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VECM Method as a Prediction Tool for Inflation in Mataram City Based on Exchange Rate Fluctuations

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Abstract: This research is important because inflation is an economic indicator that greatly affects people's purchasing power and the economic stability of a region. Therefore, the purpose of this study is to forecast the inflation of Mataram City for the next five years by considering the influence of fluctuations in the exchange rate of the rupiah against the United States dollar (IDR/USD) using the Vector Error Correction Model (VECM) method. This research is a forecasting experiment that uses annual data on inflation and exchange rates for the period 2014-2023, obtained from the Central Statistics Agency (BPS). The results show that the VECM model is able to capture the long-term relationship between inflation and exchange rates, with inflation predictions for 2024 to 2028 showing a fluctuating pattern, including deflation in 2024 and inflation spikes in 2026 and 2027. The accuracy evaluation shows that the Mean Absolute Percentage Error (MAPE) value for inflation prediction reaches 45.10%, while the exchange rate prediction is more accurate with a MAPE of 1.25%. The implication of the results shows that although the model is quite reliable in predicting the exchange rate, the accuracy of inflation prediction still needs to be improved. Therefore, this result can be an important input for economic policy planners in anticipating future price dynamics and considering other model combinations to improve the accuracy of inflation forecasting.

Keywords: Inflation, Exchange Rate, VECM, Prediction, MAPE, Mataram City, Economic Forecasting

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A. INTRODUCTION

Inflation is one of the important indicators in measuring the economic stability of a region (Hafidz et al., 2023). At the regional level, such as Mataram City, inflation fluctuations can have a direct impact on people's purchasing power, the stability of basic goods prices, and the fiscal and monetary policies implemented by the local government (Heti & Ferdy, 2024). One of the external factors that is often associated with inflation dynamics is the currency exchange rate, especially the Rupiah exchange rate against the United States Dollar (IDR/USD) (Maryani, 2016). Changes in the exchange rate can affect the prices of imported goods and production costs, which are ultimately reflected in the inflation rate. Therefore, a deep understanding of the relationship between exchange rates and inflation is important as a basis for formulating responsive and adaptive economic policies (Rizani et al., 2023).

There are various methods that can be used to analyze the relationship between inflation and exchange rates, especially in the context of time series data such as those available in this

study (Sumaryani, 2019). Commonly used methods include the Autoregressive Integrated Moving Average (ARIMA) model for univariate forecasting, as well as Vector Autoregression (VAR) and Vector Error Correction Model (VECM) to analyze the dynamic relationship between variables that are non-stationary but have a cointegration relationship (Fejriani et al., 2020). In addition, the Generalized Method of Moments (GMM) and Autoregressive Distributed Lag (ARDL) methods can also be used depending on the nature of the data and the purpose of the analysis, such as testing for causality or estimating short and long runs (Adolph, 2016). In contemporary studies, machine learning-based approaches such as Long Short-Term Memory (LSTM) have also started to be used for economic forecasting, although their interpretability remains a challenge. The selection of the appropriate method depends on the characteristics of the data, such as stationarity, the number of observations, and the existence of long-term relationships between variables (Agriculture & Muhammadiyah, 2024). In analyzing the relationship between inflation and exchange rates that are dynamic and mutually influencing, the Vector Error Correction Model (VECM) method is one of the most suitable econometric approaches (Ambarita et al., 2023). VECM is used when the time series data of the analyzed variables are non-stationary but have a cointegration relationship, which indicates the existence of a long-term equilibrium between the variables. The model is not only able to capture short-run dynamics through its autoregressive component, but also accounts for deviations from the long-run equilibrium through the error correction component. Thus, VECM is very effective in studies that aim to understand how exchange rate changes can affect inflation in both the short and long run, as is relevant in the context of a regional economy such as Mataram City.

