



Dynamics of Export, Imports, and Monetary Variables on Manufacturing Industry Output in Indonesia

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ABSTRACT

This study aims to analyze the short-term and long-term relationships and influences between international trade and monetary variables on the performance of the manufacturing industry sector in Indonesia. Manufacturing output is proxied by the Industrial Production Index (IPI). The variables used in this study include exports, imports, BI Rate, inflation, exchange rate, and money supply. This research uses monthly time series data from 2010–2024 and applies the Vector Error Correction Model (VECM) to examine both short-term and long-term relationships among the variables. The Impulse Response Function (IRF) is used to analyze the dynamic response of manufacturing output to economic shocks, while Forecast Error Variance Decomposition (FEVD) is used to measure the contribution of each variable in explaining the variation in manufacturing output. The results show the existence of a long-run relationship between exports, imports, monetary variables, and manufacturing output in Indonesia. In the short run, most variables do not significantly affect manufacturing output, but the significant Error Correction Term (ECT) indicates an adjustment mechanism toward long-run equilibrium. In the long run, exports, BI Rate, and money supply have a positive and significant effect, while imports, inflation, and exchange rate have a negative and significant effect on manufacturing output. The IRF results indicate fluctuating responses in the early periods before gradually stabilizing, while FEVD shows that the contribution of exports, imports, and monetary variables in explaining manufacturing output increases in the long run.

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1. Introduction

The manufacturing sector is a key pillar of the Indonesian economy due to its significant role in the formation of Gross Domestic Product (GDP), job creation, and increasing national added value. In modern economic growth literature, the manufacturing sector is viewed as a key driver of economic development due to its ability to drive productivity increases, accelerate structural transformation, and strengthen a country's economic competitiveness (Haraguchi et al., 2017). According to data from the Central Statistics Agency (BPS), the manufacturing industry has consistently been the largest contributor to Indonesia's GDP compared to other sectors.

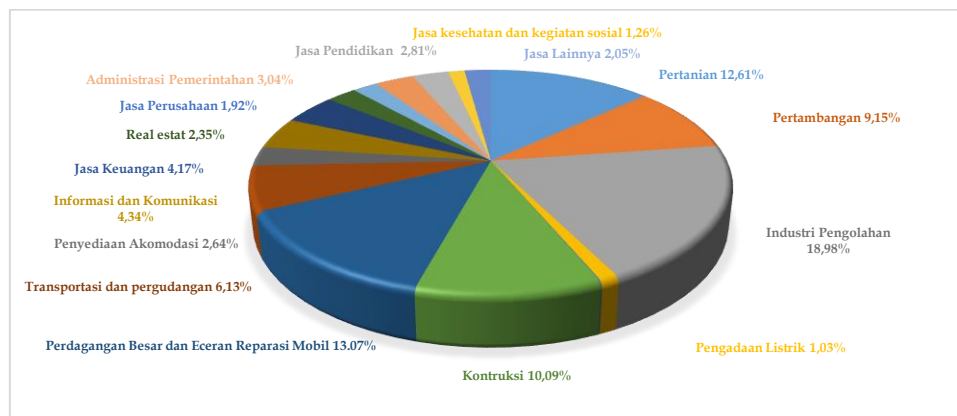


Figure 1. Percentage Distribution of GDP by Industry in 2024

However, over the past decade, the manufacturing sector's contribution to Indonesia's GDP has shown a downward trend, despite continued absolute increases in industrial output. This situation creates a structural paradox in the Indonesian economy, where increased industrial production activity is not fully translated into national GDP creation. This condition indicates the phenomenon of premature deindustrialization, namely the decline in the role of the industrial sector before a country reaches an optimal level of economic maturity. This phenomenon has the potential to hamper long-term economic growth and reduce the competitiveness of national industries. This is in line with Rodrik (2016), who emphasized that premature deindustrialization can improve economic structures and hinder the process of structural transformation in developing countries. In the context of Indonesia as a developing country with an industrial base that is not yet fully mature, the phenomenon of premature deindustrialization is a serious concern because it has the potential to hinder the process of sustainable industrialization.

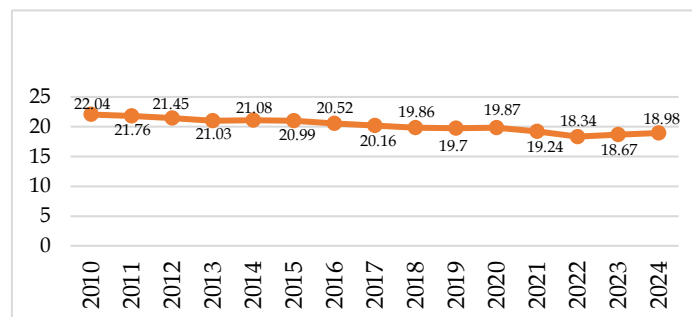


Figure 2. Development of the Manufacturing Industry's Contribution to Indonesia's GDP

On the other hand, the decline in the manufacturing industry's contribution to GDP does not fully reflect the industrial sector's production performance. The Industrial Production Index (IPI), an indicator of industrial sector output, actually shows a long-term upward trend. Statistics Indonesia (BPS) data shows that Indonesia's IPI has experienced a relatively stable increase, indicating increased industrial production activity. This condition reflects a mismatch between increasing industrial output and its contribution to the national economic structure, indicating structural issues and the influence of macroeconomic factors that have not yet been fully explained.

