

The Impact of Energy Consumption and Economic Globalization on CO2 Emissions**Murni Asliyana**

Universitas Sebelas Maret

Jl. Ir. Sutami No. 36 A Surakarta 57126, Indonesia

*Email: murniasliyanamesp@student.uns.ac.id**ABSTRACT**

CO2 emissions continue to increase due to excessive energy consumption, which impacts the environmental quality and continues to decline. This study aims to analyze the effect of energy consumption and economic globalization on CO2 emissions represented by Group of Eight member countries. The analysis was carried out using the multiple linear regression method, namely panel data from 2017-2021. The analysis results show that the Fixed Effect Model is the chosen model in this study. Based on the t-test, it is known that gross domestic product and globalization have a negative effect on CO2 emissions. At the same time, the variable that has a positive influence on CO2 is energy consumption.

Keywords: CO2 Emissions, Energy Consumption, GDP, Globalization

Proceeding Medan International Conference Economics and Business

Volume 1, Year 2023

"Entrepreneurship on Global Economics Development in the Era of Society 5.0"

INTRODUCTION

Carbon dioxide emissions have increased in recent years due to various economic factors. One of the factors causing environmental damage that has a direct impact on global warming is energy consumption. In addition, the global economy is also one of the driving factors for increasing CO₂ emissions through energy consumption. Liu et al., (2020) argue that the determinants of carbon emissions cover many sectors, such as economic growth, renewable energy, globalization, urbanization, international trade, foreign direct investment, industrialization, democracy, financial development, international tourism, and others. In 2019, according to the International Energy Agency (IEA), global CO₂ emissions amounted to 33 billion tons. However, in 2020 CO₂ emissions have decreased, followed by a decrease in the gross domestic product caused by the Covid-19 pandemic. Group Of Eight is a combination of 8 developed countries that, in improving their country's economy, consumes a lot of both renewable and non-renewable energy so that it contributes a large proportion of global CO₂ emissions.

According to Keynesian consumption theory, consumption is influenced by a person's income level, where the higher the energy consumption level, the higher the growth rate. The Group of Eight, which consists of eight developed countries, shows that economic activity in these countries is very active. Economic development can have negative and positive impacts. The positive effect of economic growth is increasing the welfare of its people. On the other side, product in developed countries hurts environmental degradation. In the initial process of economic growth, a country will exploit natural resources without paying attention to the damage that can cause environmental degradation (Magazzino et al., 2022). Energy use is an essential factor in increasing economic activity, so it can cause extensive ecological damage because it can produce air pollutants or what is commonly referred to as carbon dioxide emissions (Jeon, 2022). Energy resources consist of renewable and non-renewable energy. Technology that is not environmentally friendly in utilizing resources causes carbon dioxide emissions to increase.

Conversely, the economy develops with an ineffective management system and worsens environmental quality (Sikder et al., 2022). Darwanto et al., (2019) state that reducing energy consumption effectively controls CO₂ emission levels. On the other hand, this method can hinder economic growth, so appropriate policies are needed to make efficient resource consumption. Energy efficiency is a way to reduce CO₂ emission levels through energy imports and will have a positive impact, namely maintaining energy security (Mehmood Mirza et al., 2022).

CO₂ emissions caused by the economic growth rate can be explained through the environmental Kuznets Curve proposed by Simon Kuznets, who identified that this concept explains the relationship between economic growth and environmental quality through an inverted U-shaped curve. The hypothesis of the inverted U-curve theory shows that higher economic growth will lead to higher emissions. Zhu et al., (2016) stated that the impact of economic growth on carbon dioxide emissions is very heterogeneous, meaning it can be negative and positive. Specifically, the results of this study show a negative and significant impact where the results imply that a faster economic growth rate can mitigate increased carbon emissions in several developed countries. Tang et al., (2022) stated that the economic growth rate and carbon emissions have a positive linear curve relationship at the extensive

Proceeding Medan International Conference Economics and Business

Volume 1, Year 2023

“Entrepreneurship on Global Economics Development in the Era of Society 5.0”

development stage. That means that the acceleration of economic development will encourage an increase in carbon dioxide emissions.

