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The Impact of Industrialization, Trade Openness, Financial Development, and Energy Consumption on Economic Growth in Indonesia

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Abstract: This study aimed to scrutinize the impact of financial development, energy consumption, industrialization, and trade openness on economic growth in Indonesia over the period 1984–2018. To do so, the study employed the autoregressive distributed lag (ARDL) model to estimate the long-run and short-run nexus among the variables. Furthermore, fully modified ordinary least squares (FMOLS), dynamic least squares (DOLS), and canonical cointegrating regression (CCR) were used for a more robust examination of the empirical findings. The result of cointegration confirms the presence of cointegration among the variables. Findings from the ARDL indicate that industrialization, energy consumption, and financial development (measured by domestic credit) positively influence economic growth in the long run. However, financial development (measured by money supply) and trade openness demonstrate a negative effect on economic growth. The positive nexus among industrialization, financial development, energy consumption, and economic growth explains that these variables were stimulating growth in Indonesia. The error correction term indicates a 68% annual adjustment from any deviation in the previous period's long-run equilibrium economic growth. These findings provide a strong testimony that industrialization and financial development are key to sustained long-run economic growth in Indonesia.

Keywords: financial development; energy consumption; industrialization; economic growth; trade openness; ARDL

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1. Introduction

To achieve sustainable economic growth during this uncertain time, a targeted policy aiming at expanding economic activities would be the right path. Industrialization contributes to economic growth by enhancing productive capacity, job creation, innovation, and optimal resource use. Trade openness enhances foreign direct investment (FDI), global market integration, technological advancement, and countries' productive capacity. Financial development facilitates access to credit and financial services and capital accumulation for future investment. Energy use is one of the key productive factors that contribute to economic growth. Additionally, energy use harms the environment with rising carbon dioxide emissions (CO_2) which indirectly affect economic growth.

Industrialization contributes to economic growth by increasing industrial output, promoting innovation, and using resources for optimal production. However, as manufacturing expands, energy use will increase, and energy consumption has a negative influence on environmental quality by increasing CO_2 emissions, which indirectly affect economic growth. In addition, trade allows countries access to contemporary technology and supports FDI flows, which encourages the development of clean industries (Anwar and Elfaki 2021). As industrialization increases, resource depletion resurfaces and negatively affects the general well-being of the wider population (Mahmood et al. 2020).

Indonesia, which is the fourth-largest populated country, the tenth-largest economy based on purchasing power parity (PPP) in the world, and a G20 member, has achieved remarkable economic growth after the Asian financial crisis of the late 1990s (Aswicahyono et al. 2011; World Bank 2021a). The services sector generated more than half of Indonesia's GDP, while manufacturing, agriculture, and mining contributed 24.0 percent, 14.0 percent, and 11.0 percent, respectively. The majority of Indonesia's imports are intermediate commodities, such as chemical products, machinery, and transportation equipment, to support the country's domestic industry. Indonesia's trade performance has deteriorated in recent years due to the dominance of low-value-added commodities in its exports and the country's substantial reliance on higher-value-added manufactured imports (Tijaja and Faisal 2014).

Researchers and policymakers believe that the manufacturing sector is a growth driver due to the multifaceted benefits it has provided to growth and development (Arjun et al. 2020). Fast economic growth and the expansion of industrialization in newly industrialized countries (NICs) are driving the intensive use of energy and other natural resources which results in emitting more remains and waste into nature and potentially causing environmental degradation (Hossain 2011).

International trade can help boost economic growth significantly by supporting countries to specialize in producing products in which they have a comparative advantage and transferring resources across different countries (Belloumi and Alshehry 2020). Financial development has an essential role in promoting banking and stock market activities and attracting FDI which improves the competency of the banking system and stock markets which, again, could influence the economic activities and energy demand (Mahalik et al. 2017). Financial development might improve economic activities by boosting activities of research and development (R&D) and accelerating FDI (Charfeddine and Khediri 2016). Beck (2002) stated that financial development and degree of trade openness are associated with economic growth performance across countries. Financial development contributes to higher entrepreneurship, industrialization, and expanding economy which could also increase energy demand (Mahalik and Mallick 2014). It has also been found that energy and finance play a significant role as productive inputs and are part of the endogenous factors affecting output and long-term growth (Arjun et al. 2020). According to Hossain (2011), increased energy consumption in newly industrialized countries has resulted in rising carbon emissions and environmental degradation. Energy use promotes economic growth and is vital in the process of a country's industrialization, urbanization, and transportation network (Mahalik and Mallick 2014).