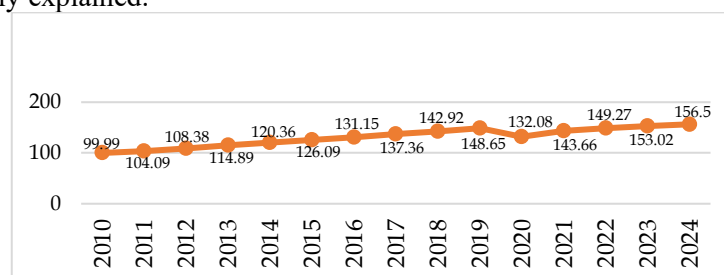


Figure 3. Development of Indonesia's Industrial Production Index (IPI)

In addition to domestic factors, the performance of the manufacturing sector is also significantly influenced by the dynamics of international trade. It should be emphasized that although this study focuses on manufacturing industry output, the export and import variables used are national aggregate data. The use of aggregate data is based on the consideration that international trade at the macro level is directly linked to the industrial sector, both through the demand side and the supply side of production inputs. National exports reflect external demand for domestic products, including manufactured products, while imports particularly raw materials and capital goods are important inputs in the industrial production process. Therefore, despite their aggregate nature, export and import variables remain relevant in explaining the dynamics of manufacturing industry output.

In the concept of export-led growth, increased exports are believed to drive industrial growth through market expansion and increased production capacity. Conversely, increased imports that are not matched by domestic industrial competitiveness have the potential to depress the performance of the domestic industrial sector. Several previous studies have shown that exports have a positive effect on industrial growth, while imports tend to have a negative impact if dependence on foreign products increases (Balassa, 1978). In the Indonesian context, the manufacturing sector's dependence on imported raw materials and capital goods makes industrial performance highly sensitive to fluctuations in global trade and exchange rates.

In addition to international trade, monetary variables also play a significant role in influencing industrial sector performance. Interest rate policy, reflected through the BI Rate, influences investment decisions and capital costs; inflation influences price stability and production costs; the exchange rate impacts the competitiveness of industrial exports and imports; and the money supply influences the level of liquidity and economic activity in the real sector. The relationship between monetary variables and the industrial sector is dynamic and can differ between the short and long term, as stated in the monetary policy transmission theory (Mishkin, 1995). Fluctuations in these monetary variables are becoming increasingly relevant in the Indonesian economy, which faces external pressures, exchange rate volatility, and monetary policy adjustments following the COVID-19 pandemic.

Previous studies have shown mixed results regarding the influence of exports, imports, and monetary variables on industrial output. Several studies, such as Sankaran et al. (2020) and Cherif & Hasanov (2024), found that exports had a positive effect on the IPI, while Rustandi & Ujjianto (2022) reported an insignificant negative effect. Meanwhile, the influence of imports also varies. Sjöholm (1999) found a positive effect, while Dyckhoff (2023) found a negative relationship for industrial sectors heavily dependent on imported raw materials. In the context of monetary variables, several studies, such as Medyawati & Yunanto (2021), Putranto et al. (2023), and Matola (2023), show that the BI Rate and inflation negatively affect industrial output, while the money supply has a positive effect because it stimulates production activity ((Ahwal & Danur, 2021); (Sana et al., 2024)). However, these research results have not yet yielded consistent conclusions, either in terms of direction or significance.

Furthermore, most previous research is limited by its time period and analytical approach. Some studies only partially highlight trade openness or monetary variables, while others fail to integrate both within a comprehensive analytical framework. Yet, understanding temporal dynamics such as time lag, impact persistence, and adjustment mechanisms is crucial for formulating effective economic policies (Juhro & Lyke, 2019). To date, there is limited research explicitly analyzing the impact of exports, imports, and monetary variables on Indonesian manufacturing industry output using monthly data through 2024.

Based on this background, the problem examined in this research concerns the relationship between exports, imports, and monetary variables, including the BI Rate, inflation, the exchange rate, and the money supply, with manufacturing industry output in Indonesia. Furthermore, this research questions the extent to which exports, imports, and these monetary variables influence manufacturing industry output in the short and long term. Furthermore, it is important to analyze the dynamic response of manufacturing industry output to shocks to exports, imports, and monetary variables, as reflected in the results of Impulse Response Function (IRF) and Forecast Error Variance Decomposition (FEVD) analyses.

This research aims to fill this gap in knowledge and policy by analyzing the influence of exports, imports, and monetary variables (BI Rate, inflation, the exchange rate, and the money supply) on Indonesia's Industrial Output (IPI). Using monthly data for the 2010–2024 period and the Vector Error

Correction Model (VECM) approach equipped with the Impulse Response Function (IRF) and Forecast Error Variance Decomposition (FEVD), this study aims to provide comprehensive empirical evidence regarding the short-term, long-term, and dynamic response relationships of the IPI to policy shocks. The results of this study are expected to not only contribute to the development of the literature on monetary economics and international trade but also serve as an empirical reference for policymakers at Bank Indonesia, the Ministry of Industry, and the Ministry of Trade in designing effective strategies to restore and strengthen the foundations of the national industry amidst global uncertainty.

2. Literature Review

2.1. Manufacturing Industry Output (Industrial Production Index)

Manufacturing industry output reflects the level of production activity in the industrial sector within an economy. In this study, industrial output is proxied using the Industrial Production Index, which describes changes in real industrial production volume. The use of the IPI is relevant because this indicator captures the dynamics of industrial production sustainably and is sensitive to changes in macroeconomic conditions.

