International Journal of Accounting and Finance in Asia Pacific (IJAFAP)
Vol. 8 No. 3, pp.497-515, October, 2025
E-ISSN: 2655-6502 P-ISSN: 2684-9763
https://www.ejournal.aibpmjournals.com/index.php/IJAFAP

Macroeconomic Variable Analysis of Crude Oil Consumption in Indonesia for the Period 1983-2023

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ARTICLE INFORMATION

Publication information

Research article

HOW TO CITE
Sultan, S., & Putri, S. R. (2025). Macroeconomic variable analysis of crude oil consumption in Indonesia for the period 1983-2023. *International Journal of Accounting and Finance in Asia Pacific*, *8*(2), 497-515.

DOI:
https://doi.org/10.32535/ijafap.v8i3.4196

Received: 14 August 2025
Accepted: 17 September 2025
Published: 20 October 2025

ABSTRACT

The imbalance between Indonesia's rising crude oil consumption and declining domestic production poses risks to sustainable economic growth and energy security. This study analyzes the long- and short-run effects of domestic crude oil prices, manufacturing sector value added, and GDP per capita on Indonesia's crude oil consumption from 1983 to 2023 using the Error Correction Model (ECM), with annual data sourced from BP Statistical Review 2024 and the World Bank 2024. Long-run results indicate that manufacturing value added ($p = 0.0000$) and GDP per capita ($p = 0.0000$) significantly influence crude oil consumption, while domestic crude oil prices ($p = 0.6800$) are insignificant. In the short run, all three variables significantly affect consumption ($p < 0.05$), with domestic crude oil prices and GDP per capita exerting positive effects and manufacturing value added exhibiting a negative effect. The error-correction coefficient of –0.2643 indicates a moderate adjustment toward long-term equilibrium. These findings demonstrate that economic growth and industrial value creation are primary drivers of energy demand, whereas price mechanisms remain less effective under government subsidies. Policy recommendations include enhancing energy efficiency, promoting industrial modernization, restructuring fuel-subsidy allocations, and investing in renewable energy to reduce oil dependence and support sustainable growth.

Keywords: Crude Oil Consumption; Domestic Oil Prices; Energy Demand; GDP per Capita; Manufacturing Sector

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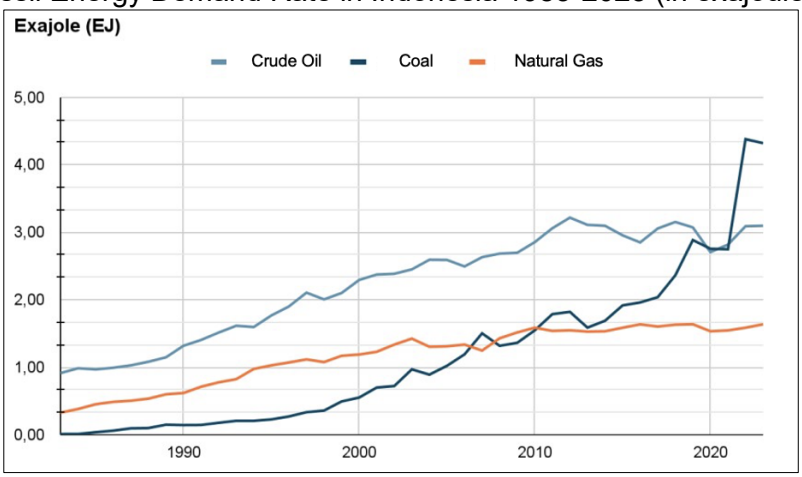
INTRODUCTION

Energy Resources (SDE) are a crucial factor in driving economic activity in Indonesia. Based on their type, SDE used in Indonesia are divided into renewable and non-renewable energy sources. Renewable energy sources include water, geothermal, biomass, and biofuels. Meanwhile, non-renewable energy sources, or fossil energy, include oil, coal, and gas. The most widely used fossil energy in Indonesia is oil, followed by coal and natural gas.

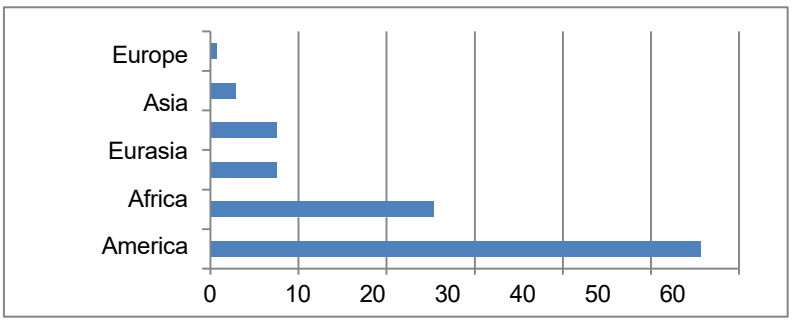
Figure 1. Fossil Energy Demand Rate in Indonesia 1983-2023 (in exajoules)



Source: British Petroleum (BP, 2024)

According to Figure 1, the most widely consumed type of fossil energy in Indonesia was oil, which is used as the primary energy source to produce fuels and essential raw materials in various industrial sectors.

Figure 2. Crude Oil Reserves by Region in 2022 (in percent)



Source: Organization of the Petroleum Exporting Countries (OPEC, 2024)

Crude oil is a form of unprocessed petroleum. Petroleum energy plays a vital role in economic growth and national energy needs. According to Reksohadiprodjo and Pradono (2012), developing countries produce more petroleum energy than coal and natural gas. This is evidenced by the abundant oil reserves generally found in developing countries, particularly in the Middle East, such as Arab countries (including Iran). According to Figure 2, which holds 55.7% of the world's total crude oil reserves of 1.56 trillion barrels per day. On the other hand, the largest energy demand comes from developed countries, where the industrial sector consumes a significant amount of energy in various economic activities. For example, the United States remains a net oil importer, despite being one of the world's largest oil producers. This is due to the high demand for petroleum energy to meet the country's industrial needs (Sartika & Amar, 2020).

Demand for oil energy in Indonesia tends to increase, in line with population growth and economic development, particularly in sectors that are highly dependent on fossil fuels, such as the manufacturing sector. This sector includes processing, manufacturing, and assembly industries, which play a crucial role in increasing economic value added. Increased activity in the manufacturing sector often directly impacts Gross Domestic Product (GDP) per capita growth, as more prosperous communities tend to increase their energy consumption to meet production and consumption needs (Banelienė, 2021). This is evident in urban areas, where populations have higher GDP per capita values than rural areas, where more oil energy is consumed due to the availability of various household products that require crude oil as a primary energy source. However, on the other hand, crude oil production in Indonesia tends to decline, resulting in a gap between domestic crude oil demand and production. As a result, Indonesia's dependence on oil imports from other countries to meet domestic demand continues to increase. Continued increases in oil imports will impact the balance of payments deficit.