Globalization is a relationship between people or governments that transcends borders between countries to share ideas and knowledge (Leal & Marques, 2020). Economic globalization that occurs between countries can be through international trade. The level of globalization in a country's economy can affect the quality of the environment (Yang et al., 2021). So that in the process of economic globalization, G8 member countries cause climate change because globalization means the transfer of technology, diversification of consumption, and specialization of global production so that CO₂ emissions increase along with the process of economic globalization. Trade openness also has a positive effect, helping a country's economy grow faster by increasing trade volume (Shahbaz et al., 2017).

On the other, free trade has a negative effect and causes environmental degradation. Increasing trade liberalization will harm the environment because it can increase CO₂ emissions (Gaies et al., (2022)). That means if income from international trade is low, it can reduce CO₂ emission levels (Lin et al., 2022).

Based on the description of the background above, the research entitled **The Impact of Energy Consumption and Economic Globalization on CO₂ Emissions** conducted to see the effect of Economic Growth, Energy Consumption, and Globalization on carbon dioxide in developed countries are members of the Group of Eight.

METHOD

The population and sample in this research are member countries of the Group of Eight (G8), eight developed countries, namely the United States, Britain, Italy, Japan, Germany, Canada, France, and Russia. This research uses secondary data obtained from the World Bank, British Petroleum, The Statistical Review of World Energy and the KOF Swiss Economic Institute were processed using panel data regression to see the effect of the independent on the dependent variable in a period from 2017-2021. The econometric model (estimator) in this research is as follows:

$$\text{LogCo2}_{it} = \beta_0 \text{LogGDP}_{it} + \beta_1 \text{LogCONS}_{it} + \beta_2 \text{LogGLOB}_{it} + \varepsilon_{it}$$

Where :

LogCO₂ = CO₂ Emissions (Million Tonnes); LogGDP = Gross Domestic Product Per Capita (US\$); LogCONS = Energy Consumption (Kg) ; LogGLOB = Globalization Index (%); β₀ = Constant ; β₁= coefficient; i = the regency/city; t = Year; ε= Error Term

RESULTS AND DISCUSSION

Chow test

Table 1. Chow test

Effect Test	Statistics	df	Probability
Cross-section F	725.800614	(7,29)	0.0000

Proceeding Medan International Conference Economics and Business

Volume 1, Year 2023

"Entrepreneurship on Global Economics Development in the Era of Society 5.0"

The first stage in multiple linear regression is to do a Chow Test to choose the best model between the pooled least square and the fixed effect model. Table 1 shows that the correct model in this study is the fixed effect model because it has a probability value of $0.0000 < 0.05$.

Hausman test

Table 2. Hausman test

Test Summary	Chi-Sq. Statistics	Chi-Sq. df	Probability
Random cross-sections	38.576085	3	0.0000

Then the Hausman Test was carried out, which was a test to see the best model between the fixed effect model and the random effect model. Table 2 shows that the model chosen in this research is the fixed effect model with a probability value of $0.0000 < 0.05$. From the Chow and Hausman test, it can be concluded that the fixed effect model (FEM) model is well-estimated. The estimation results of the selected models are presented in Table 3.

Table 3. Estimating the Regression Estimation of the FEM Method

Indicators	Coefficient	Std. Error	t-Statistics	Prob.
C	20.16749	9.492494	2.124573	0.0423
LOG(GDP)	-0.036050	0.060453	-0.596321	0.5556
LOG(CONS)	1.539564	0.073794	20.86297	0.0000
LOG(GLOB)	-4.630779	2.114925	-2.189571	0.0367
R-squared	0.999667	F-statistics		8699550
Adjusted R-squared	0.999552	Prob(F-statistic)		0.000000

Source: Data processing, 2023

Based on Table 3, the panel data regression equation obtained from the selected model Fixed Effect Model is as follows:

$$\text{LogCo2}_{it} = 20,1675 - 0,0361\text{LogGDP}_{it} + 1,539\text{LogCONS}_{it} - 4,6318\text{LogGLOB}_{it} + \varepsilon_{it}$$

From Table 3, it can be seen that in the influence validity test or commonly referred to as the t-test, the probability value of the Gross Domestic Product (GDP) variable is 0.5556 (> 0.1), the energy consumption variable (CONS) is 0.0000 (< 0.1), and the Globalization variable (GLOB) is 0.0367 (< 0.1). The probability value of each dependent variable indicates that there is a significant effect on CO2 emissions. Meanwhile, simultaneously or the F test, the probability value of the F-statistic shows a value of 0.0000, so it can be concluded that simultaneously the dependent variables affect the independent variables.