The link between energy consumption and economic growth has been a subject of academic concern among energy economists (Mahalik et al. 2017). It has been evident that industrialization, trade openness, financial development, and energy consumption are the key determinants of economic growth. Many studies have examined the links between economic growth and its determinants. For instance, Raghutla and Chittedi (2020) examined the causal links between trade openness, financial development, energy consumption, and economic growth in India. By applying the autoregressive distributed lag (ARDL), Belloumi and Alshehry (2020) also investigated the link between trade openness, economic growth, energy consumption, and financial development in Saudi Arabia over the period 1971–2016. However, there exist few studies that include industrialization as a relevant factor in determining the economic growth path with other factors. Thus, this study aimed to fill this gap in the case of Indonesia and to contribute to existing literature. The innovative contribution of this study was the examination of the impact of industrialization, trade openness, financial development, and energy consumption on economic growth in Indonesia for the period 1984–2018. To achieve this purpose, the ARDL model was applied to estimate the long-run and short-run relationships among the variables. The robustness of the ARDL was tested by using fully modified ordinary least squares (FMOLS), dynamic least squares (DOLS), and canonical cointegrating regression (CCR).

The remainder of this paper is arranged as follows: the next section provides a related literature review. Section 3 is devoted to the methodology and data. Section 4 presents the empirical results and analysis. Section 5 concludes the study and provides policy suggestions.

2. Literature Review

In the available literature, the link between financial development, energy consumption, trade openness, and economic growth has been widely tested by many (Belloumi and Alshehry 2020; Le 2020; Raghutla and Chittedi 2020). However, few studies considered industrialization among the factors that influence economic growth (Iheoma and Jelilov 2017; Ndiaya and Lv 2018; Opoku and Yan 2019; Saba and Ngepah 2021; Wonyra 2018). In a different context, many studies examined the link between energy consumption, financial development, economic growth, industrialization, trade openness, and urbanization (Ayinde et al. 2019; Gungor and Simon 2017; Sahoo and Sethi 2020). For instance, Sahoo and Sethi (2020) used the ARDL model and considered the influence of industrialization, urbanization, financial development, and economic growth on energy consumption in India over the period 1980–2017. The empirical results reveal that industrialization, urbanization, and economic growth positively influenced energy consumption, while financial development was found to be negatively associated with energy consumption. In addition, empirical findings by Gungor and Simon (2017) indicate that financial development, industrialization, and urbanization were positively linked to energy consumption in South Africa for the period.

Levine et al. (2000) used a generalized method of moments (GMM) dynamic panel estimators and a cross-sectional design to examine the effect of exogenous components of financial intermediary development on economic growth in 74 countries' data covering the period 1960–1995. The empirical result shows that the exogenous components of financial intermediary development have a positive impact on economic growth. King and Levine (1993) used various measures to study the impact of financial intermediary development on real per capita GDP growth data from 80 countries covering the period 1960–1989 and found that the various measures are strongly connected with the growth of real per capita GDP.

Using a generalized method of moments (GMM), Opoku and Yan (2019) examined the effect of industrialization on economic growth in 37 African countries for the period 1980–2014. The empirical results indicate a positive nexus between industrialization and economic growth. Saba and Ngepah (2021) found a negative link between industrialization and economic growth in a panel of 171 countries over the period 2000–2018. Ndiaya and Lv (2018) applied ordinary least squares (OLS) and examined the effect of industrialization on economic growth in Senegal for the period 1960–2017. The empirical strategy demonstrated that industrialization has a positive influence on economic growth. In the case of Sub-Saharan Africa, a study by Wonyra (2018) also found a positive association between industrialization and economic growth over the period 1990–2015. In another study, Szirmai and Verspagen (2015) investigated the impact of manufacturing on economic growth in developed and developing countries for the period 1950–2005. Their empirical finding reveals that manufacturing has a positive impact on economic growth. In the case of Tunisia, Shahbaz and Lean (2012) established a causal relationship between financial development and energy consumption, financial development and industrialization, industrialization, and energy consumption in the long run and found that, in the short run, industrialization and energy consumption Granger cause economic growth.