Table 1. Average Production, Consumption, and Import Export of Crude Oil in Indonesia 1983-2023 (in barrels/day)

	1983-1992	1993-2002	2003-2012	2013-2022	2023
Average production	1475.6	1495.2	1026.4	793.6	638
Growth(%)	1.8	-1.9	-3.2	-3.4	-1.3
Average consumption	544.4	974.4	1345.5	1534.5	1603.7
Growth(%)	4.9	4.9	3.4	0.1	0.4
Export	960	770.3	355.3	194.7	55.8
Growth(%)	0.2	-2.2	-8.1	-7.9	41.1
Import	81.1	221.3	300.5	316.3	332.7
Growth(%)	76.7	10.4	0.864	1.729	6.936

Source: BP (2024) and OPEC (2024)

Table 1 shows that Indonesia's increasing dependence on crude oil imports is one of the reasons it withdrew from the Organization of the Petroleum Exporting Countries (OPEC). Indonesia has been a member of OPEC since 1962, which plays a role in determining global oil prices and production. However, this membership also brings its own challenges, where production policies must align with OPEC agreements that sometimes do not align with domestic needs. Therefore, Indonesia withdrew from OPEC membership to focus on more sustainable domestic energy management (Yusgiantoro, 2000). This decision demonstrates the importance of Indonesia to re-evaluate its dependence on crude oil, which not only impacts the economy but also influences energy and environmental policies.

Given the instability caused by dependence on crude oil, it is crucial to analyze the factors influencing fluctuations in crude oil consumption and imports in Indonesia, with oil prices being a key factor. Oil prices are a key driver of fluctuating energy consumption. When prices fall, demand increases, and vice versa, when prices rise, consumption decreases, a phenomenon known as the law of demand (Ilmanita & Aimon, 2019). Within Indonesia's market mechanism, domestic pricing is still influenced by subsidy policies and income distribution; thus, fuel pricing in Indonesia is still not fully efficient. Therefore, it is crucial to understand the impact of crude oil price changes on meeting Indonesia's crude oil needs.

Based on this phenomenon, researchers are interested in conducting a study entitled "Macroeconomic Variable Analysis of Crude Oil Consumption in Indonesia for the Period 1983-2023." A good understanding of the factors that influence crude oil consumption in Indonesia can help in identifying steps to reduce negative impacts on the environment

and increase energy efficiency, which can ultimately support the creation of stable economic growth.

Based on the background of this research, which emphasizes crude oil consumption as a primary energy source in developing countries, including Indonesia, it is evident that such dependence creates economic instability and shapes energy policy. In the midst of this instability, analyzing the factors influencing fluctuations in consumption becomes essential, with oil prices serving as a significant determinant. In addition, the value added of the manufacturing sector and GDP per capita also act as important indicators in explaining crude oil consumption patterns in Indonesia.

In light of these considerations, the research raises several questions. First, how do domestic oil prices affect crude oil consumption in Indonesia in both the long and short term during the period 1983 to 2023? Second, how does the value added of the manufacturing sector influence crude oil consumption in Indonesia over the same period and across both time horizons? Third, how does GDP per capita affect crude oil consumption in Indonesia in the long and short term from 1983 to 2023?

Based on these research questions, the objectives of this study are formulated as follows. The first objective is to analyze the effect of domestic oil prices on crude oil consumption in Indonesia in both the long and short term from 1983 to 2023. The second objective is to examine the effect of value added in the manufacturing sector on crude oil consumption within the same timeframe and across the two time perspectives. The third objective is to analyze the influence of GDP per capita on crude oil consumption in Indonesia in the long and short term during the period from 1983 to 2023. Thus, it can be said that crude oil consumption can be an important indicator in assessing a country's energy needs and is closely related to economic growth (Mlaabdal et al., 2020).

Recent empirical works from ASEAN contexts also highlight the macro-to-micro linkage between economic performance and consumption behavior. For example, Ee et al. (2024) found that consumers' economic expectations and purchasing decisions are highly sensitive to perceived value and trust, implying similar behavioral mechanisms that may influence Indonesia's oil-consumption pattern.

In summary, this study contributes to the empirical discussion on Indonesia's energy policy by integrating macroeconomic indicators into an extended Error Correction Model (ECM) framework using long-term data from 1983 to 2023. The novelty lies in simultaneously examining domestic oil prices, manufacturing value added, and GDP per capita to capture both short-run dynamics and long-run equilibria of oil consumption. The findings are expected to provide theoretical insights for energy-demand modeling and practical implications for designing policies on oil dependency reduction and economic diversification in Indonesia.

LITERATURE REVIEW

Several researchers in previous studies have focused solely on general energy consumption or petroleum energy consumption. This research model uses the ECM to analyze long-term and short-term effects. Although several previous studies have used the ECM model, such as those by Oltulular (2024) and Santoso (2022), their focus differs from this study. Oltulular (2024) emphasizes the relationship between oil prices and oil consumption across countries, while Santoso (2022) focuses on oil imports in Indonesia. Furthermore, this study is located in Indonesia, but with a longer time span, from 1983 to 2023, so it is expected to provide deeper long-term insights.

Crude Oil Consumption

Crude oil is a thick, black, and foul-smelling liquid energy source derived from petroleum drilling and is one of the world's largest energy sources, alongside natural gas and coal. Processed crude oil can be converted into various fuels such as gasoline, diesel, aviation fuel (avtur), and kerosene, or used for non-energy purposes such as lubricants or the manufacture of plastic pellets (Setiawan et al., 2019). For every country, including Indonesia, crude oil energy is a crucial need, especially for maintaining human civilization in this era of industrialization. Therefore, this energy source is a serious concern for governments in many countries. To prevent energy shortages, increasing the use of New and Renewable Energy (NRE) is necessary.

The high demand for crude oil energy will drive increased crude oil consumption. Crude oil consumption refers to the amount of crude oil used to meet human needs and carry out daily activities. Crude oil consumption in some countries increases by 2-3% annually compared to total crude oil production. This creates a gap between global demand and crude oil availability. In the 2021 Statistical Review of World Energy report (BP, 2021), based on 2020 data, estimated that current oil reserves are only sufficient to meet demand for the next 50 years. Meanwhile, the Organization of OPEC estimates that global demand will be met within 50 to 53 years (Astuti et al., 2023).

Crude Oil Prices

Crude oil prices are the market value of oil, determined by global supply and demand (Santoso, 2022). Over the past ten years, Indonesia has experienced significant fluctuations in crude oil prices. Fluctuations in oil prices, both short-term and long-term, impact macroeconomic variables. Rising oil prices can reduce aggregate demand by widening the income distribution between oil-exporting and oil-importing countries. This aligns with Marshall's law of demand, which states that when the price of a good rises, demand for that good falls, and vice versa (Ilmanita & Aimon, 2019).

On the other hand, falling oil prices can reduce income and investment in the energy sector. Therefore, appropriate government policies are essential to avoid economic and social instability. The Indonesian government has implemented a fuel subsidy policy in response to price fluctuations to ensure fuel remains affordable for the public. However, in recent years, the government has diverted subsidy funds to social programs such as Direct Cash Assistance (BLT), education funds through School Operational Assistance (BOS), and health funds through health insurance for poor households (Santoso, 2022).