Theoretically, industrial output can be explained through the Production Function Theory Cobb & Douglas (1928), which states that output is determined by the combination of capital and labor at a given level of technology. In a macroeconomic context, variables such as exports, imports, and monetary policy influence the effectiveness of production input use through changes in the cost of capital, investment, and productivity. Therefore, fluctuations in the IPI reflect not only changes in physical inputs but also economic conditions that influence industrial production efficiency. Empirical findings support the relevance of this theory. Matola (2023) shows that changes in investment and capital significantly influence manufacturing industry output. Sjöholm (1999) also found that the combination of labor and capital drives increased industrial output in Asian countries, although this impact is influenced by trade openness.

2.2. Exports

Exports are a crucial component of the economy, playing a role in increasing demand for domestic industrial products. In Aggregate Demand Theory Keynes (1936), exports are positioned as a component of aggregate demand that directly influences output levels. Increased exports will encourage producers to increase production capacity to meet external demand.

Furthermore, the Export-Led Growth Theory proposed by Balassa (1978) and Feder (1983) emphasizes that exports not only increase demand but also boost efficiency, production scale, and industrial productivity. Feder (1983) explains that the export sector has higher productivity than the non-export sector, so export growth generates spillover effects on overall industrial output. Empirically, Sjöholm (1999) and Ramadhani et al. (2018) found that exports have a positive and significant effect on industrial output. However, Sankaran et al. (2020) and Oey (2019) show that the effect of exports is not always significant and can even be negative, especially when industries face limited production capacity or cost pressures.

2.3. Imports

Imports play an ambivalent role on industrial output. Within the Keynesian aggregate demand framework, imports reduce domestic aggregate demand. However, from a production perspective, imports, particularly of raw materials and capital goods, can increase industrial production capacity and efficiency.

Empirical findings show mixed results. Oey (2019) and Rustandi & Ujianto (2022) found that imports positively impact industrial output, particularly in sectors dependent on imported inputs. Conversely, Habibillah & Novelyanti (2023) found a negative effect of imports on industrial output, indicating that import dependence can depress domestic industry when competitiveness is low. These differing findings confirm that the impact of imports on industrial output is highly dependent on industrial structure, the type of import, and macroeconomic conditions, including the exchange rate.

2.4. Monetary Variables

The relationship between monetary variables and industrial output is explained by Mishkin (1995) Monetary Policy Transmission Theory. Monetary policy affects the real sector through interest rates, exchange rates, and liquidity. An increase in the BI Rate increases the cost of capital and depresses industrial investment, while a decrease in interest rates encourages production expansion.

The exchange rate affects export competitiveness and the cost of raw material imports. High inflation increases production costs and reduces economic stability, while the money supply reflects the level of liquidity, which influences consumption and investment. Empirical research has yielded mixed results. Ahwal & Danur (2021) and Matola (2023) found that interest rates negatively affect industrial output in the

long run. Kutu & Ngalawa (2016) found that the money supply positively affects industrial output, while inflation and the exchange rate showed effects that depend on economic conditions and industrial structure.

3. Research Methods

This study uses a quantitative approach with an explanatory design, aiming to analyze the causal relationship between exports, imports, and monetary variables on manufacturing industry output in Indonesia. Industrial output is proxied using the IPI, while explanatory variables include exports, imports, the BI Rate, inflation, the exchange rate, and the money supply (M2).

The data used is secondary monthly data from January 2010 to December 2024, obtained from the Central Statistics Agency (BPS) and Bank Indonesia (BI). The export and import variables used in this study are national aggregate data. The use of aggregate data is based on the consideration that international trade at the macro level is directly linked to manufacturing industry activity, both through external demand and the supply of production inputs. Therefore, although the study focuses on manufacturing industry output, the use of aggregate trade data remains relevant within the framework of sectoral macroeconomic analysis. The selection of the research period is intended to capture the long-term and short-term dynamics of the Indonesian economy, including the crisis and post-pandemic recovery phases.

The analytical method used is the Vector Error Correction Model, which is an extension of the Vector Autoregressive (VAR) model and is used when the variables in the system are non-stationary but have a cointegrating relationship. The VECM model allows for analysis of long-term relationships as well as short-term adjustment dynamics between variables, as well as dynamic responses through the Impulse Response Function and Forecast Error Variance Decomposition ((Gujarati & Porter, 2009);(Stock & Watson, 2015)).

Several variables, namely exports, imports, the exchange rate, and the money supply, were transformed into natural logarithms to stabilize variance and increase estimation reliability. The analysis phase begins with a stationarity test using Augmented Dickey-Fuller (ADF) at the level and first differential with a 5 percent significance level to ensure the data are free from unit roots. Once the data is declared stationary, the optimal lag is determined using the Akaike Information Criterion (AIC), Schwarz Information Criterion (SC), and Hannan-Quinn (HQ) criteria, selecting the lag with the smallest criterion value (Wooldridge, 2012).

Next, a model stability test is performed to ensure all characteristic roots lie within the unit circle, ensuring the stability of the VAR/VECM model. The Johansen cointegration test is then used to identify long-term relationships between variables. Once cointegration is identified, VECM estimation is performed to analyze long-term relationships and short-term adjustment mechanisms, as reflected by the Error Correction Term (ECT) (Wooldridge, 2012). The final stage of analysis includes IRF to see the dynamic response of IPI to shocks to each variable, as well as FEVD to measure the relative contribution of each variable in explaining variations in manufacturing industry output (Stock & Watson, 2015).