Many studies have examined the nexus between financial development, energy consumption, trade openness, and economic growth in different contexts. For instance, Le (2020) used augmented mean group (AMG), mean group (MG), and common correlated effects mean group (CCEMG) and investigated the link between energy consumption, economic growth financial development, and trade openness in 46 emerging markets and developing economies for the period 1990–2014. Findings indicate that energy consump-

tion, financial development, and trade openness have a positive significant impact on economic growth. Using the vector error correction model (VECM), Raghutla and Chittedi (2020) found a bidirectional relationship between energy consumption and economic growth in India for the period 1970–2018. Over the period 1984–2014, Elfaki et al. (2018) used the ARDL model and investigated the link between energy consumption, economic growth, and trade openness in Sudan. The empirical finding shows a negative relationship between energy consumption and economic growth, while trade openness is positively linked to economic growth. In another study, Abosedra et al. (2015) applied the ARDL model and investigated the link between financial development, energy consumption, and economic growth in Lebanon. The results confirm that financial development and energy consumption have a positive link with economic growth. Using DOLS, Okoye et al. (2021) found that energy consumption and financial development positively influenced economic growth in Nigeria over the period 1981–2018.

In the case of China, Shahbaz et al. (2013) examined the nexus between energy consumption, economic growth, trade openness, and financial development for the period 1971–2011. Findings from the ARDL model reveal that energy consumption, trade openness, and financial development are positively linked with economic growth. Komal and Abbas (2015) used the system GMM technique and observed that financial development and trade openness are positively associated with economic growth in Pakistan for the period 1972–2012.

3. Data and Method

3.1. Data

This paper used annual time series data to examine the link between industrialization, trade openness, financial development, energy consumption, and economic growth in Indonesia. Industrialization is measured by manufacturing value-added as a percent of gross domestic product. The total of exports and imports of goods and services as a percent of gross domestic product is used to capture trade openness. Domestic credit to the private sector by banks and broad money as a percent of the gross domestic product is used as a proxy for financial development. Energy consumption is defined by primary energy consumption per capita. GDP per capita in constant 2010 USD is used to proxy economic growth. The data for economic growth, industrialization, trade openness, and financial development were obtained from World Bank Indicators, World Bank (2021b), while the data for energy consumption were sourced from the British Petroleum Statistical Review of World Energy, BP (2021).

3.2. Method

To examine the impact of industrialization, trade openness, financial development, and energy consumption on economic growth in Indonesia over the period 1965–2018, this study applied the ARDL model to estimate the long-run and short-run relationship among the variables. FMOLS, DOLS, and CCR were used to check the robustness of the empirical findings of the ARDL model. The ARDL was chosen because it is more applicable in the small sample and takes into account the error correction model. ARDL approach provides consistent and robust results because it allows describing the existence of an equilibrium relationship in both long-run and short-run dynamics without losing long-run information. The ARDL bounds test approach can be applied irrespective of whether the underlying variables are integrated of order one I(1) or order zero I(0) by (Pesaran et al. 2001).

To achieve this, the augmented Dickey-Fuller (Dickey and Fuller 1979) and Phillips–Perron (PP) (Phillips and Perron 1988) unit root tests were applied to test the stationarity of the variables. The existence of a cointegration relationship among the series indicated the need to proceed further to estimate the long-run and short-run relationship. Therefore, the ARDL model bounds test for cointegration developed by Pesaran et al. (2001) was used to determine the cointegration relationship. Furthermore, the ARDL model, FMOLS, DOLS, and CCR were used to estimate the long-run relationship between the variables. Besides

that, the ARDL error correction model (ECM) was employed to estimate the short-run relationship.

The ARDL is applicable in the case of a small sample, and it takes into consideration the ECM. Therefore ARDL is the most appropriate model to use in this study. ARDL approach provides consistent and robust results because it allows and describes the existence of an equilibrium relationship in terms of the long-run and short-run dynamics without losing the long-run information (Pesaran et al. 2001). The FMOLS, DOLS, and CCR were utilized for robustness check. The unit root test is applied to confirm whether the mean and variance of the variables change over time and to ensure whether the time-series data are stationary or nonstationary. The time-series data in some cases involve random features that influence the statistical inferences and lead to the estimate of a spurious model. To test for the unit root of the underlying variables, the null hypothesis that the variables are nonstationary was tested against the alternative. Despite that, the ARDL model for cointegration can be used irrespective of whether the variables are integrated of order I(0) or I(1). The unit root tests were applied to ensure that the variables are not integrated at the order I(2). The cumulative sum (CUSUM) of recursive residual and cumulative sum square (CUSUMSQ) of recursive residuals techniques developed by (Brown et al. 1975) were used to detect the movement from the constancy of regression coefficients.

To examine the relationship between economic growth and the main explanatory variables, this paper describes economic growth as a function of industrialization, trade openness, financial development, and energy consumption. Therefore, the simple economic model describing this relationship can be presented in the following functional form:

$$GDP_t = f(MVA_t,\ T_t,\ DC_t,\ M_t,\ EC_t) \tag{1}$$

where *GDP* represents the real per capita gross domestic product, *MVA* represents the manufacturing value-added, *T* represents trade openness, *DC* represents domestic credit to the private sector by banks, *M* represents the broad money, and *EC* indicates energy consumption.