Fluctuating oil prices can impact various economic sectors, from inflation to transportation costs. Therefore, maintaining stable crude oil prices is essential to boost Indonesia's economic growth. Achieving stability requires accurate pricing. Currently, global crude oil pricing is based on two common groups or standards: Brent Crude (Brent) and West Texas Intermediate (WTI). Meanwhile, in Indonesia, the global crude oil basket price is used to calculate the Indonesian Crude Price (ICP). The ICP, or Indonesian crude oil price, is the basis for the price of Indonesian crude oil on the international market, used in the state budget (APBN). The ICP is set monthly in US dollars per barrel by the Directorate General of Oil and Gas and the Ministry of Energy and Mineral Resources of the Republic of Indonesia. The determination of the ICP is inseparable from various factors that influence oil prices in Indonesia (Saraswati & Kusumawati, 2017).

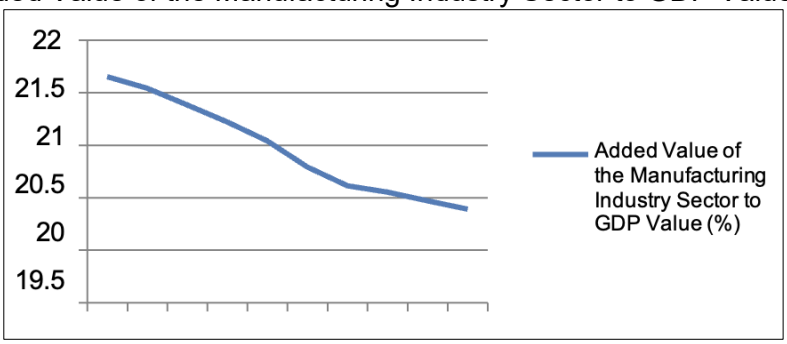
The price of crude oil in Indonesia is determined based on a formula stipulated in Regulation of the Minister of Energy and Mineral Resources of the Republic of Indonesia Number 29 of 2021. The crude oil pricing team is tasked with evaluating and submitting proposals for determining the Indonesian crude oil pricing formula to the minister. Article

2 of Regulation Number 29 states that Indonesian crude oil consists of primary crude oil and other crude oil. Other crude oil consists of permanent crude oil and temporary crude oil (Ministry of Energy and Mineral Resources, 2021). The Determination of the Indonesian Crude Oil Price Formula Methodology is regulated in Chapter II, Article 3, paragraph 1.

The Added Value of the Manufacturing Sector

In general, based on Lewis's two-sector development theory, a country will begin its economic development from the agricultural sector, which is the starting point for an economy that relies solely on labor, land, and minimal capital. Subsequently, a country's economic focus will shift to the manufacturing sector, which can absorb a larger workforce with less land requirements and higher productivity. At this point, planning a country's manufacturing industry development becomes crucial (Kuncoro, 2010).

Figure 3. Added Value of the Manufacturing Industry Sector to GDP Value (in percent)



Source: Central Agency of Statistics of Indonesia (BPS Indonesia, 2024)

According to Figure 3, however, with technological and global economic developments, sector development has become increasingly complex. Some developed countries have begun to focus on the service sector, where productivity and labor quality are key factors rather than labor quantity.

The manufacturing sector, part of the industrial subsector, is a key source of economic growth in Indonesia. Figure 3 shows that over the past ten years, the manufacturing sector's contribution to national GDP has declined, but its share has consistently remained above 20% from 2014 to 2023. These results correspond with Kee et al. (2022), who emphasized that sustained economic and industrial activity strongly drives consumption even under cost-pressure conditions. Similarly, Kee et al. (2023) demonstrated that customer satisfaction and brand trust analogously reflect economic confidence, variables that parallel GDP growth effects on energy demand. This annual decline indicates that the service sector is beginning to overtake the manufacturing sector. Therefore, the development of the manufacturing industry is a crucial component of the structural change in the economy, which will impact economic growth. Capital investment is a crucial aspect of economic growth.

Figure 4. Contribution of Ten Business Sectors to Total GDP Value in 2023 (in percent)

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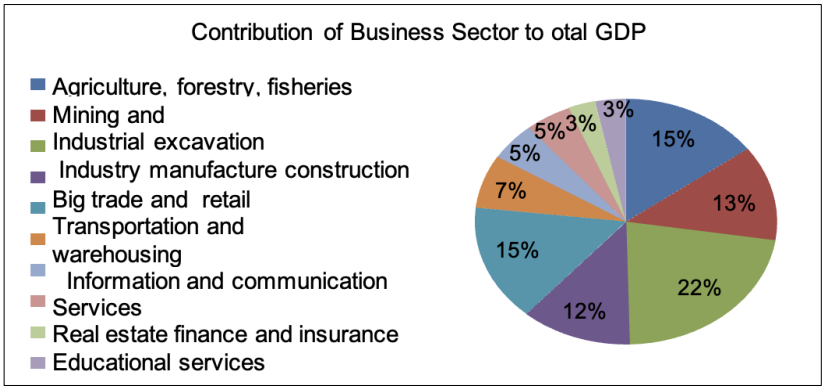


Source: BPS Indonesia (2024)

Technological advancements, or the Industrial Revolution 4.0, have made the industrial development planning process multidimensional. The natural resources and agriculture sectors can support the raw materials needed for the manufacturing industry, while the services sector can support research and development (R&D) for manufactured products. According to Figure 4, therefore, industrialization policies in Indonesia need to consider the interrelationships between potential manufacturing sectors and subsectors to increase Indonesia's participation in international trade, which can impact the sector's added value.

Gross Domestic Product (GDP) per Capita

GDP is often considered the best measure of economic performance. The purpose of GDP is to summarize economic activity in a specific monetary value over a specific period. GDP simultaneously measures two things: the total income of each person in the economy and the total expenditure on the economy's output of goods and services. GDP measures something that most people care about: a person's total income (GDP per capita). Similarly, an economy with a greater output of goods and services can better meet the demands of households, businesses, and the government (Mankiw, 2006).

According to the World Bank Data Help Desk (n.d.), countries around the world are classified into five groups based on their per capita income. Low-income economies are those with a per capita income of US$520 or less. Countries categorized as lower-middle-income economies have a per capita income of around US$1,740, while middle-income economies are those with a per capita income of approximately US$2,990. Upper-middle-income economies are classified as countries with a per capita income of about US$4,870. Lastly, high-income economies are defined as countries with a per capita income reaching around US$25,480.

Mankiw (2006) explains that the calculation of GDP per capita is divided into two parts, namely real GDP per capita and nominal GDP per capita. The difference between the two lies in how it is calculated. Nominal GDP per capita uses current prices, while real GDP per capita uses constant prices. Real GDP per capita shows what would happen to spending on output if the quantity changed but the price did not. Real GDP per capita will vary from year to year in value only if the quantity produced varies because the ability of society to meet the economic needs of its members depends heavily on the quantity of goods and services produced, so real GDP per capita provides a better measure of economic prosperity than nominal GDP per capita.

