Available online at
https://journal.rescollacomm.com/index.php/ijqrm/index

International Journal of Quantitative Research and Modeling

e-ISSN 2721-477X
p-ISSN 2722-5046

Vol. 6, No. 3, pp. 292-297, 2025

The Effect of Macroeconomic Variables on Indonesia's Import Value Using the OLS Method

Trisha Magdalena Adelheid Januaviani[1*], Kalfin[2], Aned Miranda Hutabarat[3], Nikita[4], Selvy Musdaifah[5], Nasria Nacong[6]

[1]*Data Science Study Program Tadulako University, Indonesia*
[2]*Department of Mathematics, Universitas Negeri Makassar, Indonesia*
[3]*Department of Regional Development Management, Bogor Agricultural University, Indonesia*
[4,5,6]*Mathematics Study Program Tadulako University, Palu, Indonesia*

[*]*Corresponding author email: trishadelheid@gmail.com*

Abstract

This study analyzes the factors influencing Indonesia's import value during the period 2021–2025 using the Ordinary Least Squares (OLS) method. To ensure the validity of the model, a series of classical assumption tests was conducted in accordance with the Best Linear Unbiased Estimator (BLUE) criteria, including tests for normality, multicollinearity, heteroscedasticity, and autocorrelation. The data were obtained from official publications of the Central Statistics Agency (BPS) and other relevant sources. The estimation results demonstrate that the independent variables, namely the exchange rate (X_1), national income (X_2), foreign exchange reserves (X_3), inflation rate (X_4), and interest rate (X_5), exert varying effects on Indonesia's import value, with certain variables exhibiting significant influence while others remain insignificant. The model is free from violations of the classical assumptions, thereby meeting the criteria of the Best Linear Unbiased Estimator (BLUE).

Keywords: Import Value, OLS, Classical Assumption Tests, Macroeconomics

1. Introduction

The economy of a country is significantly influenced by imports, as high imports may reflect domestic demand for goods or services that cannot be supplied locally. However, unrestrained imports can have adverse effects on the trade balance and economic stability (Ektiarnanti et al., 2021). International trade is one of the main drivers of a country's economy, where export and import activities play an important role in maintaining the availability of goods, increasing productivity, and strengthening economic relations between countries. For Indonesia, imports are a vital instrument for meeting domestic needs that cannot yet be optimally produced domestically, whether in the form of raw materials, capital goods, or consumer goods (Suwardi et al., 2023).

Over the past few decades, there has been a notable rise in imports to Indonesia. Data from the Statistics Indonesia (BPS) indicate that Indonesia's import value has experienced fluctuations influenced by both internal and external factors, such as economic growth, the rupiah exchange rate, national income, foreign exchange reserves, inflation rate, and trade policies (Slamet and Hidayah, 2022).

Previous research has shown a correlation between macroeconomic variables and Indonesia's import value by employing macroeconomic variables. Hidayat et al. (2024) found that foreign investment and government expenditure have a significant effect on imports, while the depreciation of the rupiah exchange rate does not always lead to an increase in imports. Loso and Damanik (2023) demonstrated that exchange rate movements have a significant impact on Indonesia's imports, indicating a high sensitivity to currency fluctuations. In general, prior research confirms that macroeconomic variables affect import values. Therefore, this research focuses on variables that are assumed to influence import values, namely exchange rate (X_1), national income (X_2), foreign exchange reserves (X_3), inflation (X_4), and interest rate (X_5). By applying multiple linear regression analysis, this study is expected to provide a comprehensive understanding of the relationships among these variables using Indonesia's import value data for the period 2021–2025.

2. Methods

2.1 Multiple Linear Regression Analysis

The relationship or influence of two or more independent variables on one dependent variable is analyzed using the multiple linear regression model. This model allows for the simultaneous evaluation of the contribution of each independent variable in explaining the dependent variable. The form of the multiple linear regression model can be written as (Januaviani et al., 2019):

$$y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \ldots + \beta_j x_{ij} + \ldots + \beta_p x_{ip} + \varepsilon_i \tag{1}$$

y_i : Dependent variable -i, for $i = 1.2, \ldots, n$
x_{ij} : Independent variable ij, for $j = 1.2, \ldots, p$
$\beta_0, \beta_1, \beta_2, \ldots, \beta_p$: Regression coefficient
ε_i : Error

This model remains relevant and widely used in various fields of research, including economics, social sciences, and health, due to its ability to capture complex relationships between variables. The multiple linear regression also plays an important role in data-driven decision-making, especially when it involves accurate model parameter prediction and estimation (Montgomery et al., 2021).