In general, the VECM model can be formulated as follows:

$$\Delta Y_t = \alpha e_{t-1} + \sum_{i=1}^{p-1} \beta_1 \Delta Y_{t-1} + \varepsilon_t$$

Description:

- ΔY_t : vector of first derivatives of the dependent variable
- α : cointegration coefficient matrix
- e_{t-1} : error obtained from the regression equation between Y and X at lag -1, also called ECT (Error Correction Term).
- β_1 : matrix of coefficients of the i-th dependent variable, where $i = 1, 2, \dots, p$
- p : optimal lag length
- ε_t : residual vector or error term

4. Result and Discussion

4.1. Result

4.1.1 Descriptive Statistics

Before conducting the econometric analysis, descriptive statistics were used to provide an overview of the characteristics and distribution of the research variables during the observation period from January 2010 to December 2024. The variables analyzed include the Industrial Production Index (IPI), exports, imports, BI Rate, inflation, exchange rate, and money supply.

Table 1. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
IPI	180	131.34	18.84621	92.22	167.95
Export	180	9.672486	.2276652	9.17466	10.23425
Import	180	9.593222	.2085143	9.04057	10.00786
BI Rate	180	5.691667	1.251284	3.5	7.75
Inflation	180	4.102333	1.868195	.05	8.79
Exchange Rate	180	9.445957	.1959419	9.04876	9.70632
Money Supply	180	15.40597	.4193504	14.54136	16.03589

Source: Data processed with Stata 14, 2025

The descriptive statistics indicate that all variables experienced fluctuations during the observation period. The Industrial Production Index (IPI) recorded an average value of 131.34, with a minimum value of 92.22 and a maximum value of 167.95, reflecting the growth dynamics of Indonesia's manufacturing industry. Export and import variables also showed fluctuations, indicating changes in international trade performance during the study period.

Meanwhile, monetary variables such as BI Rate, inflation, exchange rate, and money supply reflected macroeconomic and monetary policy dynamics in Indonesia. The BI Rate had an average value of 5.69 percent, while inflation averaged 4.10 percent during the observation period. In addition, the money supply showed a consistent upward trend, reflecting increasing liquidity in the Indonesian economy.

4.1.2 Stationary Test

The stationarity test was conducted using Augmented Dickey–Fuller (ADF) to ensure data stability before VECM estimation. The test was conducted at the level and first difference levels with a significance level of 5 percent.

Table 2. Results of the ADF Stationarity Test at the Level and First Difference Levels

Variable	Level		First Difference	
	Adj t-Stat	Probability	Adj t-Stat	Probability
IPI	-2.796	0.0588	-21.094	0.0000*
Export	-2.810	0.0569	-22.571	0.0000*
Import	-4.569	0.0001*	-23.447	0.0000*
BI Rate	-1.049	0.7349	-8.105	0.0000*
Inflation	-2.360	0.1535	-14.474	0.0000*
Exchange Rate	-1.062	0.7298	-14.056	0.0000*
Money Supply	-1.812	0.3745	-18.053	0.0000*

Source: Data processed with Stata 14, 2025

*stationary at the 5% level

Based on Table 2, the results of the ADF test at the level level show that the IPI variable has a p-value of 0.0588, exports of 0.0569, BI Rate of 0.7349, inflation of 0.1535, exchange rate of 0.7298, and money supply of 0.3745 have a probability value greater than $\alpha = 0.05$, so it is declared non-stationary. Meanwhile, the import variable has been stationary at the level with a probability value of 0.0001 which is smaller than $\alpha = 0.05$. Because most variables are not stationary at the level, the test is continued at the first difference. The results of the ADF test at the first difference show that all variables have a probability value of 0.0000 which is smaller than $\alpha = 0.05$, so all variables are declared stationary at the first difference (I(1)) level.

4.1.3 Determining Optimal Lag

This test was conducted to determine at what lag position the model is optimal.

Table 3. Lag Test Results

lag	LL	LR	FPE	AIC	HQIC	SBIC
0	-667.227		5.00E-06	7.66167	7.71282	7.78777
1	654.562	2643.6	2.60E-12	-6.80184	-6.39268*	-5.79305*
2	730.151	151.18	1.9e-12*	-7.10399*	-6.33681	-5.2125
3	776.41	92.519*	2.00E-12	-7.07284	-5.94765	-4.29867
4	802.548	52.277	2.60E-12	-6.81305	-5.32984	-3.15619

Source: Data processed with Stata 14, 2025

The optimal lag was determined using the AIC, HQIC, and SBIC criteria with lag lengths ranging from 0 to 4. Based on the data processing results in Table 3, it can be seen that in the optimal lag test for the variables IPI, exports, imports, BI Rate, inflation, exchange rate, and money supply, the asterisk (*) in the AIC criterion appears at lag 2, indicating the minimum AIC value at that lag. Meanwhile, HQIC and SBIC recommend lag 1 as the optimal lag. Considering that AIC is the most commonly used criterion in VAR/VECM analysis because it better captures short-term dynamics, the recommended optimal lag for further testing is lag 2.

4.1.4 Stability Test

After conducting the lag selection test, the next step is to ensure the stability of the estimated model. The results show that the model is stable, and it can be concluded that the data has passed the stability test. This is evident from Table 4, where the modulus value is still below one.