The value of the coefficient of determination (R^2) in Table 3 is 0.9997, meaning that the variables gross domestic product, energy consumption, and globalization can explain 99.97% of the variation in the variables in the CO2 equation. While other variables outside this research model explain the remaining 0.13%.

Proceeding Medan International Conference Economics and Business

Volume 1, Year 2023

"Entrepreneurship on Global Economics Development in the Era of Society 5.0"

DISCUSSION**The Effect of Economic Growth on CO₂ Emissions**

According to the neoclassical theory proposed by Robert Solow, economic growth is a development process that originates from four factors: humans, capital, technology, and output. So that economic growth is described in the form of Gross Domestic Product (GDP) which is the development of the economy in a certain period. The Gross Domestic Product variable has no significant effect on CO₂ emissions in Group of Eight (G8) member countries. The coefficient of the GDP variable is -0.0361 with a logarithmic-logarithmic relationship pattern. If GDP increases by 1 per cent, CO₂ emissions will decrease by 3.61 per cent. Mikayilov et al., (2018) stated that economic growth positively impacts Azerbaijan emissions in the long run. The results of this study are also inconsistent with the Kuznets environmental curve, which says that when economic growth increases, it will cause CO₂ emissions to grow even though statistically, it does not show a significant effect. Khezri et al., 2022 showed that the coefficient of GDP per capita has a negative effect on CO₂ emissions because as economic growth increases, environmental quality will be much better than before. Hence, the results following this study.

Effect of Energy Consumption on CO₂ Emissions

The energy consumption variable significantly influences CO₂ emissions in Group of Eight member countries. The coefficient of the energy consumption variable is 1.5396 with a relationship pattern that is logarithm-logarithm. If energy consumption increases by 1 per cent, CO₂ emissions will increase by 153.96 per cent. This study's results align with research conducted by Punttoon et al., (2022), which revealed that energy consumption shows positive evidence that determines the level of CO₂ emissions. Consumption which continues to increase, is caused by the rate of economic growth in addition to the consumptive pattern of society which tends to be wasteful and inefficient in using technology (Kurniarahma et al., 2018). Chen et al., (2022) argue that the consumption of renewable energy has a negative and significant relationship to CO₂ emissions. This only happens in countries that consume energy below a specific limit in energy consumption.

A country's energy consumption level has an essential role in economic development because a higher level of consumption can increase and expand employment, trade, transportation, and other sectors of the economy (Anwar et al., 2021).

Effect of Economic Globalization on CO₂ Emissions

The theory of globalization formulated by a sociologist named Anthony Giddens is that globalization is synonymous with global economic phenomena and involves transnational companies from all over the world. Globalization can increase CO₂ emissions through trade liberalization, directly impacting environmental damage.

Globalization variables significantly affect CO₂ emissions in Group of Eight member countries. The coefficient of the Globalization variable is -4.6318 with a logarithmic-logarithmic relationship pattern. This means that if GLOB increases by 1 per cent, CO₂ emissions will decrease by 463.18 per cent. In their research, Kwabena, Twerefou et al., (2017) showed similar results, which revealed that globalization harms both quality and environmental sustainability and the negative effect is greater than the positive income effect on environmental quality and sustainability. You & Lv, (2018) argue that globalization has a positive relationship with CO₂ emissions, which means that the higher the level of globalization through international trade, the higher CO₂ emissions will be.

Proceeding Medan International Conference Economics and Business

Volume 1, Year 2023

"Entrepreneurship on Global Economics Development in the Era of Society 5.0"

IMPLICATIONS

It is hoped that the results of this study will contribute to determining the following policies:

1. For academics, it is hoped that this research will provide benefits in the form of helpful knowledge to add insight into the factors that cause CO₂ emission levels.
2. For the government as a policy maker, it is hoped that this research can increase knowledge about the impact of economic globalization and excessive energy consumption, so it is expected that with this research, the government can implement policies that can reduce CO₂ emission levels in a country through energy efficiency and user-friendly technology environment in exploiting energy resources.