In research by (Azizah, 2024) forecasting inflation in Indonesia using the VECM method with variables of the Consumer Price Index (CPI), money supply, BI Rate, and Rupiah exchange rate. The results showed that the VECM model has a good level of accuracy with a Mean Absolute Percentage Error (MAPE) value of 10.39%, and identifies the causal relationship between inflation and these variables. Research by (Sinay, 2014) used the VECM model to analyze the long-term and short-term causality relationship between the inflation rate, BI Rate, and the USD exchange rate against the IDR. This study shows that there is a significant causality relationship between these variables, which affects the movement of the Rupiah exchange rate against the US Dollar. And research (Adnan et al., 2024) analyzed the effect of inflation, BI Rate, and money supply on the Rupiah exchange rate in Indonesia using the VECM method. The estimation results show that in the short term, inflation has a positive and significant effect on the Rupiah exchange rate, while in the long term, inflation has a positive but insignificant effect. In the research conducted by Syaharuddin et al. (2025) highlighted the importance of proper parameter configuration, such as the number of neurons, hidden layers, and learning rate, which can significantly improve prediction accuracy. In addition, the combination of optimal techniques with accurate parameter settings is proven to increase efficiency and accuracy in producing better predictions (Hidayanti et al., 2025).

Several previous studies have been conducted to analyze the dynamics of inflation and the macroeconomic factors that influence it, both nationally and regionally, including Mataram City. Research by (Khairunnisa & Syaharuddin, 2022) used the Backpropagation Neural

Network algorithm to forecast inflation in Mataram City based on data from 2011 to 2021. The results show that artificial intelligence-based methods are able to provide a fairly accurate estimate of inflation patterns in the region. Furthermore, (Wira et al., 2024) examined the effect of the tourism sector on inflation in Mataram City and found that an increase in tourism activity contributed significantly to the inflation rate through an increase in aggregate demand for goods and services. Meanwhile, research conducted by students of Universitas Muhammadiyah Mataram (Firdausi, 2020) shows that macroeconomic variables such as interest rates, inflation, and exchange rates have a significant influence on stock returns on the Indonesia Stock Exchange, indicating a structural relationship between economic stability and financial market movements. Other studies have also found that fluctuations in exchange rates and inflation affect property sector stock prices simultaneously, reinforcing the assumption of a long-term link between these macroeconomic variables. Although the majority of these studies have not explicitly applied the VECM model nor specifically examined data for Mataram City, the approach and results obtained provide an important empirical basis for developing inflation prediction models based on the cointegration relationship between inflation and exchange rates at the regional level (Mauliddiyah, 2021).

This study aims to analyze and model the relationship between inflation and the exchange rate of the Rupiah against the United States Dollar (Rp/USD) in Mataram City using the Vector Error Correction Model (VECM) approach. Through this approach, the research is expected to identify the long-run and short-run relationship between the two variables, as well as reveal the adjustment dynamics that occur when there is a deviation from equilibrium conditions. In addition, this research also aims to develop a predictive model that is able to forecast the inflation rate more accurately based on exchange rate movements, so that it can contribute to economic decision making and policy formulation that is more responsive and data-based at the regional level.

B. METHOD

This study aims to analyze and model the relationship between inflation and the exchange rate of the Rupiah against the United States Dollar (Rp/USD) in Mataram City using the Vector Error Correction Model (VECM) approach. Through this approach, the research is expected to identify the long-run and short-run relationship between the two variables, as well as reveal the adjustment dynamics that occur when there is a deviation from equilibrium conditions. In addition, this research also aims to develop a predictive model that is able to forecast the inflation rate more accurately based on exchange rate movements, so that it can contribute to economic decision making and policy formulation that is more responsive and data-based at the regional level.