The econometric model representing the relationship as presented in equation (1) is given in the following log-linear model:

$$LGDP_t = \beta_0 + \beta_1 LMVA_t + \beta_2 LT_t + \beta_3 LDC_t + \beta_4 LM_t + \beta_5 LEC_t + \mu_t \tag{2}$$

where β_0 is an intercept, μ represents the error term, and β_1, β_2, β_3, β_4, and β_5 are the model coefficients. All the variables in Equation (2) are as defined in Equation (1) and are transformed to a natural logarithm.

As an initial step to estimate the long-run and short-run relationship between the variables, Equation (2) can be presented in the general framework of the ARDL model as follows:

$$\begin{aligned} \Delta LGDP_t = \ \alpha_0 + \ & \alpha_1 LGDP_{t-1} + \alpha_2 LMVA_{t-1} + \alpha_3 LT_{t-1} + \alpha_4 LDC_{t-1} + \alpha_5 LM_{t-1} \\ & + \alpha_6 LEC_{t-1} + \sum_{i=1}^{q} \beta_1 \Delta LGDP_{t-i} + \sum_{p=0}^{q} \beta_2 \Delta LMVA_{t-p} \\ & + \sum_{m=0}^{q} \beta_3 \Delta LT_{t-m} + \sum_{r=0}^{q} \beta_4 \Delta LDC_{t-r} + \sum_{h=0}^{q} \beta_5 \Delta LM_{t-h} \\ & + \sum_{v=0}^{q} \beta_6 \Delta LEC_{t-v} + \mu_{2t} \end{aligned} \tag{3}$$

where Δ denotes the first difference, α_0 is constant, and q denotes the optimal lag length selected based on the Akaike information criterion (AIC). α_1, α_2, α_3, α_4, and α_5 symbolize the long-run coefficients. β_1, β_2, β_3, β_4, β_5, and β_6 indicate the short-run coefficients. μ_{2t} is the error term.

To test the cointegration relationship between industrialization, trade openness, financial development, energy consumption, and economic growth, the null hypothesis of no cointegration relationship (H_0: $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = \alpha_6 = 0$) was tested against the alternative hypothesis of the presence of cointegration relationship (H_1: $\alpha_1 \neq \alpha_2 \neq \alpha_3 \neq \alpha_4 \neq \alpha_5 \neq \alpha_6 \neq 0$). The presence of the cointegration relationship is based on comparing the calculated F-statistic with the lower I(0) and upper I(I) critical values of bounds test at 1%, 5%, and 10% significance levels as proposed by (Pesaran et al. 2001). When the calculated F-statistic is lower than the critical value of the bounds test at 1%, 5%, and 10% significance levels, the null hypothesis is accepted indicating that there is no cointegration relationship between the variables. In contrast to this, the null hypothesis is rejected if the estimated F-statistic exceeds the critical value of the bounds test at 1%, 5%, and 10% significance levels, and it proves the existence of a cointegration relationship between the underlying variables.

Once the cointegration relationship is established, the next step is to estimate the long-run and short-run relationship between the variables. Accordingly, from Equation (3), the error correction model (ECM) was formulated to estimate the short-run relationship as follows:

$$\begin{aligned}\Delta LGDP_t = \gamma_0 + & \sum_{\mathrm{i}=1}^{q} \gamma_1 \Delta LGDP_{\mathrm{t-i}} + \sum_{\mathrm{p}=0}^{q} \gamma_2 \Delta LMVA_{t-p} + \sum_{m=0}^{q} \gamma_3 \Delta LT_{t-m} \\ & + \sum_{r=0}^{q} \gamma_4 \Delta LDC_{t-r} + \sum_{h=0}^{q} \gamma_5 \Delta LM_{t-h} + \sum_{v=0}^{q} \gamma_6 \Delta LEC_{t-v} \\ & + \varphi ECM_{t-1} + \varepsilon_t\end{aligned} \tag{4}$$

where γ_0 is the constant; γ_1, γ_2, γ_3, γ_4, γ_5, and γ_6 are the short-run coefficients; *ECM* represents the error correction term; φ is the coefficient of error correction term which explains the speed of adjustment, and εt represents the error term.

4. Empirical Results Analysis

4.1. Descriptive Statistics and Correlations

Before examining the relationship between the variables in this part of the analysis, the study provided some descriptive statistics and correlation analysis of the variables. These are reported in Table 1.