Alkofahi and Bousrih (2024) present an empirical analysis of the energy transition in Saudi Arabia, emphasizing the factors driving fuel consumption. The results, using the Vector Error Correction Model (VECM), show that in the long run, GDP, labor,

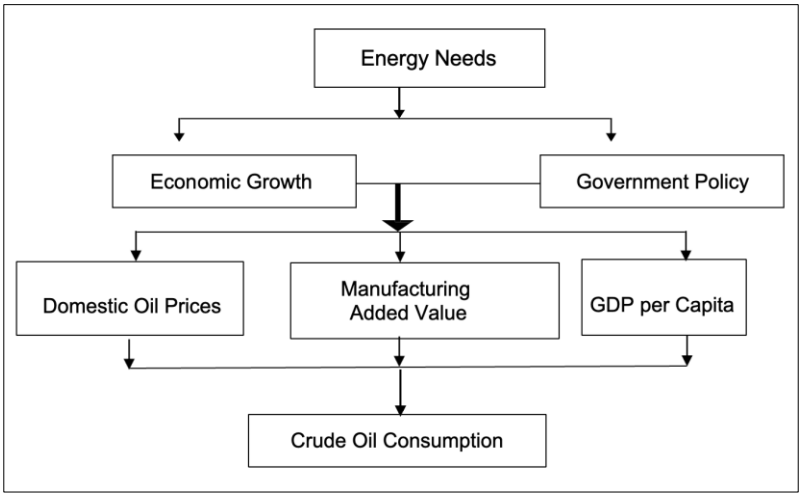
investment, and crude oil prices each significantly influence oil consumption. Meanwhile, in the short run, only investment has a negative impact on oil consumption.

Oltulular (2024) conducted a study that focused on analyzing oil consumption and oil prices from 1965 to 2022 in the largest and smallest oil-consuming countries. The Fourier-based Granger causality test used showed a causal relationship between oil consumption and oil prices in the US, Japan, Luxembourg, and New Zealand. Meanwhile, a long-term relationship between oil consumption and oil prices was found in the US, India, Japan, South Korea, Saudi Arabia, Russia, Canada, Mexico, and Estonia.

Conceptual Framework

Energy needs are often closely linked to increased economic growth. The development of economic activity and increasing urbanization have led to a higher demand for energy sources to support production and consumption activities, particularly in sectors that rely heavily on fossil fuels, such as industry, households, and transportation. Therefore, government policies play a crucial role in determining how Indonesia's energy needs can be optimized to support sustainable growth and efficient energy use. These policies include price regulations, subsidies, and energy efficiency, which can impact energy availability. Economic growth, influenced by government policies regulating energy availability, indicates an increase in energy demand in Indonesia.

Figure 5. Research Framework



Based on the theory of supply and demand, increased energy demand can impact the global energy market, potentially affecting market prices. High demand for crude oil consumption in the global market can lead to inflationary price increases. According to Figure 5, this increase negatively impacts economic growth due to reduced purchasing power. The use of crude oil as an energy source will drive production processes in the manufacturing industry and contribute to government revenue as capital for sustainable development. GDP per capita reflects the value of output from a country's economic activity over a specific period. An increase in GDP per capita reflects increased economic growth, which will determine how much energy is used to support economic activity. Ultimately, these three macroeconomic factors will influence crude oil consumption patterns in Indonesia.

Based on theoretical rationale and previous empirical studies in this field, the following hypotheses are proposed:

H1: Domestic crude oil prices negatively and significantly affect crude oil consumption in Indonesia in both the long and short term (1983–2023).
H2: Manufacturing sector value added negatively and significantly affects crude oil consumption in Indonesia in both the long and short term (1983–2023).
H3: GDP per capita positively and significantly affects crude oil consumption in Indonesia in both the long and short term (1983–2023).

RESEARCH METHOD

This study employed descriptive and associative research methods with a quantitative approach. Descriptive research methods are used to analyze data by describing or depicting the collected data as it is, without the intention of drawing general conclusions or generalizations. This method aims to provide a comprehensive picture of the state of the object being studied. Meanwhile, associative research methods are used to provide a comprehensive overview of the influence of one variable on another (Sugiyono, 2013). Associative research methods not only describe but also analyze how one variable can influence another, which is the main focus of this study.

This type of research uses a quantitative approach, namely a method that collects data in the form of numbers or qualitative data that is quantified. Quantitative research methods can be defined as research methods based on the philosophy of positivism, which assumes that phenomena can be classified and measured. Data analysis in this study is quantitative/statistical, with the aim of testing the established hypotheses (Sugiyono, 2013). Quantitative research is an approach to testing objective theories by examining the relationships between variables measured using research instruments, allowing numerical data to be analyzed using statistical procedures (Ghanad, 2023). Quantitative methods are used when the research problem, which serves as the starting point for the research, is clear. In preparing a research proposal, this problem must be demonstrated with data, both from the research itself and documentation (Sinaga, 2022).

The type of data used in this study is secondary data in the form of a time series from 1983 to 2023. This data was obtained from agencies or institutions related to the research. Secondary data sources are those that do not directly provide data to the data collector, for example, through other people or through documents (Sugiyono, 2013). The data used in this study are data on Indonesian crude oil consumption and prices from the BP Statistical Review of World Energy published by BP, and data on GDP per capita and value added in the manufacturing sector from the World Bank. Furthermore, important information was also obtained from various sources, including books, articles, and relevant previous research journals, through a literature review technique, with the hope of supporting in-depth research analysis on the topic under study. The data analysis tool used in this study was the ECM method. The ECM method is used as an econometric tool to identify the long-term and short-term effects that occur due to cointegration among research variables (Basuki & Prawoto, 2016). The ECM model has several uses, but its primary use in econometric work is to address problems with non-stationary time series data and spurious regression (Abdellah, 2025). Before estimating the ECM, several steps must be completed, including stationarity testing, determining the lag length, and testing the degree of cointegration. The ECM method is characterized by the inclusion of an Error Correction Term (ECT) element in the model. A stationary ECT is used not only to determine the presence of cointegration but also to measure how quickly variables return to long-term equilibrium (Utama, 2014).

The initial model used in this study is as follows:

$$Kt = f(Ht, Nt, Pt)$$

The model function above can be transformed into an econometric model by including a constant ($\beta 0$) and an error term (εt) as follows:

$$Kt = \beta 0 + \beta 1Ht + \beta 2Nt + \beta 3Pt + \varepsilon t$$

Where:

$LnKt$	: crude oil consumption in period t
$\beta 0$: constant $LnHt$	: crude oil price in period t
Stationarity	: value added by the manufacturing sector in period t
Stationarity	: GDP per capita in period t
Stationarity	: error term or residual value.

