The Cost of Carbon: How Emissions and Energy Consumption Impede Indonesia's Economic Growth

Sri Rahayu Budi Hastuti(✉), Didit Welly Udjianto, Asih Sriwinarti, and Rias Wenerda

Universitas Pembangunan Nasional Veteran Yogyakarta, JL. SWK 104, Condong Catur, Yogyakarta 55283, Indonesia
rahayubudiupn@gmail.com, asihsriwinarti@upnyk.ac.id

Abstract. This article aims to analyze the impact of carbon emissions, energy consumption, the financial sector, and economic openness on economic growth in Indonesia from 1990 to 2019. The study uses regression analysis to examine the relationship between these variables and economic growth. The results suggest that an increase in carbon emissions and energy consumption may lead to a decrease in economic growth in Indonesia. On the other hand, the financial sector may encourage economic growth by increasing the money supply. However, economic openness does not appear to have an impact on the Indonesian economy. These findings imply that Indonesia needs to implement policies that prioritize sustainable development and reduce carbon emissions to maintain its economic growth while preserving the environment.

Keywords: carbon emissions · economic growth · energy consumption · financial sector · economic openness

1 Introduction

Use of natural resources, particularly those that generate energy, is intrinsic to economic growth. There is a strong correlation between the state of the economy and the availability of energy sources in the present day [1]. Consumption requirements in the household sector and consumption in the industrial sector for production activities make energy a dynamic and intricate part of the economy. Consumption of energy can propel the economy forward or act as a replacement for other forms of development capital when it comes time to produce goods and services.

However, progress in technology and globalization have helped raise people's understanding of the significance of protecting the planet's natural resources and ecosystems. As a result, studies concentrating on ecological context have become increasingly common. It is generally agreed that environmental indicators are just as essential as social and economic ones when trying to gauge a country's progress toward full development. The ability to control energy policies and develop resources sustainably [2] depends on a thorough comprehension of the link between economic growth and carbon emissions. As the economy and the industrial sector have continued to expand, so have output and

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consumption of energy. Greenhouse gas emissions from burning fossil fuels like coal, petroleum, and natural gas are a major source of the environmental pollution that has such a negative impact on people's health and the ecological niche [3].

Climate change and global heat have worsened as the globalization process has accelerated. Sustainable growth, reduced emissions, and energy efficiency are now commonplace discussions. As a result, it's important to think about how carbon emissions affect economic development and how that might play out in various models of economic growth. Another critical concern is how rising energy prices affect economic development. Energy loss is linked to economic development, according to growth theory [4].

Another impact of globalization is the development of the financial sector and the increasingly open economy. The financial sector plays an important role in a country's economy as the main provider of funds for financing the economy. The financial sector is the locomotive of real sector growth through capital accumulation and technological innovation [5–7]. An increasingly open economy encourages increased international trade, both exports and imports to increase. When looking at the relationship between economic growth and international trade, the relationship between the two can influence each other, considering that international trade is one of the driving forces of the economy [8]. The existence of international trade can encourage the economic growth of a country through increasing output and allow each country to specialize in producing goods that have a comparative advantage. In addition, international trade can also encourage economic growth by facilitating the diffusion of knowledge and technology through the import of high-tech goods [9].

2 Literature Review

Expanding production of products and services is what economists mean when they talk about economic growth. On the whole, the issue of slow economic expansion can be classified as a macroeconomic issue [10]. The capacity to manufacture goods and provide services within a nation tends to rise over time. All production variables, including quantity and quality, are expected to rise in the future, which makes this improvement possible [11].

Planning the output and consumption of renewable energy is a hot topic at the national and international levels due to concerns about sustainable development and climate change [12]. High levels of energy consumption are critical to economic growth, but they are also a major cause of environmental damage in both developed and developing nations, according to a number of other studies [13, 14], and [15].

Academic inquiry into the factors that foster economic growth and development is perennial and topical. Academics have spent a lot of time studying the correlation between economic development and energy usage [15, 16], and [17]. Other research has shown a significant correlation between energy consumption and economic development; these findings are crucial for formulating policies and strategies that take into account the dynamics of economic growth as they relate to energy consumption [18].