Table 1. Descriptive statistics and correlations.

	LGDP	LMVA	LT	LDC	LM	LEC
Mean	7.775	3.118	3.959	3.422	3.706	2.921
Median	7.756	3.093	3.949	3.356	3.723	3.042
Maximum	8.363	3.464	4.566	4.108	4.092	3.425
Minimum	7.231	2.712	3.622	2.835	3.037	2.137
Std. Dev.	0.329	0.186	0.183	0.375	0.234	0.391
Skewness	0.080	−0.194	0.927	0.368	−0.856	−0.561
Kurtosis	2.061	2.358	4.964	1.919	3.816	2.087
Jarque–Bera	1.322	0.820	10.64	2.495	5.251	3.048
Probability	0.516	0.663	0.004	0.287	0.072	0.218
Observations	35	35	35	35	35	35
LGDP	1					
LMVA	0.315	1				
LT	−0.248	0.565	1			
LDC	0.056	−0.006	0.036	1		
LM	0.283	0.761	0.605	0.415	1	
LEC	0.949	0.536	−0.015	−0.069	0.434	1

Source: Authors' calculation.

As shown in Table 1, domestic credit to the private sector and energy consumption is more volatile among the series as indicated by standard deviation. The Jarque–Bera test shows that all the variables are normally distributed except trade openness and money supply. Moreover, the skewness test demonstrates that gross domestic product, trade openness, and domestic credit to the private sector are positively skewed, while the manufacturing value-added, money supply, and energy consumption are negatively skewed.

In addition, Table 1 displays that gross domestic product is positively correlated with manufacture value-added, domestic credit to the private sector, money supply, and energy consumption, whereas trade openness shows a negative association to gross domestic product. Notably, manufacturing value-added and energy consumption show a high correlation with gross domestic product. Furthermore, a positive correlation is found between trade openness, money supply, energy consumption, and manufacturing value-added. Moreover, a positive correlation is found between domestic credit to the private sector, money supply, and trade openness.

4.2. Unit Root Tests

After explaining some of the descriptive statistics and correlations properties, the study performed the Phillips and Perron (PP) and augmented Dickey-Fuller (ADF) tests to check for the presence of the unit root in the variables. The results are presented in Table 2.

Table 2. Unit root tests.

Variable	PP				ADF			
	Level		First Difference		Level		First Difference	
	Constant	Constant and Trend	Constant	Constant and Trend	Constant	Constant and Trend	With Constant	Constant and Trend
	t-Statistic	t-Statistic	t-Statistic	t-Statistic	t-Statistic	t-Statistic	t-Statistic	t-Statistic
LGDP	0.063	−1.755	−4.275 ***	−4.199 **	0.063	−2.214	−4.288 ***	−4.214 **
LMVA	−2.227	−1.261	−6.249 ***	−11.563 ***	−2.228	−1.474	−6.245 ***	−7.078 ***
LT	−2.363	−2.390	−7.935 ***	−8.925 ***	−1.464	−2.495	−1.128	−4.412 ***
LDC	−2.184	−2.198	−4.155 ***	−4.127 **	−2.361	−2.493	−4.164 ***	−4.132 **
LM	−3.198 **	−2.930	−3.353 **	−3.653 **	−1.239	−3.930 **	−3.424 **	−2.996
LEC	−5.129 ***	−1.147	−4.456 ***	−6.008 ***	−3.900 ***	−1.323	−4.456 ***	−4.62 ***

Source: Authors' estimate; *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

The results depicted in Table 2 indicate that, based on Phillips and Perron's (PP) test, money supply and energy consumption are stationary at levels. Meanwhile, gross domestic product, manufacture value-added, trade openness, and domestic credit to the private sector are found to be stationary after taking the first difference. The augmented Dickey-Fuller (ADF) test shows that energy consumption is stationary at levels whereas gross domestic product, manufacture value-added, trade openness, domestic credit to the private sector, and money supply are found to be stationary after taking the first difference. Overall, the findings of the Phillips and Perron (PP) and the augmented Dickey-Fuller (ADF) tests show that the series is integrated at different orders.

4.3. ARDL Bounds Test for Cointegration

To analyze the cointegration relationship between the variables, the ARDL bounds test for cointegration was employed. The results are depicted in Table 3.

Table 3. Bounds test for cointegration.

Test Statistic	Value	Significance Level	I(0)	I(1)
F-statistic	8.862	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

Source: Authors' estimate.