2.2 Ordinary Least Squares

The Ordinary Least Squares (OLS) method is a commonly used technique for obtaining coefficient estimators in linear regression models. In multiple linear regression, OLS is used to estimate the parameter β such that the sum of the squares of the differences between the observed values and the predicted values is minimized. In general, the estimated multiple linear regression model can be expressed as (Burton, 2021):

$$\hat{y}_i = \hat{\beta}_0 + \hat{\beta}_1 + \hat{\beta}_2 + \ldots + \hat{\beta}_j + \ldots + \hat{\beta}_p \tag{2}$$

with the parameter estimator $\hat{\beta}$ in OLS, namely:

$$\hat{\beta}_{OLS} = (X^t X)^{-1} X^t y \tag{3}$$

This method remains one of the main approaches in parameter estimation due to its simplicity, efficiency, and unbiased estimates under classical linear regression assumptions. Recent research shows that although this method has been widely used, developments such as regularized least squares can improve estimation performance on data with high multicollinearity or a large number of predictors (Ghojogh and Crowley, 2021).

2.3 Coefficient of Determination

The coefficient of determination (R^2) basically measures the extent to which the regression model can explain the variation in the dependent variable (Ghozali, 2018). The coefficient of determination is often used as the main indicator of model goodness. The value of (R^2) ranges from 0 to 1, where a value close to 1 indicates a better ability of the model to explain data variability. The formula for the coefficient of determination is expressed as (Gao, 2023):

$$R^2 = \frac{SSR}{SST} \tag{4}$$

SSR (Sum of Squared Residuals) : $\hat{\beta}^t X^t y - n\bar{y}^{\,2}$
SST (Sum of Squared Total) : $y^t y - n\bar{y}^{\,2}$

2.4 Classical Assumption Test

In linear regression analysis, classical assumption tests are performed to ensure that the model meets the statistical requirements that guarantee Best Linear Unbiased Estimator or BLUE parameter estimation (Hansen, 2022). These tests include normality test, multicollinearity test, heteroscedasticity test, and autocorrelation test.

2.4.1 Normality

Aims to check whether the residuals are normally distributed. One commonly used method is the Jarque–Bera (JB) test (Glinskiy rt al., 2024):

$$JB = \left(\frac{n}{6}\right) \times \left(S^2 + \left(\frac{(K-3)^2}{4}\right)\right) \tag{5}$$

n : sample size
S : skewness

K : kurtosis
If $p - value$ > 0.1, then the residuals are considered to be normally distributed (Gujarati and Porter, 2021).

2.4.2 Multicollinearity

This test aims to detect high correlations between independent variables. One approach is to calculate the Variance Inflation Factor (VIF) (Ahmad et al., 2025):

$$VIF_{\mathrm{i}} = \frac{1}{(1 - R_{\mathrm{i}}^2)} \tag{6}$$

R_{i}^2 is the coefficient of determination of the regression of the i independent variable against the other independent variables. If $VIF > 5$, then multicollinearity is indicated (Ghozali, 2018).

2.4.3 Heteroscedasticity

This test aims to check the equality of residual variances. One method is the Breusch–Pagan (BP) test:

$$BP = n \times R^2 \tag{7}$$

R^2 is obtained from the residual square regression against the independent variable. If the $p - value < 0.05$, there is an indication of heteroscedasticity (Wooldridge, 2020).

2.4.4 Autocorrelation

The test aims to detect serial correlation in residuals. A commonly used method is Durbin–Watson (DW) (Kim, 2021):

$$DW = \frac{\Sigma(e_i - e_i{}^{-1})^2}{\Sigma(e_i^2)} \tag{8}$$

The value of DW close to 2 indicates no autocorrelation (Gujarati and Porter, 2021).