Table 4. Stability Test

Eigenvalue		Modulus
0.9948717		0.994872
0.940425	+ .051349i	0.941826
0.940425	- .051349i	0.941826
0.9269661		0.926966
0.797038		0.797039
0.7435053		0.743505
0.6384447		0.638445
-0.4408107	+ .1784769i	0.475571
-0.4408107	- .1784769i	0.475571
0.3236134		0.323613
-0.1910469	+ .149894i	0.242831
-0.1910469	- .149894i	0.242831
-0.2258609		0.225861
-0.03286147		0.032861

Source: Data processed with Stata 14, 2025

4.1.5 Johansen Cointegration Test

Based on Table 5, the results of the Johansen cointegration test show that the trace statistic values in the maximum rank rows 0 and 1 are 153.7842 and 105.7948, respectively, which are greater than the critical values (5% critical value) of $153.7842 > 124.24$ and $105.7948 > 94.15$, indicating a cointegration equation in long-run equilibrium. Therefore, based on the results obtained, the VECM model will be used due to the presence of cointegration in the model.

Table 5. Co-integration Test

Maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	56	664.42357	.	153.7842	124.24
1	69	688.41827	0.23632	105.7948	94.15
2	80	708.35893	0.20073	65.9135*	68.52
3	89	722.09682	0.14304	38.4377	47.21
4	96	732.02855	0.10559	18.5742	29.68
5	101	737.64562	0.06116	7.3401	15.41
6	104	740.49277	0.03148	1.6458	3.76
7	105	741.31567	0.00920		

Source: Data processed with Stata 14, 2025

4.1.6 Vector Error Correction Model (VECM) Estimation

a. Short-Term VECM Estimation

Table 6. Short-Term VECM Estimation

Variable	Coef.	P> Z
_cel L1.	0.0165914	0.011
IPI	-0.3596383	0.001
Export	-9.105662	0.308
Import	5.265533	0.445
BI Rate	1.744402	0.588
Inflation	-0.6744052	0.354
Exchange Rate	12.69616	0.573
Money Supply	12.09172	0.629

Source: Data processed with Stata 14, 2025

Based on the short-term VECM estimation results in Table 6, the resulting short-term VECM equation is as follows:

$$\begin{aligned} \Delta IPI_t = & 0,0166 ECT_{t-1} - 0,3596 \Delta IPI_{t-1} - 9,1057 \Delta Export_{t-1} + 5,2655 \Delta Import_{t-1} \\ & + 1,7444 \Delta BI Rate_{t-1} - 0,6744 \Delta Inflation_{t-1} + 12,6962 \Delta Exchange Rate_{t-1} \\ & + 12,0917 \Delta Money Supply_{t-1} \end{aligned}$$

Based on this equation, the error correction term (ECT_{t-1}) has a coefficient of 0.0166 and significant at the 5 percent level. This indicates that in the short term, an error correction mechanism exists, where any deviation from long-term equilibrium is adjusted back toward equilibrium, albeit at a relatively slow rate of 1.66 percent per period.

Furthermore, the lag coefficient for changes in the IPI is -0.3596 and significant at the 5 percent level, indicating an inertia effect in the industrial sector. This means that increases in the IPI in the previous period tend to be followed by downward adjustments in the current period.

Meanwhile, the variables exports (0.308), imports (0.445), the BI Rate (0.588), inflation (0.354), the exchange rate (0.573), and the money supply (0.629) do not significantly influence changes in the IPI in the short term, as they have probability values greater than 0.05.

b. Long-Term VECM Estimation

Table 7. Long-Term VECM Estimation

Variable	Coef.	P> Z
Export	321.4939	0.030
Import	-822.3592	0.000
BI Rate	33.80296	0.012
Inflation	-27.28097	0.004
Exchange Rate	-837.1013	0.007
Money Supply	383.2871	0.030

Source: Data processed with Stata 14, 2025

Based on the long-term VECM estimation results in Table 7, the long-term equilibrium relationship equation is as follows:

$$\begin{aligned} IPI_t = & 321,4939 Export_t - 822,3592 Import_t + 33,8030 BI Rate_t - 27,2810 Inflation_t \\ & - 837,1013 Exchange Rate_t + 383,2871 Money Supply_t \end{aligned}$$

Based on the long-run equation, the export variable has a coefficient of 321.4939 with a p-value of 0.030, thus having a positive and significant effect on the IPI. This indicates that a 1 percent increase in exports will increase the IPI by 321.4939 in the long run. This finding indicates that Indonesia's industrial sector remains highly dependent on external demand as the primary driver of production. The import variable has a coefficient of -822.3592 with a p-value of 0.000, thus having a negative and significant effect

on the IPI, indicating that a 1 percent increase in imports will decrease the IPI by 822.3592 in the long run. This condition reflects that a high dependence on imported products, especially finished goods, can weaken the performance of the domestic industry.

Furthermore, the BI Rate has a coefficient of 33.80296 with a p-value of 0.012, indicating a positive and significant effect on the IPI. This suggests that in the long term, increases in the benchmark interest rate are positively correlated with increases in the IPI. This may indicate that a stable interest rate policy is able to maintain the investment climate and industry confidence. The inflation variable has a coefficient of -27.28097 with a p-value of 0.004, thus having a negative and significant effect on the IPI, indicating that a 1 percent increase in inflation will decrease the IPI by 27.28097. This finding confirms that high inflation can increase production costs and reduce people's purchasing power.

The exchange rate variable has a coefficient of -837.1013 with a p-value of 0.007, indicating a negative and significant effect on the IPI. Thus, a 1 percent depreciation of the rupiah will decrease the IPI by 837.1013. This suggests that rupiah depreciation will reduce industrial performance in the long term, primarily due to increased import costs for raw materials and capital goods. The money supply has a coefficient of 383.2871 with a p-value of 0.030, thus having a positive and significant effect on the IPI. A 1 percent increase in the money supply will increase the IPI by 383.2871. This indicates that increased liquidity in the economy can stimulate industrial production activity in the long term.