Table 3 reveals that the calculated F-statistic is greater than the critical value of the bounds test at a 1% significance level which confirms the rejection of the null hypothesis of no cointegration relationship and proves the existence of a cointegration relationship between industrialization, trade openness, financial development, energy consumption, and economic growth in Indonesia.

4.4. The Long-Run Relationship Estimates

Since the long-run cointegration was determined amid variables as indicated by the bounds test for cointegration, the next step was to estimate the long-run and short-run relationship between the variables. Thus, the long-run and short-run relationship was estimated and is reported in Table 4.

Table 4. ARDL long-run and short-run relationship.

ARDL Long-Run Relationship			ARDL Short-Run Relationship		
Variable	**Coefficient**	***p*-Value**	**Variable**	**Coefficient**	**Prob.**
LMVA	0.313	0.058	D(LGDP(-1))	0.260365	0.044
LT	−0.672	0.000	D(LGDP(-2))	−0.665604	0.001
LDC	0.192	0.008	D(LMVA)	0.430895	0.000
LM	−0.339	0.024	D(LMVA(-1))	0.092241	0.024
LEC	0.874	0.000	D(LT)	−0.168584	0.000
C	7.558	0.000	D(LT(-1))	0.089640	0.017
			D(LDC)	−0.044037	0.176
			D(LDC(-1))	−0.079776	0.008
			D(LM)	−0.094103	0.066
			D(LM(-1))	0.208456	0.000
			D(LEC)	0.468088	0.000
			D(LEC(-1))	−0.256983	0.007
			D(LEC(-2))	−0.091131	0.210
			D(LEC(-3))	0.114586	0.065
			ECM(-1)	−0.678966	0.000
R-squared		0.966			
Adjusted R-squared		0.936			
Durbin−Watson stat		2.541			

Source: Authors' estimate.

As shown in Table 4, in the long run, industrialization has a statistically significant positive impact on economic growth at a 10% level of significance, and this result is consistent with (Ndiaya and Lv (2018); Opoku and Yan (2019); Szirmai and Verspagen 2015; Wonyra 2018) and also contradicts (Saba and Ngepah 2021). Financial development shows a statistically significant positive influence on economic growth at a 1% level, and this finding is supported by (Abosedra et al. 2015; Le 2020; Okoye et al. 2021; Shahbaz et al. 2013). However, money supply displays a statistically significant negative effect on economic growth at a 5% level of significance. Similarly, trade openness asserts a negative impact on economic growth at a 1% significance level, and this result is not in line with (Elfaki et al. 2018; Le 2020; Shahbaz et al. 2013) findings. Energy consumption is found to be positively associated with economic growth at a 1% significance level, and this result is in line with (Abosedra et al. 2015; Le 2020; Okoye et al. 2021; Shahbaz et al. 2013) and

contradicts (Elfaki et al. 2018). The positive relationship between industrialization, financial development, energy consumption, and economic growth reveals that a 1% increase in industrialization, financial development, and energy consumption is associated with an increase in the economic growth of 0.312%, 0.192%, and 0.873%, respectively. These findings clearly explain that industrialization, financial development, and energy consumption are important factors to stimulate and enhance economic growth and development in Indonesia.

The estimated coefficient of error correction term as apparent in the short-run estimate is negative and statistically significant. The estimated value demonstrates that the deviation from the long-run equilibrium in the previous years will be adjusted by 68% annually.

4.5. Robustness Check Analysis

As mentioned early, the FMOLS, DOLS, and CCR were applied to check the robustness of the empirical findings. Therefore, these estimates are presented in Table 5.

Table 5. Robustness check.

Variable	FMOLS		DOLS		CCR	
	Coefficient	***p*-Value**	**Coefficient**	***p*-Value**	**Coefficient**	***p*-Value**
LMVA	−0.256	0.009	0.167	0.030	−0.252	0.039
LT	−0.224	0.009	−0.529	0.000	−0.274	0.068
LDC	0.152	0.000	0.159	0.000	0.140	0.002
LM	−0.107	0.261	−0.212	0.003	−0.074	0.516
LEC	0.913	0.000	0.881	0.000	0.906	0.000
C	6.674	0.000	7.035	0.000	6.806	0.000

Source: Authors' estimate.