Stationarity is an important concept in econometric theory that refers to the stochastic process of a set of random variables in a time series. Data resulting from a random or stochastic process is said to be stationary if it meets three criteria: its mean and variance are constant over time, and the covariance between two time series data sets depends only on the lag between the two time periods. Non-stationary data indicates the data is experiencing spurious regression. Spurious regression is a situation where the regression results show statistically significant regression coefficients and high coefficients of determination, but the relationship between the variables in the model is unrelated (Fakhr & Bouabid, 2023). In the stationarity test, there are two stages of analysis that must be carried out: The stationary test for time series data in this study was conducted using the Augmented Dickey-Fuller (ADF) unit root test. If the time series data is non-stationary, then the data is facing a unit root problem and is moving randomly (random walk) (Basuki & Prawoto, 2016). The equation model for the unit root test using the ADF method is as follows:

$$\Delta Kt = \alpha 0 + \alpha 1Ht + \alpha 2Nt + \alpha 3Pt + \gamma Kt{-}1 + \sum p\ \beta i\ \Delta Kt{-}1{+}1 + \varepsilon t$$

Description:

ΔKt	: change in crude oil consumption in period t ($Kt - Kt{-}1$)
$\alpha 0$	: constant
Ht	: domestic crude oil price in period t
Nt	: value added by the manufacturing sector in period t
Pt	: GDP per capita in period t
γ	: coefficient for the value of oil consumption in the previous period
$(Kt{-}1)$ p	: length of the time lag based on i = 1.2.
p. βi	: coefficient for the lag of the change in oil consumption
$(\Delta Kt{-}1{+}1)\ \varepsilon t$	: error term or residual value.

If the unit root test shows that the observed time series data is not stationary, the next step is to perform a data differentiation process. This test for data stationarity through differentiation is called the degree of integration test. The degree of integration test aims to determine what degree of integration the data will become stationary (Basuki & Prawoto, 2016). The formulation of the degree of integration test for the ADF model is as follows:

$$\Delta 2Kt = 0 + 1Ht + 2Nt + 3Pt + 1\gamma \Delta Kt{-}1 + \sum p\ \beta i\ 2Kt{-}1 + 1 + \varepsilon t$$

Description:

$\Delta 2Kt$	: second change in crude oil consumption in period t
$(\Delta Kt - \Delta Kt{-}1)\ \alpha 0$	: constant

Ht : crude oil price in period t
Nt : value added by the manufacturing sector in period t
Pt : GDP per capita in period t
γ : coefficient for the change in oil consumption in the previous period
$(\Delta Kt-1)$ r : length of time lag based on i = 1.2 p.
βi : coefficient for the lag of the second change in oil consumption
$(\Delta 2Kt-1+1)$ εt : error term or residual value.

Cointegrated variables indicate a long-term relationship or equilibrium between the dependent and independent variables. However, in the short term, these variables may experience imbalance. Therefore, to address this difference, adjustments and an appropriate model are required for the analysis, namely the ECM. The ECM is an econometric model that includes adjustments to correct short-term imbalances towards long-term equilibrium and explains the influence between cointegrated variables in the study. The ECM method in this study uses the Engle-Granger (E-G) ECM model, also known as the two-step model. The first stage is the analysis of the long-term, and the second stage is for the short-term regression equation. According to the E-G, if two variables, Y and X, are not stationary but cointegrated, the relationship between the two can be explained using the ECM model (Utari, 2025). The short-term regression equation model can be explained as follows:

$$\Delta Kt = \alpha 0 + \alpha 1 \Delta Ht + \alpha 2 \Delta Nt + \alpha \Delta Pt + \alpha 4 ECT + \varepsilon t$$

Where:

$$ECT = (Kt-1 - \beta 0 - \beta 1 It - \beta 2 Ht - \beta 3 Nt - \beta 4 Pt)$$

Description:
ΔKt : change in crude oil consumption in period t
$Kt-1$: crude oil consumption in the previous period
$\alpha 0$: constant
ΔHt : change in crude oil price in period t
ΔNt : change in value added of the manufacturing sector in period t
ΔPt : change in GDP per capita in period t
$\alpha 5 ECT$: imbalance correction coefficient
εt : residual value

The ECT coefficient is said to be statistically significant if its probability value is less than 5%, indicating that the ECM model used is valid (Utama, 2014).

RESULTS

This study analyzes the effect of oil consumption on domestic crude oil prices, manufacturing sector value added, and GDP per capita in Indonesia from 1983 to 2023 using the ECM. The data used in this analysis is secondary time series data, consisting of annual data for the period 1983 to 2023, obtained from relevant institutions. Secondary data for oil consumption and Indonesian crude oil prices were obtained from BP, and GDP per capita and manufacturing sector value added from the World Bank.

The relationship between crude oil consumption and each independent variable remains uncertain. Therefore, to confirm the influence of oil consumption and the independent variables, we conducted a regression analysis between the variables, examining both the long-term and short-term effects.

The data tables for the variables in this study were processed using auxiliary tables to facilitate calculations in determining the results of hypothesis tests from the long-term and short-term regression analyses. The auxiliary data tables in this study underwent natural logarithm (ln) transformation to correct the distribution of the variables and reduce the effect of outliers. This transformation is performed to ensure the analysis is more valid and in accordance with the assumptions of the regression model.

Stationarity Test

The stationarity test is a crucial step in analyzing time series data to eliminate autocorrelation issues. One way to determine whether the data is stationary is by using the unit root test and the degree of integration. Unit Root Test in the ADF test, if the data is non-stationary at the level, the data can be further differenced using the degree of integration test to obtain the stationarity level at the nth level, I(n). After conducting the unit root test at the level-intercept level for each research variable, the results are shown in the following table:

Table 2. Unit Root Test Results Using the ADF Test Method Level-Intercept

Variabel	ADF Test Statistic	5% - Critical Value	Probability
Ln Crude Oil Consumption (Y)	-2.483845	-2.936942	0.1269
Ln Domestic Crude Oil Prices (X1)	-1.853702	-2.936942	0.3501
Ln Added Value of the Manufacturing Sector (X2)	-0.323692	-2.936942	0.9123
Ln GDP per capita (X3)	-1.208294	-2.936942	0.6615

Source: Processed EViews 12 output

Degree of integration test based on the unit root in Table 2. Since the time series data is not stationary at the same level, the next step is to conduct a degree of integration test to determine at what degree of integration the data will become stationary.