4.1.7 Impulse Response Function (IRF) and Forecast Error Variance Decomposition (FEVD) Analysis

a. Impuls Response Function (IRF)

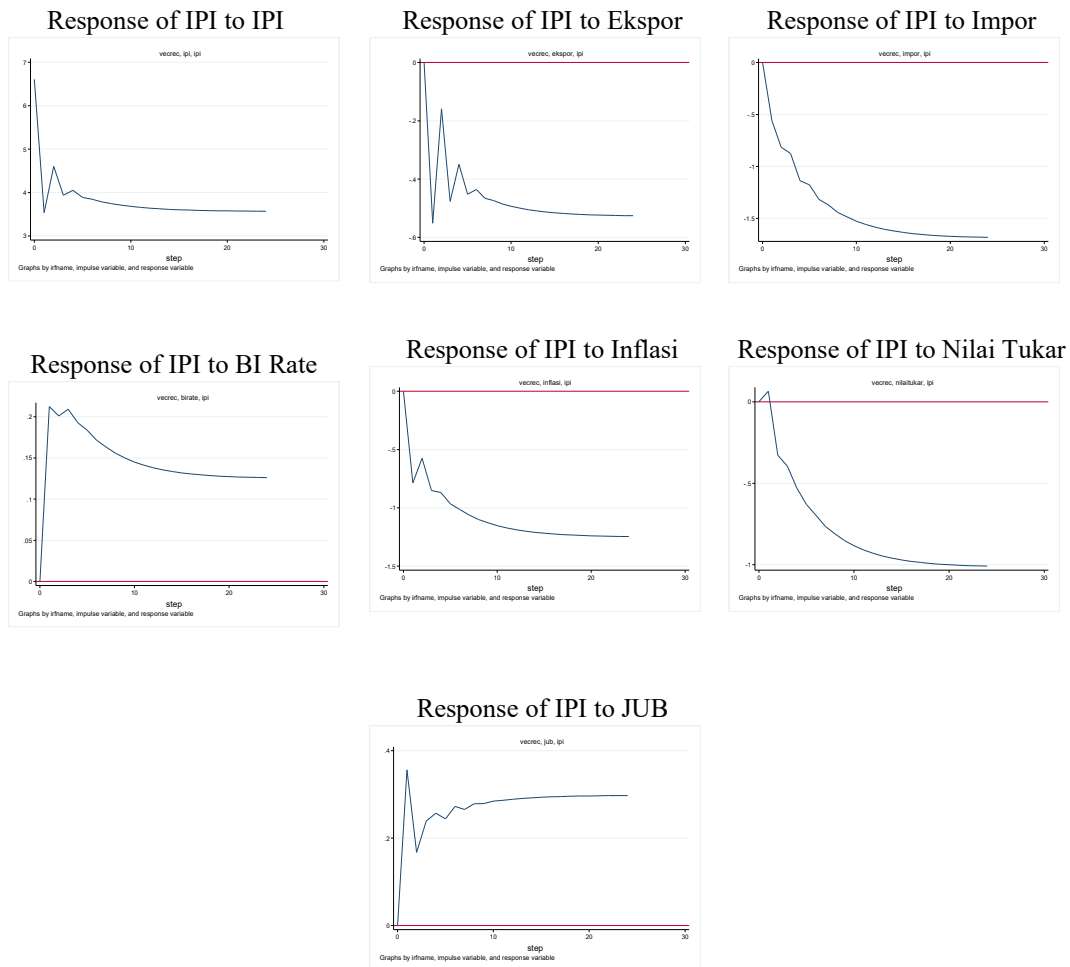


Figure 5. IRF Graph

According to Figure 5, the Industrial Production Index response to shocks itself shows a fairly strong positive response in the initial period. This indicates the persistence of IPI dynamics, where a shock to the IPI will immediately increase the IPI in the following period. This positive response tends to decrease gradually as the period progresses and begins to approach the equilibrium line (zero) after several periods, indicating that the impact of the shock is temporary and the system returns to a stable state in the long run.

Then, at the beginning of the period, the export shock provides a positive response to the IPI, which tends to increase. This increase continued until around the 6th period, after which fluctuations began to narrow and approached the zero line. Import shocks had a negative response to the IPI. In the initial period up to around the 6th period, the response decreased sharply. However, after the 7th period, the decline began to narrow and returned to the zero line.

Next, shocks to the BI Rate caused a decrease in the IPI response in the initial period. However, entering periods 5 to 8, the response began to improve. After the 10th period, fluctuations became smaller and tended to approach stability. Inflation shocks had a negative response to the IPI. In the initial period up to around the 8th period, the response was quite volatile. After the 8th period, fluctuations narrowed and the graph approached stability.

Next, exchange rate shocks (rupiah depreciation) had a negative response to the IPI. In the initial period up to around the 7th period, the response decreased sharply, then began to narrow and returned to stability. Money supply shocks had a positive response to the IPI. In the initial period, the response increased significantly. Fluctuations occurred until around the 6th period, then began to narrow and approached the zero line after the 10th period.

b. Forecast Error Variance Decomposition (FEVD)

Based on Table 8, the variation in forecasting errors for the IPI in the initial period is almost entirely explained by the IPI shock itself. In the short term, the IPI's contribution to the IPI variation remains very dominant, exceeding 97%, while other variables such as exports, imports, the BI Rate, inflation, the exchange rate, and the money supply contribute only relatively little. As the time horizon increases, the role of macroeconomic variables begins to increase, although the IPI remains the primary factor. In the medium to long term, the IPI's contribution gradually decreases to approximately 78% in period 24, while the contributions of other variables increase.