As seen in Table 5, the estimated coefficients of the DOLS are the same as the ARDL long-run estimated coefficients. Industrialization, financial development when measured by domestic credit to the private sector, and energy consumption showed a positive influence on economic growth at 5%, 1%, and 1% significance levels, respectively. However, financial development when measured by money supply and trade openness displayed a statistically significant negative effect on economic growth at a 1% significance level. In contrast to this, the estimated coefficient of industrialization based on the FMOLS and CCR estimators was found to be negatively connected with economic growth which is not in line with the ARDL long-run coefficients. Besides that, money supply as an indicator for financial development was found to be insignificant. Furthermore, domestic credit to the private sector and energy consumption positively influenced economic growth at a 1% significance level based on the FMOLS and CCR estimators. In addition, openness demonstrated a negative impact on economic growth. These findings provide a strong empirical testimony that industrialization and financial development are essential keys to achieving sustained economic growth in the long run in Indonesia.

4.6. Diagnostic Test and Parameter Stability

The diagnostic tests of heteroscedasticity, serial correlation, normality, and Ramsey RESET were applied, and the results are reported in Table 6.

Table 6 shows that the estimated model is homoscedastic, not suffering from serial correlation, and normally distributed and that the functional form is correctly formulated. Additionally, the cumulative sum (CUSUM) of recursive residuals and cumulative sum square (CUSUMSQ) of recursive residuals techniques were conducted to detect the stability and reliability of estimated coefficients in the long run and short run. The results are presented in Figures 1 and 2, respectively.

Table 6. Diagnostic tests.

Test	F-Statistic	Probability
Heteroscedasticity Test: Breusch−Pagan−Godfrey	1.22	0.38
Breusch−Godfrey Serial Correlation LM Test	4.497	0.05
Normality Jaraue−Bera	0.297	0.86
Ramsey RESET Test	0.001	0.97

Source: Authors' estimate.

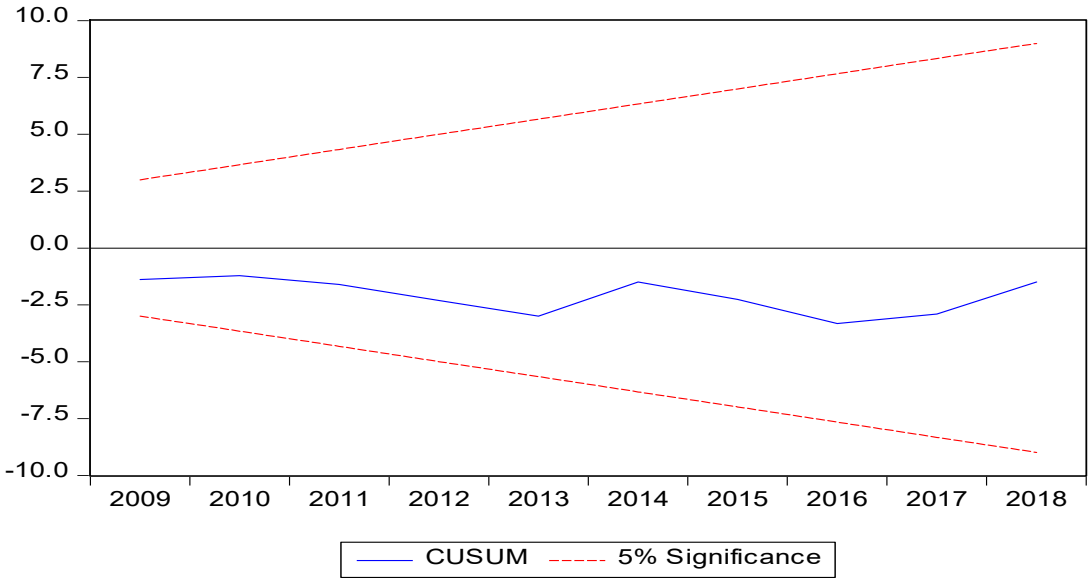

Figure 1. Cumulative sum (CUSUM) of recursive residuals.