The research steps are carried out systematically, starting with the collection and preparation of data into a format that can be processed through statistical software such as MATLAB. Next, the stationarity of the data is tested using the Augmented Dickey-Fuller (ADF) method, followed by the Johansen cointegration test to assess the existence of a long-term relationship between variables. If the relationship proves to be significant, then the process continues with determining the optimal lag and estimating the VECM model

manually through algorithm development and programming in MATLAB. The resulting model is used to forecast inflation for the next five years, with the prediction results presented in the form of tables and graphs. To assess the accuracy of the prediction results, accuracy indicators are used in the form of Mean Squared Error (MSE) and Mean Absolute Percentage Error (MAPE), where the lower the value of these two parameters, the higher the accuracy of the model in describing the dynamics of inflation based on exchange rate movements. The general formula of the VECM model is as follows:

$$\Delta Y_t = \Pi Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \, \Delta Y_{t-i} + \mu + \epsilon_t \quad (1)$$

Di mana:

- Y_t is a vector of variables (e.g. inflation and exchange rate)
- ΔY_t is the change (first differencing) of YtY_tYt
- ΠY_{t-1} is the cointegrating relationship (long−run equilibrium)
- Γ_i is the coefficient matrix for the short-run relationship
- μ Constant or intercept, can also be considered as a deterministic trend (if necessary)
- ϵ_t varepsilon_tεt are residuals

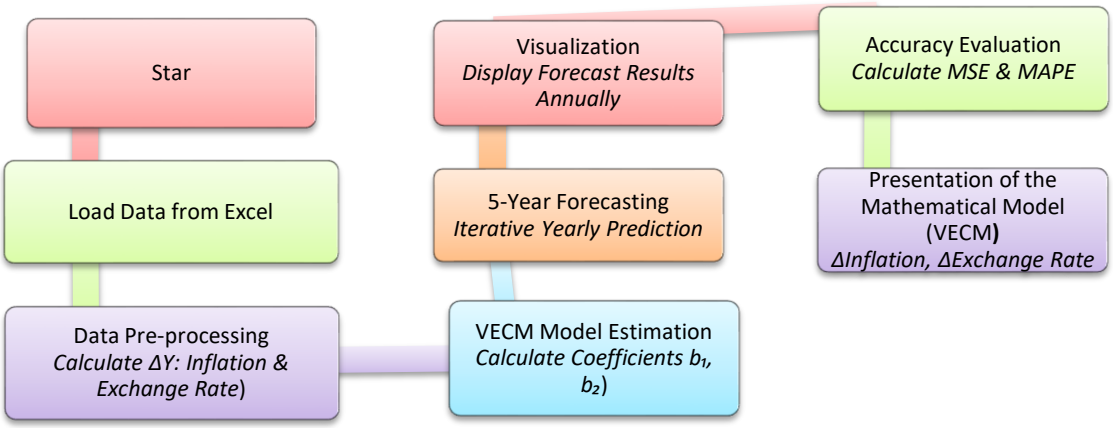

Figure 1. Illustrates The Systematic Flow Of Predicting Inflation Using The Vector Error Correction Model (VECM)

Figure 1 illustrates the systematic flow of predicting inflation using the Vector Error Correction Model (VECM) which consists of nine main steps. The process begins with loading historical data from Excel, which includes inflation and exchange rate variables. Next, data pre-processing is performed, namely calculating the difference (ΔY) to ensure data stationarity. The third stage is the estimation of the VECM model, which includes the calculation of long- and short-term coefficients. After the model is formed, predictions for the next five years are made iteratively based on the parameters obtained. The prediction results are then visualized on an annual basis to provide an overview of the trends formed. Two stages of accuracy evaluation are carried out separately, namely for inflation and exchange rate predictions, using the Mean Squared Error (MSE) and Mean Absolute Percentage Error

(MAPE) metrics. Finally, the VECM mathematical model is presented explicitly in the form of equations that explain the relationship between the analyzed variables. This whole process provides a comprehensive framework for economic forecasting based on cointegrated time series data.