Table 8. FEVD for the IPI variable

Period	IPI	EXPORT	IMPORT	BI RATE	INFLATION	EXCHANGE RATE	MONEY SUPPLY
0	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
12	85.21%	0.92%	6.99%	0.14%	4.37%	2.04%	0.33%
24	77.94%	1.17%	10.67%	0.12%	6.16%	3.55%	0.40%

Source: Data processed with Stata 14, 2025

4.2. Discussion

4.2.1 The Relationship between Exports, Imports, and Monetary Variables with Manufacturing Industry Output in Indonesia

The ADF test results indicate that all variables are non-stationary at the level but stationary in the first difference, thus the VECM model is suitable for use. The Johansen cointegration test found at least one cointegration equation between exports, imports, the BI Rate, inflation, the exchange rate, the money supply (JUB), and the Industrial Production Index (IPI). This finding confirms the long-term relationship between international trade, monetary variables, and manufacturing industry output in Indonesia. Although in the short term these variables may fluctuate unidirectionally, in the long term their movements tend to move towards a common equilibrium. Theoretically, these results are in line with Keynes (1936) theory of aggregate demand, which places exports and imports as important components in output formation, and Frederic Mishkin's theory of monetary policy transmission, which explains that interest rates, inflation, exchange rates, and liquidity influence the real sector through various transmission channels.

4.2.2 The Effect of Exports, Imports, and Monetary Variables on Manufacturing Industry Output in the Short and Long Run

The Vector Error Correction Model estimation results show that in the short term, changes in exports, imports, and monetary variables have not significantly impacted the Industrial Production Index. This finding indicates that manufacturing output in Indonesia does not respond directly to changes in macroeconomic conditions. Theoretically, this condition aligns with the Cobb–Douglas Production Function Theory (Cobb & Douglas, 1928), which asserts that industrial output is determined by the accumulation of production factors, such as capital and labor. Therefore, changes in macroeconomic variables require time before being reflected in increased production capacity. Thus, the impact of exports, imports, and monetary policy on industrial output is time lagged.

The presence of a significant Error Correction Term (ECT) indicates the existence of an adjustment mechanism toward long-term equilibrium, although this adjustment process is relatively slow. This reflects the structural rigidity of the manufacturing sector, as stated by Juhro and Iyke (2019), which states that the real sector in developing countries tends not to respond quickly to macroeconomic shocks. This finding is also consistent with research by Ahwal & Danur (2021) and Handayani (2023), which found a weak influence of monetary variables on industrial output in the short term. Although the export variables used are national aggregate data, export dynamics at the macro level are still significantly transmitted to the manufacturing industry sector, a major contributor to Indonesian exports. Therefore, the use of national export data remains relevant in explaining the dynamics of manufacturing industry output. This finding is consistent with Ramadhani et al. (2018). Policy-wise, these results reinforce the urgency of strengthening export competitiveness and industrial downstreaming, as prioritized in the 2020–2024 National Medium-Term Development Plan (RPJMN) (Bappenas, 2020).

Conversely, imports negatively impact manufacturing industry output in the long run. This finding suggests that the Indonesian manufacturing industry's high dependence on imported raw materials and capital goods increases the sector's vulnerability to external pressures. Increased imports, especially when accompanied by exchange rate depreciation, will increase production costs and undermine the competitiveness of domestic industry. This finding aligns with research by Habibillah and Noveltyanti (2023) and Dyckhoff (2023), but differs from the findings of Sjöholm (1999), which showed a positive impact of imports in countries with more competitive industrial structures. The relevance of using national aggregate import data is also reinforced by Indonesia's import structure, which is dominated by raw materials and capital goods directly related to the manufacturing industry's production process. This policy implication is the importance of strengthening import substitution and Domestic Component Level (TKDN) policies to strengthen the national industrial structure (Kementerian Perindustrian, 2025).

Monetary variables play a significant role in influencing manufacturing industry output in the long run. The BI Rate has a positive and significant effect on the IPI. Theoretically, according to Mishkin (1995), the interest rate transmission mechanism explains that interest rate increases increase borrowing costs and suppress investment, thus negatively impacting output. However, the results of this study point in a different direction. This condition can be explained by the reaction function of monetary policy, where Bank Indonesia raises interest rates in response to inflationary pressures or economic strengthening. Thus, the positive relationship more closely reflects a policy response to economic expansion (Bank Indonesia, 2025a). This finding differs from Otero (2017) and Matola (2023) but aligns with Ahwal & Danur (2021) who suggest that the impact of interest rates is dynamic and contextual. From a policy perspective, interest rate management needs to maintain a balance between price stability and real sector growth momentum.

Inflation negatively impacts industrial output, as rising inflation drives up production input costs and creates uncertainty that hampers long-term investment planning. This finding supports the cost-push inflation theory and is consistent with research by Köse & Ünal (2024) and Baba (2025). In policy implementation, these findings reinforce the importance of controlling inflation through Bank Indonesia's Inflation Targeting Framework, as well as synergy with government policies through the Central and Regional Inflation Control Teams (TPIP-TPID). Inflation stability is a crucial prerequisite for sustainable manufacturing production (Bank Indonesia, 2026).

The exchange rate negatively impacts manufacturing industry output in the long run, indicating that rupiah depreciation tends to depress industrial performance. Although depreciation theoretically can increase export competitiveness, in the Indonesian context, the negative impact is more dominant due to

the industry's high dependence on imported inputs. The increase in raw material and capital goods costs due to exchange rate depreciation is not fully offset by increased exports, resulting in a decline in industrial output. This finding aligns with research by Matola (2023) and Dyckhoff (2023). Therefore, this finding indicates the importance of exchange rate stabilization through Bank Indonesia's monetary and macroprudential policy mix to maintain the competitiveness and sustainability of domestic industrial production (Bank Indonesia, 2025b).