Greenhouse gas emissions, which contribute to environmental degradation, will rise in tandem with rising energy use and economic activity. Large increases in the economy

are not necessarily accompanied by improvements in the environment. Sustainable economic growth requires environmentally friendly economic strategies. Using data from the region, we find a positive correlation between economic growth and carbon emissions [19], and we find a causal connection between economic growth and carbon emissions [9].

When people with extra money want to help those with less money who have promising investment prospects, the financial system must be able to do so smoothly and effectively [20]. Banking allows the financial sector to collect and redistribute public savings in the shape of credit to those who need it. It will hasten economic expansion by boosting investment tangentially. Inefficient financial markets exacerbate the effects of asymmetric knowledge by increasing transaction and information costs. Therefore, the government's policies ought to be designed to stimulate the economy's finance sector.

Neoclassical growth theory attributes the positive correlation between international trade and GDP development to the efficiency effect brought about by reduced rent seeking and the benefits gained from economies of scale brought about by liberalized international trade. According to the new or endogenous growth theory, which forecasts that international trade and investment in physical capital and human capital can increase economic growth, the efficiency effect is the primary source of long-term economic growth.

3 Research Method

The research method is carried out empirically to confirm the theoretical aspects, which are mainly based on the quantitative framework of time series data estimation. This study uses the Ordinary Least Squares analysis tool to estimate how the variables of carbon gas emissions, energy consumption, the financial sector, and economic openness influence on economic growth, 1990–2019. The research model is as in the following equation.

$$\text{GROWTH} = \alpha_0 + \alpha_1 \,\text{EMISI} + \alpha_2 \,\text{KONS} + \alpha_3 \,\text{KEU} + \alpha_4 \,\text{XM} + \varepsilon \qquad (1)$$

GROWTH is economic growth proxied by gross domestic product. EMISI are carbon emissions, KONS is energy consumption, KEU is the financial sector as proxied by the money supply, and XM is economic openness proxied by exports plus imports. All variables in natural logarithm.

4 Analysis and Discussion

The regression results in Table 1 show that carbon gas emissions have a negative effect on Indonesia's economic growth, for the period 1990–2019. This means that an increase in carbon gas emissions hampers economic growth in Indonesia. Carbon emissions affect productivity levels in Indonesia, through their effects on health levels. Deteriorating health causes a person to be unable to work properly, so the resulting output is reduced. Energy consumption has no effect on economic growth in Indonesia. Energy consumption is increasing, but energy in Indonesia is still abundant so that it does not hamper the production process and economic growth.

Table 1. Regression Results

Variable	Coeffficient	Std Error	t-statistics	Prob.
C	12.05804	0.514849	23.42051	0.0000
EMISI	−0.966489*	0.028580	−33.81733	0.0000
KONS	−0.151359**	0.086569	−1.748425	0.0927
KEU	0.182864*	0.017696	10.33347	0.0000
XM	−0.006915	0.007247	−0.830056	0.4144
R-squared	0.996287	Mean dependent var		7.332128
Adjusted R-squared	0.995693	S.D. dependent var		0.714049
S.E. of regression	0.046860	Akaike info criterion		−3.132280
Sum squared resid	0.054897	Schwarz criterion		−2.898748
Log likelihood	51.98421	Hannan-Quinn criter.		−3.057571
F-statistic	1677.136	Durbin-Watson stat		0.973020
Prob(F-statistic)	0.000000			
Notes:				
*significance at 0,05 level	**at 0,1 level			

The growth of the financial sector through an increase in the money supply can lead to an increase in economic growth through an increase in aggregate demand. Expansive monetary policy causes interest rates to fall and increases household consumption. Lower interest rates reduce the household's incentive to save so that spending increases at a steady level of income. Lower interest rates also increase the company's incentive to borrow funds because the cost of capital is cheaper so that investment increases.