C. RESULTS AND DISCUSSION

1. Data Description

Tabel 1. Data To Be Predicted

Year	Inflation(%)	Exchange Rate (IDR)
2014	7,23	12.440
2015	3,41	13.795
2016	2,61	13.436
2017	3,7	13.380
2018	3,16	14.237
2019	1,87	14.146
2020	0,6	14.577
2021	2,12	14.308
2022	6,23	14.876
2023	3,02	15.416

Based on Table 1, Indonesia's annual inflation data from 2014 to 2023 generally shows a downward trend. In 2014, the inflation rate was recorded at 7.23%, which was the highest value during that period. Subsequently, inflation experienced a gradual decline, reaching its lowest point in 2020 at 0.60%. After 2020, inflation briefly increased, amounting to 2.12% in 2021 and reaching 6.23% in 2022. However, in 2023, inflation declined again to 3.02%. Thus, despite fluctuations in the last two years, overall the inflation trend during the 2014-2023 period can be said to tend to decline. Statistically, the average inflation during the period was 3.40%. The minimum value of inflation was recorded in 2020 at 0.60%, while the maximum value occurred in 2014 at 7.23%. This data shows that inflationary pressures in Indonesia are relatively declining in the long term, although there are still dynamics influenced by various domestic and global economic factors.

2. Forecasting Results and Decision Making

Tabel 2. Forecast Results for 5 Years

Year	Inflation(%)	Exchange Rate (IDR)
2024	-1,42%	14.929,60
2025	0,01%	14.344,19
2026	4,45%	14.637,07
2027	4,52%	15.294,42
2028	0,49%	15.260,36

Based on Table 2 forecasting results for the period 2024 to 2028, there are significant fluctuations in the inflation rate, while the exchange rate shows a relatively stable movement. Inflation in 2024 is predicted to experience deflation of -1.42%, which reflects a general decline in prices and may indicate weak aggregate demand in the economy. However, in 2025, inflation is expected to return to the positive zone albeit very small, at 0.01%. Subsequently, there are high spikes in inflation in 2026 and 2027, at 4.45% and 4.52% respectively, potentially reflecting increased price pressures from either the demand or supply side. In 2028, inflation slows down again to 0.49%, indicating a price stabilization process.

Meanwhile, the exchange rate of the rupiah against the US dollar over the same period shows a more stable trend compared to inflation. The exchange rate is estimated to be in the range of Rp14,344.19 to Rp15,294.42 per US dollar. The year 2025 is predicted to experience a strengthening of the exchange rate compared to the previous year, but then it will gradually weaken again until 2028. These fluctuations indicate that the exchange rate remains within a moderate and manageable range, which is a positive signal for Indonesia's external economic stability. Overall, although inflation shows high volatility, the stability of the exchange rate can provide an important foundation for future macroeconomic policy setting.

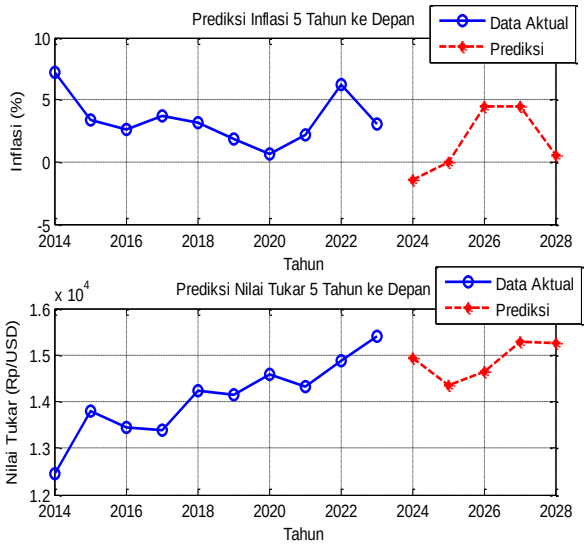

Figure 2. A comparative graph

Figure 1 above is obtained from the mathematical model of the Mathematical Model: (VECM) ---

?Inflation_t = -1.5269 * Inflation_{t-1} + -0.0017 * Exchange_{t-1} + 0.7280 * ?Inflation_{t-1} + 0.0008 * ?Exchange_{t-1} + 28. 4006

?NilaiTukar_t = 102.7653 * Inflation_{t-1} + -0.2636 * ?NilaiTukar_{t-1} + 92.7791 * ?Inflation_{t-1} + -0.3337 * ?NilaiTukar_{t-1} + 3745.1124.