Meanwhile, the money supply (JUB) had a positive and significant effect on the IPI. Increased liquidity strengthened credit distribution and encouraged production capacity expansion. This finding aligns with Mishkin's monetary transmission theory and research by Kutu & Ngilawa (2016) and Ahwal & Danur (2021). In a policy context, these results support accommodative monetary policy and strengthening banking intermediation for the productive sector, as reflected in Bank Indonesia's macroprudential policy and government support for financing priority manufacturing industries (Bank Indonesia, 2025).

4.2.3 Dynamic Response of Manufacturing Industry Output to Shocks on Export, Import, and Monetary Variables

The IRF results show that the export shock responded positively to the IPI in the initial period, indicating that increased external demand stimulated manufacturing production activity. Conversely, the import shock responded negatively before stabilizing, indicating that increased imports tend to depress domestic industrial output, especially in the short term. Regarding monetary variables, shocks to the BI Rate, inflation, and exchange rates responded negatively because they increased capital and production costs, while shocks to the money supply responded positively because they loosened liquidity and encouraged production expansion. Empirically, these findings align with Ramadhani et al. (2018), who found a positive impact of export shocks on the manufacturing industry, as well as Köse & Ünal (2024) and Ahwal & Danur (2021), who showed that shocks to imports, interest rates, and inflation negatively impacted industrial output, while increased liquidity positively impacted industrial output.

Theoretically, this positive response to export shocks aligns with the Export-Led Growth theory Balassa (1978) and Feder (1983), which positions exports as a driver of growth through market expansion and increased production scale. The negative response to import shocks can be explained theory of aggregate demand Keynes (1936), where increased imports reduce demand for domestic products. Meanwhile, the IPI's response to monetary shocks is consistent with monetary policy transmission theory Mishkin (1995), which explains that rising interest rates, inflation, and exchange rate depreciation pressure the real sector by increasing capital costs and production costs, while an increase in the money supply stimulates production activity by increasing liquidity.

Furthermore, the FEVD results show that in the short term, IPI variation is still dominated by internal shocks. However, in the long term, the contribution of external variables increases, particularly imports, which are the largest determinant after internal factors. These results are consistent with research by Habibillah & Novelyanti (2023), which shows that imports are the most influential external factor affecting long-term variations in manufacturing industry output. From a policy perspective, the negative response to import and exchange rate shocks emphasizes the importance of strengthening the domestic industrial structure to reduce dependence on imported inputs, in line with the policy direction of the Ministry of Industry of the Republic of Indonesia through the 2015–2035 RIPIN (Kementrian Perindustrian, 2015). The positive response to the export shock supports the downstreaming strategy and strengthening of export-oriented industries as outlined in the 2020–2024 National Medium-Term Development Plan (RPJMN) prepared by the National Development Planning Agency (Bappenas, 2020). Furthermore, the significance of the monetary shock demonstrates the importance of policy coordination between the government and Bank Indonesia in maintaining stability in inflation, interest rates, the exchange rate, and liquidity to support real sector growth, particularly the manufacturing industry.

5. Closing

5.1 Conclusion

Based on the problem formulation, research objectives, and the results of empirical analysis conducted using the Vector Error Correction Model (VECM), Impulse Response Function (IRF), and Forecast Error Variance Decomposition (FEVD) approaches, this study yields several key findings. There is a long-term relationship (cointegration) between exports, imports, the BI Rate, inflation, the exchange rate, and the money supply with manufacturing industry output in Indonesia, as proxied by the Industrial Production Index (IPI). The cointegration test results indicate that these variables are structurally related and move together in long-run equilibrium. Thus, the dynamics of international trade and monetary policy are part of a system that simultaneously relates to movements in manufacturing industry output.

In the short term, most export, import, and monetary variables have not shown a significant effect on changes in manufacturing industry output. This indicates that the manufacturing sector does not directly respond to changes in macroeconomic variables over a single period. However, the presence of a significant Error Correction Term (ECT) indicates the existence of an adjustment mechanism toward long-run equilibrium. In the long run, all variables have been shown to have a significant effect on manufacturing industry output. Exports, the BI Rate, and the money supply have a positive and significant effect, while imports, inflation, and the exchange rate have a negative and significant effect on the IPI. These findings indicate that over the long term, export performance and economic liquidity conditions drive manufacturing industry growth, while import pressures, inflation, and exchange rate depreciation tend to depress industrial sector performance.

The IRF analysis results indicate that the response of manufacturing industry output to shocks in exports, imports, and monetary variables fluctuates in the initial period, but gradually returns to equilibrium in the medium to long term. This indicates that the impact of economic shocks on manufacturing industry output is not permanent. Meanwhile, the FEVD results indicate that in the short term, variations in manufacturing industry output are largely explained by shocks to the variables themselves. However, in the long term, the contribution of exports, imports, and monetary variables in explaining variations in manufacturing industry output increases.

5.2 Research Limitations

This study has several limitations. First, the use of export and import data in aggregate national form does not fully reflect the characteristics of each manufacturing subsector. Second, the variables used are limited to international trade and monetary variables, thus not including other structural factors such as labor productivity, foreign direct investment, and technological development. Therefore, future research is recommended to use more specific data on the manufacturing subsector and add other relevant variables to produce a more comprehensive analysis.

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