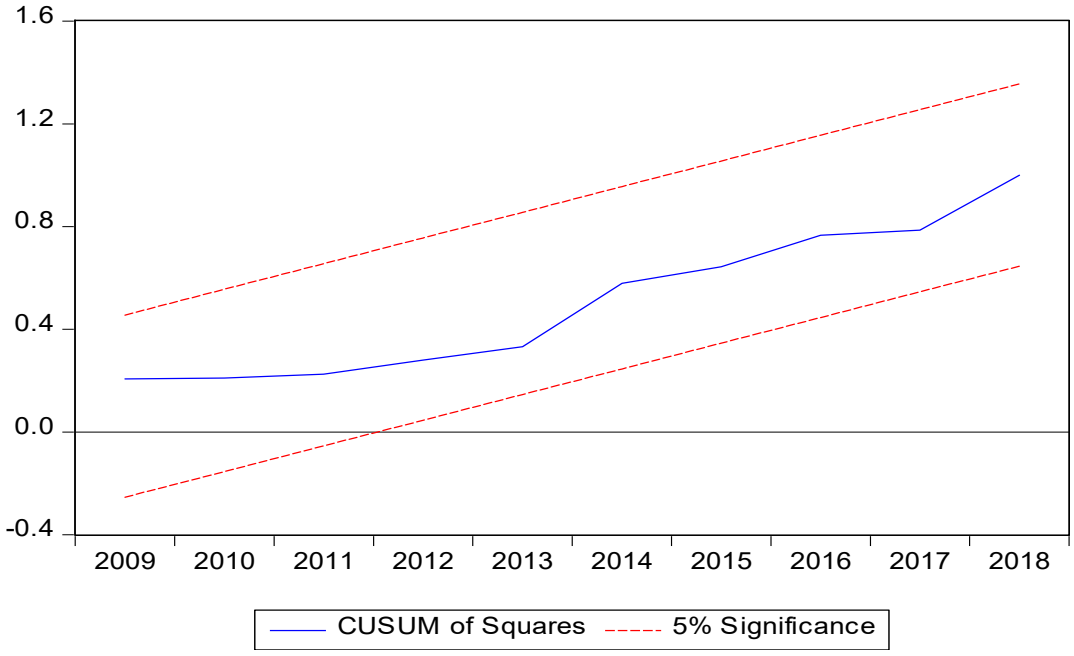

Figure 2. Cumulative sum square (CUSUMSQ) of recursive residuals.

Figures 1 and 2 illustrate that the cumulative sum (CUSUM) of recursive residuals and cumulative sum square (CUSUMSQ) of recursive residuals fall within the critical bounds straight line at a 5% significance level. This finding indicates that the estimated coefficients are stable and reliable during the study period.

5. Conclusions and Policy Implication

This study examined the influence of industrialization, trade openness, financial development, and energy consumption on economic growth in Indonesia over the period 1984–2018. The study employed the ARDL model and estimated the long-run and short-run relationship between the variables while the robustness check was conducted using FMOLS, DOLS, and CCR. The empirical strategy from the Phillips and Perron (PP) and augmented Dickey−Fuller (ADF) tests showed that the series is integrated at different orders. The result of the bounds test for cointegration confirms the existence of the cointegration relationship between the variables in Indonesia.

The empirical results of the ARDL model indicate that, in the long run, industrialization and financial development (measured by domestic credit to the private sector) positively influence economic growth. However, financial development (measured by money supply) displays a negative effect on economic growth. In addition, trade openness impacts economic growth negatively. Energy consumption is found to be positively associated with economic growth. The positive relationship between industrialization, financial development, energy consumption, and economic growth reveals that a 1% increase in industrialization, financial development, and energy consumption will generate an increase in the economic growth of 0.312%, 0.192%, and 0.873%, respectively. These findings clearly explain that industrialization, financial development, and energy consumption are important factors in stimulating and enhancing economic growth in Indonesia.

The coefficient of error correction term (ECM) is negative and statistically significant and indicates that the economic growth deviation from the long-run equilibrium in the previous years will be adjusted by 68% annually. The robustness of the ARDL was tested by FMOLS, DOLS, and CCR. The findings from DOLS are in line with the ARDL long-run estimated coefficients. Industrialization, financial development (measured by domestic credit to the private sector), and energy consumption have a positive influence on economic growth. However, money supply as a proxy for financial and trade openness exhibits a significant negative effect on economic growth. On the other hand, industrialization, based on the FMOLS and CCR estimators, is negatively connected to economic growth and not consistent with the ARDL long-run coefficients. Furthermore, domestic credit to the private sector and energy consumption positively influence economic growth based on the FMOLS and CCR estimators. Trade openness asserts a negative impact on economic growth. Besides that, the money supply is insignificantly connected to economic growth.

These findings provide a strong empirical testimony that industrialization, financial development, and energy use are essential to achieving sustained long-run economic growth in Indonesia. Based on these findings, the study shows a need to adopt policies aimed at expanding economic activities and investment into vital sectors. There is also a need to expand the industrial base to further promote economic growth, create job opportunities, promote innovation, and ensure efficient resource allocation. Since trade was found to negatively affect economic growth, a policy measure should be put in place to ensure beneficial trade that is compatible with long-term economic growth by reversing the negative effect of trade on economic growth to be positive and supportive. The study further shows a need to strengthen the energy policy to ensure sustained energy use and long-term economic growth. There is also a need for financial institutions to boost credit to the vital sectors of the Indonesian economy to further promote economic growth.

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