roshan (2015) attempted to compare the forecasting performance of the ARIMA model and hybrid ARMA-GARCH Models by using daily data of the Iran's exchange rate against the U.S. Dollar (IRR/USD) for the period of 20 March 2014 to 20 June 2015. The period of 20 March 2014 to 19 April 2015 was used to build the model while remaining data were used to do out of sample forecasting and check the forecasting ability of the model. All the data were collected from central bank of Iran.

With the same topic, the objective of Abu & Rosbi (2017) was to forecast Bitcoin exchange rate in high volatility environment. Methodology implemented in this study was forecasting using autoregressive integrated moving average (ARIMA). This study performed autocorrelation function (ACF) and partial autocorrelation function (PACF) analysis in determining the parameter of ARIMA model. Result showed the first difference of Bitcoin exchange rate was a stationary data series. The forecast model implemented in this study was ARIMA (2, 1, 2). The findings of this study are important to predict the Bitcoin exchange rate in high volatility environment.

Another related research was carried out by Basnayake & Chandrasekara (2022). The objective of this study was to forecast daily exchange rates in Sri Lanka using Double Seasonal Autoregressive Integrated Moving Average (DSARIMA) and Seasonal Autoregressive Integrated Moving

Average (SARIMA) with Autoregressive Conditional Heteroscedasticity (ARCH)/ Generalized ARCH (GARCH) models. The study collected a few daily exchange rates from the Yahoo finance website in terms of LKR from 1st January 2008 to 28th February 2022. The DSARIMA and SARIMA models were incorporated with the ARCH/ GARCH specifications of normal, skew-normal, student-t and skew-t due to the accurate specification of the proper error distribution led to an increase in the accuracy of the fitted model. The model comparisons were carried out considering different performance measures. The overall results from the actual and fitted graphs and lower error values of the fitted models suggested a SARIMA model for CHF/LKR, a SARIMA model with ARCH/GARCH for USD, EURO, JPY, GBP and AUD against LKR and a DSARIMA model with ARCH/GARCH for CAD and SGD against LKR were suitable to forecast the respective exchange rate.

Continuing with SARIMA model for the case of Nigeria, Mustapha et al. (2021) was aimed at developing a model of exchange rate for Nigeria with higher data points, taking into cognizance its periodic seasonal component and used the estimated model to make forecast. The monthly statistics from Nigeria from January 1981 to December 2018, taken from the Central Bank of Nigeria (CBN) Statistical Bulletin, were used in the study. The seasonal ARIMA model (SARIMA), which is an extension of the autoregressive (AR) and moving average (MA) processes in the well-known Box-Jenkins technique, was used to analyze the data. The study created SARIMA (0,1,1) x (1,1,1)₁₂ from among the competing models based on its AIC and BIC values, using 456 data points.

Considering the case of Turkey, Ganbold et al. (2017) proposed a heightened approach to modeling and forecasting of exchange rate volatility in Turkey. Daily exchange rate data had been taken from 2005-2017 and applied autoregressive conditional heteroskedasticity ARCH and GARCH families (EGARCH, IGARCH, and PARCH) to forecast exchange rate volatility. Moreover, this paper also investigated the monthly data forecasting by applying ARIMA SARIMA along with SVAR technique for next few months. The forecast result of SARIMA and SVAR distributed the same direction of fluctuation in the exchange rate that was declining of the current exchange rate in the future. However, ARIMA's forecast tended to increase and different with two models.

For the case of Vietnam, Ngan (2013) used real foreign exchange rate data from the first day of 2013 to the last day of 2015, the author introduced ARIMA model with four steps to forecast foreign exchange rate between VND/USD in the next twelve months of 2016. After having forecasted foreign exchange data, the author compared them with real foreign exchange rate data to check the suitable level of ARIMA model for forecasting foreign exchange rate in Vietnam and the results showed that ARIMA model is suitable for estimating foreign exchange rate in Vietnam in short-time period. In our paper, we improved the method, instead of using ARIMA model, we tested SARIMA model with updated data of USD/VND.

It has been consistently emphasized in prior empirical investigations that forecasting exchange rate dynamics

necessitates rigorous econometric modelling. Through an extensive review of the literature, it was revealed that the application of the Seasonal Autoregressive Integrated Moving Average (SARIMA) framework to the USD/VND series is not only methodologically justified but also widely acknowledged as a robust approach. Scholars have argued that such models, by capturing seasonal fluctuations and structural persistence, provide more reliable estimations compared to conventional linear specifications.

III. METHODOLOGY AND RESEARCH DATA

This study uses daily time series data of USD/VND from Jan 1st 2021 to Jan 31st 2025, with data of Feb 2025 is for forecasting procedure. The set of data was collected from investing.com.