3. Results and Discussion

3.1 Research Object

The problem analyzed in this journal is to analyze the factors that influence import values in Indonesia (Y) with a focus on economic variables, namely the exchange rate of the rupiah against the US dollar (USD) X_1, national income (X_2), foreign exchange reserves (X_3), inflation rate (X_4), and interest rate (X_5),

Based on the results of multiple linear regression analysis covering all independent variables, namely the exchange rate (X_1), national income (X_2), foreign exchange reserves (X_3), inflation rate (X_4), and interest rate (X_5), the coefficient of determination (*RSquare*) was obtained at 0.363 or 36.3%. This indicates that the five variables together can explain 36.3% of the variation in import values in Indonesia from 2021 to 2025. In other words, 36.3% of the variation in import values in the analyzed data can be explained by the macroeconomic factors included in the model.

3.2 Classical Assumption Test

3.2.1 Normality Test

Normality testing was conducted to determine whether the regression model residuals were normally distributed. This test is important because one of the classical assumptions of linear regression is that the residuals must be normally distributed (Gujarati and Porter, 2021). In this study, normality testing was conducted using graphical testing methods through Normal Q-Q Plots and Shapiro-Wilk statistical test.

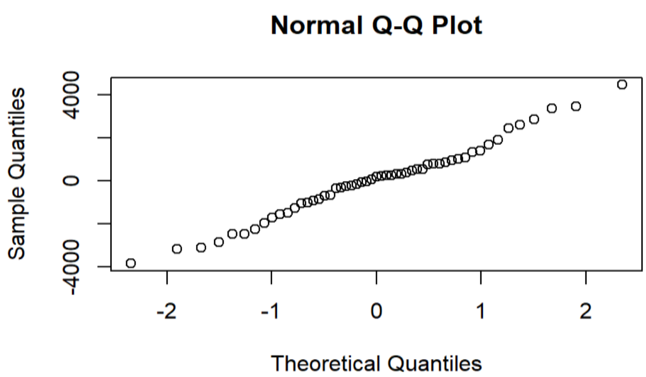

Figure 1. Normality Test

Based on the Normal Q-Q Plot in Figure 3.1, the residual points tend to follow the red diagonal line, indicating that the residual data has a distribution close to normal. Some minor deviations are visible at the ends (tails), but overall the pattern of points follows the reference line, so the assumption of normality can be accepted.

Table 1: p-values of Independent Variables

Variable	$p - value$
X_1	0.173807
X_2	0.000864
X_3	0.628314
X_4	0.083718
X_5	0.078013

Based on Table 1, the variables that significantly affect import values at a significance level of 1% are national income (X_2) ($p - value = 0.000864$), suggesting that increases in income enhance the capacity to purchase imported goods. Inflation (X^4) demonstrates a marginally significant positive influence at the 10% level ($p - value = 0.083718$), implying that higher inflation is associated with greater import demand. Conversely, the interest rate (X_5) exhibits a marginally significant negative effect at the 10% level ($p - value = 0.078013$), indicating that higher borrowing costs suppress import activities. By contrast, the exchange rate (X_1) with a $p - value$ of 0.173807 (17.38%) and foreign exchange reserves (X_3) with a $p - value$ of 0.628314 (62.83%) are not statistically significant, suggesting that their variations do not meaningfully account for changes in import values during the period.

3.2.2 Multicollinearity Test

Multicollinearity is used to detect strong correlations between independent variables in a regression model. One indicator used is the Variance Inflation Factor (VIF) value. A regression model is said to be free from multicollinearity if the VIF < 5.

Table 2: Variance Inflation Factor Value

X_2	X_4	X_5
2.627586	1.011181	2.638911

Based on the results of calculations using the RStudio program, the following VIF values were obtained for the independent variables: X_2 (National Income) = 2.627586; X_4 (Inflation Rate) = 1.011181; dan X_5 (Interest Rate) = 2.638911. VIF of all values obtained are less than 5, so it can be concluded that there is no evidence of multicollinearity in the regression model of Indonesia's import value. Thus, the independent variables in this study can be used without causing distortion in the estimation of regression coefficients (Gujarati and Porter , 2021).