Table 3. Results of the 1st Difference Degree of Integration Test

Variabel	ADF Test Statistic	5% - Critical Value	Probability
Ln Crude Oil Consumption (Y)	-5.165999	-2.938987	0.0001
Ln Domestic Crude Oil Prices (X1)	-5.506667	-2.941145	0.0000
Ln Added Value of the Manufacturing Sector (X2)	-6.286945	-2.938987	0.0000
Ln GDP per capita (X3)	-6.854304	-2.938987	0.0001

Source: Processed EViews 12 output

Table 3 presents the results of the ADF test conducted at the first difference to determine the degree of integration for each variable in the model. The variables include crude oil consumption (Y), domestic crude oil prices (X1), the added value of the manufacturing sector (X2), and GDP per capita (X3). The results show that all variables have ADF test statistics greater in absolute value than the 5% critical value, indicating that each variable is stationary at the first difference level. Specifically, the ADF test statistics for Ln Crude Oil Consumption, Ln Domestic Crude Oil Prices, Ln Added Value of the Manufacturing Sector, and Ln GDP per Capita are -5.165999, -5.506667, -6.286945, and -6.854304, respectively, all of which are more negative than their corresponding critical values at the 5% significance level.

Furthermore, all probability values are below 0.05, confirming statistical significance and supporting the rejection of the null hypothesis of a unit root. This indicates that the data

series for all variables are integrated of order one, I(1), meaning they become stationary after the first differencing. These results validate that the variables are suitable for further econometric analysis, such as cointegration testing or long-run model estimation, as they meet the stationarity requirements essential for time-series regression analysis.

Cointegration Test

After the research data is stationary and meets the criteria for time series data, the next step is to conduct a cointegration test. This cointegration test aims to demonstrate the possibility of a long-run equilibrium relationship between the dependent and independent variables. One of the cointegration test methods used in this study is the EG method, which develops the ADF and DF tests to test the stationarity of regression residuals. The resulting residuals are used to calculate the ECT.

Table 4. Results of the ADF ECT Test at Level

Variable	ADF Test Statistic	Test Critical Value			Probability
		1%	5%	10%	
ECT	-3.456735	-3.605593	-2.936942	-2.606857	0.0146

Source: Processed EViews 12 output

Table 4 presents the results of the ADF test on the ECT to assess the presence of cointegration among the variables in the model. The ADF test statistic for the ECT is –3.456735, which is more negative than the 5% critical value (–2.936942) but slightly less negative than the 1% critical value (–3.605593). The corresponding probability value of 0.0146 is below the 5% significance threshold, indicating statistical significance.

These results confirm that the ECT is stationary at the level form, which implies the existence of a long-run equilibrium relationship among the variables — crude oil consumption, domestic crude oil prices, the added value of the manufacturing sector, and GDP per capita. In other words, despite short-term fluctuations, the variables tend to move together toward a stable equilibrium over time. This finding supports the validity of the cointegration model, demonstrating that any short-term disequilibrium will be corrected toward long-term stability through the error correction mechanism.

Long-Run Equation Regression Results

Based on the previous cointegration test, a long-run relationship or equilibrium was found between the studied variables. A summary of the long-run model regression results can be seen in Table 5.

Table 5. Long-Term Regression Results of Crude Oil Consumption

Variabel	Coefficient	Std. Error	t-Statistic	Probability
C	-9.108709	0.950377	-9.584311	0.0000
Ln Domestic Crude Oil Prices (X1)	0.015177	0.036510	-0.415698	0.6800
LnManufacturing Added Value (X2)	-0.500305	0.075426	-6.633046	0.0000
Ln GDP per Capita (X3)	0.786498	0.056987	13.80140	0.0000
Adjusted R-squared	0.962939			
F-statistic	347.4292			
Prob (F-statistic)	0.000000			

Source: Processed EViews 12 output

The equation model for the long-term regression results in Table 5 can be written as follows:

LnConsumption = -9.108709 + 0.015177 LnPrice - 0.500305 LnManufacturing Value Added + 0.786498 LnGDP per Capita

Based on the estimation results of the long-term model, several key findings can be identified. In the long-term regression equation, the variables LnDomestic Crude Oil Price and LnGDP per Capita exert a positive influence on crude oil consumption, while the variable LnManufacturing Value Added shows a negative influence. The results of the F-statistic test indicate that the probability value of the F-statistic is 0.000000, which is less than 0.05. This suggests that the variables LnDomestic Oil Price, LnManufacturing Value Added, and LnGDP per Capita simultaneously have a significant effect on LnCrude Oil Consumption.

Furthermore, the t-statistic test results reveal that the probability values for the Manufacturing Value Added and GDP per Capita variables are both 0.0000, signifying a significant influence on crude oil consumption because the values fall below the 0.05 threshold. In contrast, the Domestic Crude Oil Price variable records a probability value of 0.6800, which exceeds 0.05, indicating that it does not significantly affect oil consumption. The Adjusted R-squared value of 0.962939 demonstrates that the independent variables in the model can explain 96.29% of the variation in the dependent variable, with the remaining variation attributable to other factors outside the model.

Short-Run Equation Regression

When conducting a short-run regression analysis, it is necessary to include the previously obtained ECT value to measure how quickly the variables under study return to equilibrium after a disturbance. In short-run regression, this variable is included as the independent variable.

Table 6. Short-Term Regression Results of Crude Oil Consumption

Variabel	Coefficient	Std. Error	t-Statistic	Probability
C	0.024745	0.006989	3.540679	0.012
D(Ln Domestic Crude Oil Prices (X1))	0.092935	0.027371	3.395379	0.0017
D(Ln Manufacturing Added Value (X2))	-0.211871	0.102935	-2.058291	0.0471
D(Ln GDP per Capita (X3))	0.249456	0.091411	2.728940	0.0099
ECT(-1)	-0.264331	0.085602	-3.087902	0.0039
Adjusted R-squared	0.385243			
F-statistic	7.109916			
Prob (F-statistic)	0.000267			

Source: Processed EViews 12 output

Based on the short-term regression results in Table 6 above, the equation model can be written as follows:

D(LnConsumption) = 0.024745 + 0.092935 D(LnPrice) – 0.211871 D(LnManufacturing Value Added) + 0.249456 D(GDP per Capita) - 0.264331 ECT(-1)

Based on the estimation results of the short-term model, several findings can be highlighted. In the short-term regression equation, the variables LnDomestic Crude Oil Price and LnGDP per Capita exhibit a positive effect on oil consumption, while LnManufacturing Value Added has a negative effect. The results of the F-statistic test show a probability value of 0.000267, which is less than the significance level of 0.05,

indicating that LnDomestic Oil Price, LnManufacturing Value Added, and LnGDP per Capita simultaneously influence LnCrude Oil Consumption.

The results of the t-statistic test further confirm that all three independent variables significantly affect crude oil consumption, with probability values of 0.0017 for LnDomestic Crude Oil Price, 0.0471 for LnManufacturing Value Added, and 0.0099 for LnGDP per Capita, all of which are below the 0.05 threshold. The Adjusted R-squared value of 0.385243 indicates that the independent variables explain 38.52% of the variation in the dependent variable, while the remaining variation is attributable to factors outside the model.

Finally, the ECT coefficient is -0.264331, suggesting that if there was a past imbalance of -1, crude oil consumption would adjust by decreasing 0.264331 in the current period. This ECT coefficient is considered valid because it falls within the acceptable range of -1 < ECT < 0.