Formally, the model can be represented as:

$$\Phi_P(L^s)\phi_P(L)(1-L)^d(1-L^s)^Dy_t = \Theta_Q(L^s)\theta_q(L)\varepsilon_t \quad (1)$$

Where $\phi_P(L)$ represents the non-seasonal AR polynomial of order p, $\theta_q(L)$ the non-seasonal MA polynomial of order q, $\Phi_P(L^s)$ the seasonal AR polynomial (here with order P), and $\Theta_Q(L^s)$ the seasonal MA polynomial of order Q with seasonal lag length s. The disturbance term ε_t is assumed to follow a white-noise process.

IV. EMPIRICAL RESULTS

Table I below presents the descriptive statistics of USD/VND, it shows that USD/VND is not normally distributed according to Jarque-Bera test.

TABLE I. Descriptive statistics.

	USD_VND
Mean	23831.88
Median	23520.00
Maximum	25480.00
Minimum	22625.00
Std. Dev.	907.4098
Skewness	0.486195
Kurtosis	1.855342
Jarque-Bera Probability	99.91246 0.000000
Sum	25333289
Sum Sq. Dev.	8.74E+08
Observations	1063

Figure 1 below illustrates the trend of USD/VND fluctuations during the study period.

For time-series data, it should be checked for stationarity. In this study, we check the stationarity based on advanced methods, for example, Augmented Dickey Fuller (ADF) with Intercept, Intercept and trend and without Intercept and trend procedures. Table II below depicts the results of the unit root tests and indicates that USD/VND in this study is stationary in the I(1).

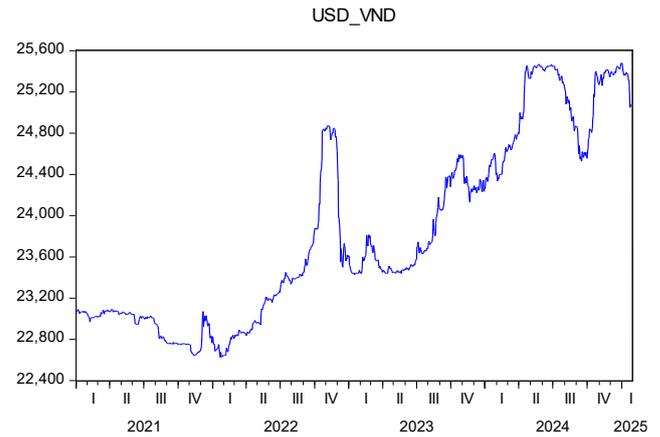


Fig. 1. Line graph of USD/VND

TABLE III. Stationarity test results of USD/VND series.

Include in test equation	Variable	Augmented Dickey-Fuller test statistic
Original time series		
Intercept	USD/VND	- 0.923073
Trend and intercept	USD/VND	- 2.844936
None	USD/VND	0.898981
First difference of original time series		
Intercept	D(USD/VND)	- 12.03797*
Trend and intercept	D(USD/VND)	- 12.03896*
None	D(USD/VND)	- 12.00234*

Note: * denotes variables that are statistically significant at the 1% level.

To evaluate the optimal model in this study, Akaike information criterion value will be used. Theoretically, the traditional way to choose the optimal lag length will affect the SARIMA model, and the selection will follow a number of times with lags descending to zero. Among some estimated SARIMA models, the study can select the one with the smallest Akaike information criterion value. The best model is ARMA(4,2)(2,2).

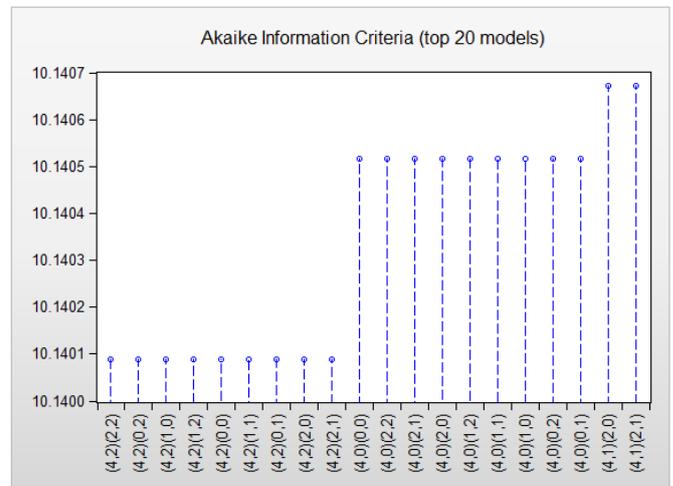


Fig. 2. Selection optimal models

The USD/VND forecast results for February 2025 and comparison with actual data are presented in Table III.

TABLE IIIII. Forecast results and actual data for February 2025.