3.2.3 Heteroscedasticity Test

The heteroscedasticity test was conducted to determine whether there was variance inequality in the residuals at each level of the independent variable in the regression model. The heteroscedasticity test using the Breusch-Pagan Test yielded a BP value of 5.336 with degrees of freedom $(df) = 3$ and $p - value = 0.1488$. Since the $p - value$ is greater than the significance level of 5% (0.05), it can be concluded that the regression model does not exhibit heteroscedasticity. This means that the residual variance is homogeneous (constant), so the regression model is suitable for further analysis.

3.2.4 Autocorrelation Test

Autocorrelation is one of the important assumptions in classical regression analysis that needs to be tested to ensure the validity of the model. Autocorrelation occurs when there is a correlation between the residuals in one period and the residuals in the previous period, which usually appears in time series data. The presence of autocorrelation can cause the error variance to become non-constant and the estimation parameters to become inefficient, although they remain unbiased. The results of the autocorrelation test using the Durbin-Watson (DW) test show a DW value of 1.856 with $p - value$ of 0.2136. The value of DW close to 2 and $p - value$ > 0.05 indicate that the regression model does not exhibit autocorrelation, either positive or negative. Thus, it can be concluded that the classical assumption of no autocorrelation in the regression model is satisfied, making the model suitable for further analysis. This finding aligns with the opinion of Gujarati and Porter (2021), who state that a DW value close to 2 and $p - value$ above the 5% significance level indicate no autocorrelation in the data. These results are also supported by recent literature such as

Wooldridge (2020), which emphasizes the importance of autocorrelation tests to ensure the reliability of regression models in economic research.

3.2.5 Model of *Ordinary Least Squares*

The regression model estimated using the OLS (Ordinary Least Squares) method produced a constant value of –5344.90, a coefficient for variable X_2 is 0.0087, variable of X_4 is 1046.63, and variable of X_5 is –556.72. Before the model was used for interpretation, a series of classical assumption tests were conducted, including normality, multicollinearity, heteroscedasticity, and autocorrelation tests. The test results showed that all assumptions were met: the residual data were normally distributed, there were no signs of multicollinearity between independent variables, no heteroscedasticity was found, and there was no autocorrelation. Thus, the regression model obtained meets the BLUE (Best Linear Unbiased Estimator) criteria, so that parameter estimates can be considered valid and reliable for use in further analysis. The resulting regression model is as follows:

$$Y = -5344.90 + 0.0087X_2 + 1046.63X_4 - 556.72X_5 + e$$

The regression model shows that the constant value of -5344.90 does not have practical meaning, as import values cannot be negative, but it functions as a mathematical starting point. The coefficient for national income (X_2) is 0.0087, meaning that an increase in national income increases Indonesia's import values. Inflation (X_4), with a coefficient of 1046.63, also increases import values. In contrast, the interest rate (X_5), with a coefficient of -556.72, decreases import values. The residual (e) represents other factors not included in the model that influence import values. Overall, this model suggests that variables X_2 and X_4 drive an increase in import values, while X_5 actually suppresses import values.

4. Conclusion

Based on the description in the previous chapter, the following conclusions can be drawn:

1) The regression model used has met all classical assumption tests, namely normality, multicollinearity, heteroscedasticity, and autocorrelation tests. This indicates that the model formed has met Best Linear Unbiased Estimator or BLUE criteria so that the parameter estimation results can be trusted and are valid for further analysis.
2) There were five macroeconomic variables tested (exchange rate, national income, foreign exchange reserves, inflation, and interest rates), but only three variables were retained in the final model, namely national income (X_2), inflation (X_4), and interest rates (X_5). Meanwhile, exchange rate (X_1) and foreign exchange reserves (X_3) were excluded from the model because they were found to be statistically insignificant in the normality test.
3) Based on the OLS model, the national income variable (X_2) was found to have a significant positive effect on Indonesia's import value, meaning that the higher the national income, the greater the demand for imports. The inflation variable (X_4) had a positive and significant effect at the 10% level, indicating that an increase in inflation drives an increase in imports. Conversely, the interest rate variable (X_5) has a negative effect on import value, indicating that an increase in interest rates can suppress import activity.