DISCUSSION

The Effect of Domestic Crude Oil Prices on Crude Oil Consumption

This study examined H1, which hypothesized a negative and significant effect of domestic crude oil prices on crude oil consumption in Indonesia. The long-term regression results show that domestic crude oil prices have an insignificant effect on consumption, with a coefficient of 0.015177 and a probability value of 0.6800 > 0.05. This suggests that, contrary to the hypothesized negative relationship, long-term increases in domestic crude oil prices do not reduce consumption. These findings are consistent with Rezki (2011), who reported that crude oil prices in Indonesia and other Southeast Asian countries did not significantly affect energy consumption between 1990 and 2004. The limited long-term effect can be attributed to government price controls and subsidy policies, which mitigate the direct influence of price changes. Recent policy shifts have redirected subsidy funds toward targeted social programs, including BLT, BOS, and health insurance for low-income households (Santoso, 2022), thereby influencing consumption patterns in specific socioeconomic groups.

In the short term, domestic crude oil prices have a positive and significant effect on crude oil consumption, with a coefficient of 0.092935 and a probability of 0.0017 < 0.05. This finding contrasts with the law of demand and prior research by Ilmanita and Aimon (2019), which found no significant short-term effect of oil prices on energy consumption in Indonesia from 1978 to 2017. The positive short-term response may reflect the essential nature of crude oil for daily activities, whereby consumers and businesses absorb price increases due to necessity rather than reducing consumption. Overall, H1 is partially supported: while the long-term effect is insignificant, the short-term effect is significant and positive, highlighting the context-dependent nature of price responses in Indonesia.

The Effect of Manufacturing Sector Value Added on Crude Oil Consumption

H2 proposed a negative and significant effect of manufacturing sector value added on crude oil consumption. The long-term regression confirms a negative and significant relationship, with a coefficient of -0.500305 and a probability of 0.0000 < 0.05. Similarly, the short-term coefficient of -0.211871 with p = 0.0471 indicates a significant negative effect. These results suggest that increases in manufacturing value added reduce crude oil consumption, reflecting the sector's adoption of technological innovations, energy efficiency measures, and diversification of energy sources. Government initiatives, such as revisions to Government Regulation (PP) No. 33 of 2023 on Energy Conservation and the broader implementation of energy management systems, are projected to save

approximately 5.28 million TOE of energy by 2030 (Mardiansyah, 2024). Moreover, fluctuations in goods and service demand allow companies to adjust production processes without proportionally increasing oil consumption, reinforcing the negative relationship. These findings confirm H2 and demonstrate the critical role of industrial efficiency and technological adaptation in reducing crude oil dependency in Indonesia.

The Effect of GDP per Capita on Crude Oil Consumption

H3 posited a positive and significant effect of GDP per capita on crude oil consumption. Long-term regression results support this hypothesis, with a coefficient of 0.786498 and a probability of 0.0000 < 0.05, indicating that a 1% increase in GDP per capita leads to a 78.65% increase in crude oil consumption. Short-term results also show a positive and significant effect, with a coefficient of 0.249456 and a probability of 0.0099 < 0.05. These findings align with Astuti et al. (2023) and Rezki (2011), who reported that higher GDP per capita levels in Southeast Asia significantly increase energy consumption. The results underscore that economic growth, rising purchasing power, population growth, and expanded industrial, household, and transportation activities drive oil demand. Differences in energy-efficiency implementation and consumer behavior across sectors sustain dependence on crude oil even as GDP per capita rises.

Summary of Hypothesis Testing

In summary, H2 and H3 are fully supported by the regression results. The negative and significant effect of manufacturing sector value added underscores the importance of technological and efficiency improvements in reducing crude oil consumption. The positive and significant relationship between GDP per capita and crude oil consumption confirms that economic growth remains a key driver of energy demand. H1, however, is only partially supported: long-term effects are insignificant, while short-term effects are significant and positive, reflecting the essential nature of crude oil and unique consumption dynamics in Indonesia. These results highlight the combined influence of economic growth, industrial modernization, and price policies on energy demand patterns.

CONCLUSION

This study examined the determinants of Indonesia's crude oil consumption from 1983 to 2023 using the ECM, focusing on domestic crude oil prices, manufacturing sector value added, and GDP per capita. The results indicate that domestic crude oil prices have no significant long-term effect on oil consumption, but exert a positive and significant influence in the short term, reflecting the mitigating role of government price-control mechanisms. The manufacturing sector value added negatively and significantly affects crude oil consumption in both the long and short term, demonstrating that industrial modernization, energy efficiency policies, and technological adoption are reducing reliance on fossil fuels. GDP per capita exerts a strong positive effect in both time horizons, confirming that rising income and economic growth remain the primary drivers of energy demand in Indonesia.

Theoretically, these findings support the energy–growth nexus, highlighting the strong link between economic expansion and energy consumption, while also illustrating the limited efficacy of price adjustments in subsidized markets. Practically, the results suggest that policymakers should prioritize expanding renewable-energy portfolios, strengthening energy-efficiency programs in the manufacturing sector, restructuring fuel-subsidy allocations toward technology investment, and promoting innovation-driven growth. Furthermore, the ECM coefficient of –0.2643 indicates a moderate adjustment toward long-term equilibrium, emphasizing the short-term responsiveness of crude oil consumption to economic and industrial changes. These measures can help align

Indonesia's energy consumption patterns with sustainable development goals while sustaining economic growth.

LIMITATION

Include reliance on secondary data, exclusion of environmental and technological variables, and the single-country scope. Future studies should incorporate sustainability indicators, conduct cross-country comparisons, or apply dynamic models such as ARDL or VECM with higher-frequency data to validate these findings.

ACKNOWLEDGMENT

We, the researchers, would like to thank the Dean of the Faculty of Economics and Business, UPN Veteran Yogyakarta, and his staff for supporting the smooth running of this research until its publication.

DECLARATION OF CONFLICTING INTERESTS

We, the researchers, have agreed to continue the publication of this manuscript as written in this manuscript.

REFERENCES

Abdellah, O. (2025). Modeling non-stationary processes in panel data econometrics: cointegration tests and error correction mechanisms applied to macroeconomic time series across multiple countries. *Journal of Experimental and Computational Methods in Applied Sciences*, *10*(5), 1-13.

Alkofahi, K., & Bousrih, J. (2024). The nexus between oil consumption, economic growth, and crude oil prices in Saudi Arabia. *Economies*, *12*(5), 105. https://doi.org/10.3390/economies12050105

Astuti, C. P., Sasana, H., & Prakoso, J. A. (2023). Analisis faktor yang mempengaruhi konsumsi energi minyak bumi pada negara importir minyak bumi di Asia. In *Prosiding Seminar Nasional & Call for Paper Fakultas Ekonomi* (Vol. 2, pp. 282-292).

Banelienė, R. (2021). Industry impact on GDP growth in developed countries under R&D investment conditions. *Journal of Small Business Strategy (archive only)*, *31*(1), 66-80.