Time	Actual	Forecast	Error (%)
2/3/2025	25280	25056	0.885397
2/4/2025	25160	25060	0.398452
2/5/2025	25145	25058	0.346499
2/6/2025	25260	25062	0.785283
2/7/2025	25290	25061	0.906005
2/10/2025	25380	25064	1.244034
2/11/2025	25530	25064	1.82463
2/12/2025	25550	25067	1.889089
2/13/2025	25440	25068	1.463317
2/14/2025	25370	25071	1.179944
2/17/2025	25470	25071	1.564981
2/18/2025	25500	25074	1.670156
2/19/2025	25515	25075	1.723996
2/20/2025	25500	25078	1.656235
2/21/2025	25510	25079	1.690047
2/24/2025	25468	25081	1.51851
2/25/2025	25520	25083	1.713859
2/26/2025	25535	25085	1.762653
2/27/2025	25520	25086	1.699147
2/28/2025	25530	25089	1.729061

Table III shows good forecast results, with a maximum error of 1.9%. Figure 3 below clearly illustrates the good forecast results in terms of both trend and value.

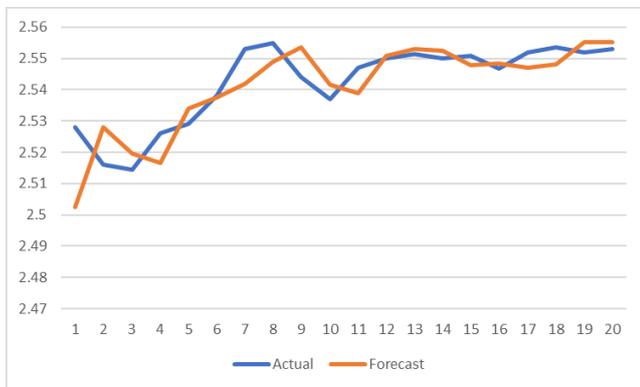


Fig. 3. Forecast results illustration

V. CONCLUSION

The empirical findings of this study demonstrate that the application of the Seasonal Autoregressive Integrated Moving Average (SARIMA) model to forecast the USD/VND exchange rate is both methodologically sound and practically effective. By incorporating autoregressive and moving-average components alongside seasonal adjustments, the SARIMA specification successfully captures the inherent volatility, cyclical fluctuations, and short-term dependencies that characterize high-frequency exchange-rate data. The out-of-sample forecast for February 2025, with a maximum deviation of only 1.9%, confirms the robustness and reliability of the model in providing highly accurate short-term projections. Such predictive precision underscores the model's capacity to generate meaningful insights for both academics and practitioners, especially in the context of an emerging market economy such as Vietnam, where exchange-rate stability is crucial for sustaining export competitiveness, managing inflationary expectations, and maintaining investor confidence. The results therefore reaffirm that univariate time-

series techniques, when rigorously specified and validated, can serve as powerful tools for navigating the complexities of exchange-rate behavior in dynamic and globally integrated financial environments.

Beyond its methodological contribution, the study holds significant implications for macro-financial policy formulation and monetary management in Vietnam. Reliable forecasts of the USD/VND exchange rate can enhance the effectiveness of monetary policy by enabling authorities to anticipate currency pressures and adjust intervention strategies in a timely manner. For financial institutions and multinational corporations, accurate projections provide a valuable basis for hedging decisions, risk assessment, and cross-border investment planning. More broadly, by reducing uncertainty in currency markets, robust forecasting models such as SARIMA contribute to strengthening financial stability, facilitating capital allocation, and sustaining long-term economic growth. In an era of heightened global volatility-characterized by interest rate differentials, capital flow reversals, and geopolitical disruptions-the ability to forecast exchange-rate movements with a reasonable degree of accuracy constitutes an indispensable element of policy resilience. The evidence presented in this study therefore substantiates the role of SARIMA as a credible forecasting tool, not only for academic inquiry but also for policy-oriented applications that directly affect trade balances, inflationary dynamics, and the stability of the Vietnamese dong in international markets.

Nevertheless, the findings also point to several avenues for further research that could enrich the predictive capacity of exchange-rate models. Future studies may extend the univariate SARIMA framework by incorporating exogenous macroeconomic variables-such as interest rate differentials, capital inflows, or commodity prices-within ARIMAX or hybrid modeling approaches, thereby capturing a broader range of determinants influencing exchange-rate dynamics. Moreover, comparative analyses with advanced machine learning and nonlinear models could provide valuable benchmarks to assess relative forecasting performance under conditions of structural breaks or regime shifts. Incorporating high-frequency financial indicators, such as order flow or implied volatility, may further improve responsiveness to market-driven shocks. Such extensions would not only advance methodological innovation but also deepen the understanding of exchange-rate behavior in emerging economies facing increasing integration with global financial markets. By situating the present findings within this broader research agenda, the study highlights that SARIMA constitutes a robust starting point for exchange-rate forecasting, while also encouraging the development of more comprehensive models to strengthen monetary stability and policy effectiveness in Vietnam's evolving financial landscape.

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