Economic openness has no effect on economic growth in Indonesia. Economic openness as proxied by international trade has not yet played enough role as an engine of growth in Indonesia. Based on data from the Central Bureau of Statistics, the contributor to Gross Domestic Product based on expenditure is household consumption with a portion above 50 percent, while international trade is in the range of 20 percent. However, the regression coefficient of economic openness is negative. This means that economic openness, which means that there is an increase in exports and imports, can lead to a slowdown in the domestic economy by increasing imports which are higher than exports. This is due to the high dependence on imported components on domestic industries, and the weak competitiveness of domestic products in the international market. On the other hand, increasing the competitiveness of domestic products in the international market is a prerequisite for high economic growth. Exports can act as an engine of growth. Domestic production must be directed towards an outward orientation to gain a wider share of foreign markets. Domestic production must rely on local raw materials or be able to substitute imported products so as to reduce dependence on imports.

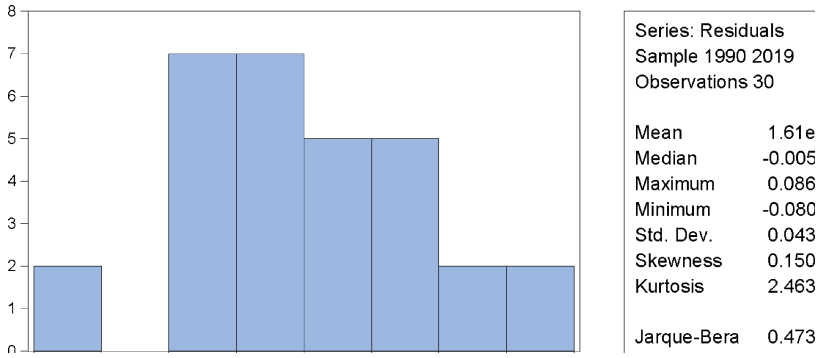

Fig. 1. Normality Test

Table 2. Multicollinearity Test

Variance Inflation Factors			
	Coefficient	Uncentered	Centered
Variable	Variance	VIF	VIF
C	0.265070	3621.361	NA
EMISI	0.000817	528.2960	2.651356
KONS	0.007494	1380.857	8.948328
KEU	0.000313	826.8021	7.249277
XM	5.25E-05	96.90106	1.193305

Table 3. Autocorrelation Test

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	2.143356	Prob. F(4,21)	0.1111
Obs*R-squared	8.697089	Prob. Chi-Square(4)	0.0691

Based on the results of the classical assumption test on the normality of the data (Fig. 1), it is known that the data is normally distributed because the Jarque-Bera probability value is 0.47 above the alpha probability value of 5 percent (0.05). This means that the null hypothesis that the data is normally distributed is acceptable.

The results of multicollinearity test (Table 2), the autocorrelation test (Table 3), heteroscedasticity test (Table 4), showed that the regression model did not deviate from the classical assumptions. There is no autocorrelation or heteroscedasticity in the model. So that the regression results are not inaccurate and the resulting regression coefficients are valid.

Table 4. Heteroskedasticity Test

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	0.805739	Prob. F(4,25)	0.5332
Obs*R-squared	3.425889	Prob. Chi-Square(4)	0.4892
Scaled explained SS	1.740549	Prob. Chi-Square(4)	0.7833

5 Conclusion

The research model has the ability to predict and estimate in the long term the factors that affect economic growth in Indonesia, namely carbon gas emissions, energy consumption, the financial sector, and economic openness. The policy implication of the results of this study is that an increase in carbon gas emissions significantly hampers economic growth in Indonesia. The negative sign of the regression coefficient of carbon gas emissions in Indonesia shows an inverse relationship between energy consumption and economic growth. This means that in the long term, if environmentally friendly policies are not implemented, the increase in carbon gas emissions in Indonesia can hamper the process of economic growth.

Economic growth in Indonesia is also positively influenced by developments in the financial sector. Bank Indonesia must be able to maintain price and exchange rate stability. Price stability ensures the stability of people's purchasing power, so that an increase in money supply can encourage economic growth. A stable exchange rate can guarantee an inflation rate in accordance with the target set, so that the price of domestic goods can be more competitive in the international market. Foreign trade increases and boosts economic growth.

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