Basuki, A. T., & Prawoto, N. (2016). *Analisis Regresi dalam Penelitian Ekonomi dan Bisnis (Dilengkapi Aplikasi SPSS & Eviews)*. Rajawali Pers.

British Petroleum (BP). (2021). *Statistical Review of World Energy 2021* (70th ed.). BP. https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2021-full-report.pdf

British Petroleum (BP). (2024). *BP Energy Outlook 2024 edition*. BP. https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook/bp-energy-outlook-2024.pdf

Central Agency of Statistics of Indonesia (BPS Indonesia). (2024). *Proporsi Nilai Tambah Sektor Industri Manufaktur Terhadap PDB, 2023*. BPS Indonesia. https://www.bps.go.id/id/statistics-table/2/MTIxNCMy/proporsi-nilai-tambah-sektor-industri-manufaktur-terhadap-pdb.html

Ee, C. G., Ibrahim, H., Gulati, C., Chok, C., Shanshan, D., Kushwah, D., …, & Kee, D. M. H. (2024). Analysis of the factors affecting customer preference towards McDonald's. *International Journal of Tourism and Hospitality in Asia Pacific, 7*(1), 129–142. https://doi.org/10.32535/ijthap.v7i1.2629

Fakhr, S. M., & Bouabid, A. (2023). Possible reasons for spurious regression in the econometric model (case study of imports in the United States of America). *International Journal of Professional Business Review*, *8*(12), 2.

Ghanad, A. (2023). An overview of quantitative research methods. *International Journal of Multidisciplinary Research and Analysis*, *6*(08), 3794-3803. https://doi.org/10.47191/ijmra/v6-i8-52

Ilmanita, H. A., & Aimon, H. (2019). Analisis keseimbangan jangka pendek dan jangka panjang konsumsi energi di Indonesia. *Jurnal Kajian Ekonomi Dan Pembangunan*, *1*(3), 807–822. https://doi.org/10.24036/jkep.v1i3.7708

Kee, D. M. H., Sin, L. G., Yuan, N. Z., Ni, N. L. Y., Wen, N. K., Fang, N. S., …, & Muhsyi, U. A. (2023). The influence of customer satisfaction, brand trust, and brand loyalty on purchase intention: A study of McDonald's in Malaysia. *International Journal of Tourism and Hospitality in Asia Pacific,* *6*(2), 88–101. https://doi.org/10.32535/ijthap.v6i2.2343

Kee, D. M. H., Veeraselvam, V. R. A., Vayapuri, V. A., Aisyah, U., A'ishah, T. A., Enakhifo, E., & Edeh, F. O. (2022). Contributing factors to customer satisfaction during the pandemic: A study of Foodpanda of Malaysia and Nigeria. *International Journal of Tourism and Hospitality in Asia Pacific, 5*(1), 21–33. https://doi.org/10.32535/ijthap.v5i1.1399

Kuncoro, M. (2010). *Masalah, Kebijakan, dan Politik Ekonomi Pembangunan*. Erlangga.

Mankiw, N. G. (2006). *Makroekonomi* (6th ed.). Erlangga.

Mardiansyah, D. (2024, May 24). *Kementerian ESDM Catat Rata-rata Intensitas Energi Indonesia Capai 3%*. Kontan. https://industri.kontan.co.id/news/kementerian-esdm-catat-rata-rata-intensitas-energi-indonesia-capai-3

Mlaabdal, S., Chygryn, O., Kwilinski, A., Muzychuk, O. M., & Akimov, O. (2020). Economic growth and oil industry development: assessment of the interaction of national economy indicators. In *Sustainable Economic Development and Advancing Education Excellence in the Era of Global Pandemic* (pp. 8102-8114).

Oltulular, S. (2024). Circular behavior of oil consumption and the impact of oil prices with the Fourier approach. *Energy Strategy Reviews*, *53*, 101386. https://doi.org/10.1016/j.esr.2024.101386

Organization of the Petroleum Exporting Countries (OPEC). (2024). *Indonesia Minyak Mentah: Impor*. CEIC Data. https://www.ceicdata.com/id/indicator/indonesia/crude-oil-imports

Reksohadiprodjo, S., & Pradono, P. (2012). *Ekonomi Sumber Daya Alam dan Energi* (2nd ed.). BPFE.

Rezki, J. F. (2011). Konsumsi energi dan pembangunan ekonomi di Asia Tenggara. *Jurnal Ekonomi dan Pembangunan Indonesia*, *12*(1), 3. https://doi.org/10.21002/jepi.v12i1.03

Santoso, R. (2022). *Analisis Faktor-Faktor yang Mempengaruhi Impor Minyak Bumi dan Gas di Indonesia Pada Tahun 1996-2020* [Undergraduate thesis, Universitas Islam Indonesia]. DSpace. https://dspace.uii.ac.id/handle/123456789/41124

Saraswati, L., & Kusumawati, R. (2017). *Fuzzy Elman Recurrent Neural Network Dalam Peramalan Harga Minyak Mentah di Indonesia dengan Optimasi Algoritma Genetika* [Undergraduate thesis, Universitas Negeri Yogyakarta]. EPrints UNY. http://eprints.uny.ac.id/id/eprint/52855

Sartika, Y., & Amar, S. (2020). Pengaruh perekonomian dan jumlah penduduk terhadap permintaan bahan bakar minyak di Indonesia. *Jurnal Kajian Ekonomi Dan Pembangunan*, *2*(3), 7-16. https://doi.org/10.24036/jkep.v2i3.10290

Setiawan, A., Tua, D. P., & Husin, M. K. E. (2019). Pengaruh konsumsi bahan bakar fosil terhadap produk domestik bruto Indonesia dan hubungan timbal balik di antara keduanya. *Jurnal Teknologi Mineral dan Batubara*, *15*(3), 213-223. https://doi.org/10.30556/jtmb.vol15.no3.2019.931

Sinaga, D. (2022). *Buku Ajar Metodologi Penelitian (Penelitian Kuantitatif)*. UKI Press.

Sugiyono, S. (2013). *Metodologi Penelitian Kuantitatif, Kualitatif dan R&D*. Alfabeta.

Utama, E. R. (2014). Analisis faktor-faktor yang mempengaruhi impor minyak mentah di Indonesia. *JEJAK: Jurnal Ekonomi dan Kebijakan*, *7*(1), 85-91. https://doi.org/10.15294/jejak.v7i1.3845

Utari, W. (2025). Analysis of the influence of national income, interest rates, and inflation on the nominal exchange rate: An approach using cointegration and Error Correction Model (ECM). *Inovbiz: Jurnal Inovasi Bisnis Seri Manajemen, Investasi dan Kewirausahaan*, *5*(1), 43-51. https://doi.org/10.35314/inovbizmik.v5i1.524

World Bank Data Help Desk. (n.d.). *World Bank Country and Lending Groups*. The World Bank. https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups

Yusgiantoro, P. (2000). *Ekonomi Energi: Teori dan Praktik*. Pustaka LP3ES.

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