Which displays the comparison between actual data and forecasting results for two key economic variables, namely inflation (top graph) and exchange rate (bottom graph), in the

period of 2014-2028. The actual data is shown with a blue line, while the forecast data for 2024 to 2028 is depicted with a dashed red line. In the inflation graph, it can be seen that the actual data from 2014 to 2023 experienced a general downward trend, although there were small fluctuations in the middle of the period, and a considerable spike in 2022. The forecasting results show that in 2024 there is deflation, indicated by a sharp drop below the horizontal axis. Subsequently, inflation is predicted to increase significantly in 2026 and 2027, before declining again in 2028. This pattern suggests volatility in future inflation movements, which may indicate uncertainty in domestic or global economic conditions. Meanwhile, the exchange rate graph shows a relatively stable upward trend in the actual data from 2014 to 2023. The forecast results from 2024 to 2028 show more moderate fluctuations than inflation. The exchange rate is expected to strengthen slightly in 2025, then gradually weaken again until 2028. The stability of the exchange rate prediction reflects a better prospect of external stability compared to the more volatile inflation dynamics. Overall, this graph indicates that while the exchange rate has shown a relatively stable trend, inflation is projected to experience higher uncertainty. Therefore, special attention is needed in the formulation of monetary and fiscal policies to maintain price stability and people's purchasing power in the future.

Tabel 3. Table of MSE and MAPE Values of Prediction Results

Variabel	MSE	MAPE
Inflasi	1,4588	45,10%
Nilai Tukar	56.357,2784	1,25%

Based on Table 3, the MSE value for the inflation variable is 1.4588 with MAPE reaching 45.10%. This high MAPE value indicates that the model has a significant prediction error rate in estimating inflation, so the prediction accuracy is low. This can occur due to the nature of inflation which is more volatile and influenced by many external and domestic factors that are difficult to model precisely. Therefore, the inflation prediction results from this model should be used with caution and, if necessary, combined with other modeling approaches or qualitative analysis to support decision making. Conversely, for the exchange rate variable, the model yielded an MSE of 56,357.2784 and a much smaller MAPE of 1.25%. This MAPE value indicates that the model has a very high level of accuracy in predicting the exchange rate of the rupiah against the US dollar. Although the MSE appears large in absolute terms, this is attributable to the high scale of the exchange rate values (in the thousands of rupiah), making MAPE a more relevant indicator of performance. Therefore, the exchange rate forecasts can be considered sufficiently reliable for use in macroeconomic policy planning and evaluation related to the external sector.

D. CONCLUSIONS AND SUGGESTIONS

This study shows that Indonesia's inflation from 2014 to 2023 exhibited a significant downward trend, despite fluctuations in recent years, particularly in 2022, which recorded a spike in inflation. Overall, the average inflation rate during this period was 3.40%, indicating a long-term decline in inflationary pressures. However, the inflation forecast for the period

2024 to 2028 suggests considerable volatility, with a predicted deflation in 2024 and inflation surges in 2026 and 2027. On the other hand, the exchange rate of the rupiah against the US dollar tended to be more stable and is projected to experience moderate fluctuations through 2028. Nevertheless, the forecasting model for inflation still requires improvement, as indicated by a relatively high MAPE of 45.10%, whereas the exchange rate prediction yielded more accurate results, with a MAPE of only 1.25%.

Based on these findings, it is recommended to develop more sophisticated inflation forecasting models using advanced statistical methods, such as ARIMA with exogenous variables or GARCH models to better capture high volatility. The use of updated Bayesian network models, incorporating external factors such as monetary policy and global price movements, could also enhance inflation forecasting accuracy. Furthermore, future research could explore hybrid modeling approaches that combine statistical techniques with machine learning methods, such as artificial neural networks (ANNs), to improve forecasting performance. For exchange rate predictions, it is suggested to expand the analysis by incorporating external factors, such as global commodity prices and trade policies, to obtain more robust forecasting results. Finally, macroeconomic policies should continue to be adapted to the fluctuating dynamics of inflation and exchange rates, with an emphasis on more comprehensive monitoring of domestic and global economic conditions.

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