References

Ahmad, I., Alasgah, A. A., Zelenakova, M., Dar, M. A., Damtie, M., and Berhan, M. (2025). Quantifying turbidity dynamics in lake water using OLS regression: A Landsat 8 OLI-based remote sensing approach. *Journal of Hydrology: Regional Studies, 60,* 102523. https://doi.org/10.1016/j.ejrh.2025.102523

Badan Pusat Statistik. (2025). *Statistical data on Indonesia's exports, imports, GDP, and inflation.* Jakarta: BPS.

Bank Indonesia. (2025). *Indonesian trade balance performance and economic indicators.* Jakarta: Bank Indonesia.

Burton, A. L. (2021). OLS (Linear) regression. *The Encyclopedia of Research Methods in Criminology and Criminal Justice, 2,* 509–514.

Ektiarnanti, R., Rahmawati, A., Krismawati Fauziah, F., and Rofiqoh, I. (2021). Indonesian trade balance performance by GDP, exports, imports, BI rate and inflation as intervening variables. *Indonesian Economic Review, 2(1), 1-11.*

Gao, J. (2023). R-squared (R^2): How much variation is explained? *Significance, 20*(6), 16–19. https://doi.org/10.1177/26320843231186398

Ghojogh, B., and Crowley, M. (2021). The theory behind least squares regression, ridge regression, and LASSO. *arXiv Preprint,* arXiv:1905.11897.

Ghozali, I. (2018). *Application of multivariate analysis with IBM SPSS 25 program (9th ed.).* Semarang: Diponegoro University Publishing Agency.

Glinskiy, V., Karmanov, M., Mustafin, A., Popov, E., and Shmakov, A. (2024). Modifications to the Jarque–Bera test. *Mathematics, 12*(16), 2523. https://doi.org/10.3390/math12162523

Gujarati, D. N., and Porter, D. C. (2021). *Basic econometrics* (6th ed.). New York, NY: McGraw-Hill Education.

Hansen, B. E. (2022). A modern Gauss–Markov theorem. *Econometrica, 90*(3), 1283–1294. https://doi.org/10.3982/ECTA19255

Hidayat, A. M., Purwanda, E., Hadijah, H. S., and Sodik, G. (2024). Impact of exchange rates, inflation, foreign direct investment, government spending, and economic openness on exports, imports, and economic growth in Indonesia. *Journal of Infrastructure, Policy and Development, 8*(6). https://doi.org/10.24294/jipd.v8i6.3270

Januaviani, T. M. A., and Bon, A. T. (2019). The LASSO (Least absolute shrinkage and selection operator) method to predict indonesian foreign exchange deposit data. In *Proceedings of the International Conference on Industrial Engineering and Operations Managemen*t (pp. 5-7).

Kim, H. (2021). A finite sample correction for the panel Durbin–Watson test. *Applied Economics, 54*(28), 3197–3205. https://doi.org/10.1080/00036846.2020.1869172

Loso, F., and Damanik, R. (2023). Exchange rate movement and its influence on Indonesian imports. *Indonesian Journal of Economics and Business, 11*(3), 233–245.

Montgomery, D. C., Peck, E. A., and Vining, G. G. (2021). *Introduction to linear regression analysis* (6th ed.). Hoboken, NJ: John Wiley and Sons.

Slamet, A., and Hidayah, A. N. (2022). Analysis of the Effect of Exports, Imports, Rupiah Exchange Rate, and Inflation on Indonesia's Economic Growth in 2000–2019. *Journal of Economics Research and Policy Studies, 1*(3), 183–192. https://doi.org/10.53088/jerps.v1i3.10

Suwardi, W. Z., & Islamiyah, N. (2023). The irrelevance of imports, external debt, and economic growth in Indonesia during 2018–2022. *Jurnal Online Manajemen ELPEI (JOMEL)*, 3(2), 602–612.

Wooldridge, J. M. (2020). *Introductory Econometrics: A Modern Approach* (7th ed.). Boston: Cengage Learning