CONCLUSION

Gross Domestic Product has a negative and insignificant effect on CO₂ emissions, Energy consumption has a positive and significant effect on CO₂ emissions, Globalization has a negative and significant effect on CO₂ emissions. The three independent variables, gross domestic product, globalization, and energy consumption, have heterogeneous influences. Economic growth, which is proxied from the GDP variable, shows a negative and insignificant effect, meaning that if a country's growth rate is high, it does not necessarily increase and directly affects carbon dioxide levels. However, when viewed from the energy consumption variable, the increase in carbon dioxide is influenced by excess energy consumption. Resource exploitation, followed by non-environmentally friendly technologies, causes severe environmental damage. The two have opposite effects from the globalization index through international trade. If globalization increases, it can reduce carbon dioxide. It can happen because if globalization uses technology that is friendly to the environment, then little by little, it can reduce carbon dioxide.

REFERENCES

- Anwar, A., Siddique, M., Eyup Dogan, & Sharif, A. (2021). The moderating role of renewable and non-renewable energy in environment-income nexus for ASEAN countries: Evidence from Method of Moments Quantile Regression. *Renewable Energy*, 164, 956–967.
- Chen, C., Pinar, M., & Stengos, T. (2022). Renewable energy and CO₂ emissions: New evidence with the panel threshold model. *Renewable Energy*, 194, 117–128.
- Darwanto, D., Woyanti, N., Budi, S. P., Sasana, H., & Ghazali, I. (2019). The Damaging Growth: an Empiric Evidence of Environmental Kuznets Curve in Indonesia. *International Journal of Energy Economics and Policy*, 9(5), 339–345.
- Gaies, B., Nakhli, M. S., & Sahut, J. M. (2022). What are the effects of economic globalization on CO₂ emissions in MENA countries? *Economic Modelling*, 116, 106022.
- Jeon, H. (2022). CO₂ emissions, renewable energy and economic growth in the US. *Electricity Journal*, 35(7), 107170.
- Khezri, M., Heshmati, A., & Khodaei, M. (2022). Environmental implications of economic complexity and its role in determining how renewable energies affect CO₂ emissions.

Proceeding Medan International Conference Economics and Business

Volume 1, Year 2023

"Entrepreneurship on Global Economics Development in the Era of Society 5.0"

Applied Energy, 306(PB), 117948.

- Kurniarahma, L., Laut, L. T., & Prasetyanto, P. K. (2018). Analisis Faktor-Faktor Yang Mempengaruhi Emisi Co 2 Di Indonesia (Analysis of Factors Affecting Co2 Emissions in Indonesia). *DINAMIC: Directory Journal of Economic*, 2(2), 369–385.
- Leal, P. H., & Marques, A. C. (2020). Rediscovering the EKC hypothesis for the 20 highest CO2 emitters among OECD countries by level of globalization. *International Economics*, 164, 36–47.
- Lin, C., Zhang, L., & Zhang, Z. (2022). The impact of the rise of emerging economies on global industrial CO2 emissions: Evidence from emerging economies in Regional Comprehensive Economic Partnership. *Resources, Conservation and Recycling*, 177, 106007.
- Liu, M., Ren, X., Cheng, C., & Wang, Z. (2020). The role of globalization in CO2 emissions: A semi-parametric panel data analysis for G7. *Science of the Total Environment*, 718, 137379.
- Magazzino, C., Toma, P., Fusco, G., Valente, D., & Petrosillo, I. (2022). Renewable energy consumption, environmental degradation and economic growth: the greener the richer? *Ecological Indicators*, 139, 108912.
- Mehmood Mirza, F., Sinha, A., Rehman Khan, J., Kalugina, O. A., & Wasif Zafar, M. (2022). Impact of energy efficiency on CO2 Emissions: Empirical evidence from developing countries. *Gondwana Research*, 106, 64–77.
- Mikayilov, J. I., Galeotti, M., & Hasanov, F. J. (2018). The impact of economic growth on CO2 emissions in Azerbaijan. *Journal of Cleaner Production*, 197(2018), 1558–1572.
- Puntoon, W., Tarkhamtham, P., & Tansuchat, R. (2022). The impacts of economic growth, industrial production, and energy consumption on CO2 emissions: A case study of leading CO2 emitting countries. *Energy Reports*, 8, 414–419.
- Shahbaz, M., Nasreen, S., Ahmed, K., & Hammoudeh, S. (2017). Trade openness–carbon emissions nexus: The importance of turning points of trade openness for country panels. *Energy Economics*, 61, 221–232.
- Sikder, M., Wang, C., Yao, X., Huai, X., Wu, L., KwameYeboah, F., Wood, J., Zhao, Y., & Dou, X. (2022). The integrated impact of GDP growth, industrialization, energy use, and urbanization on CO2 emissions in developing countries: Evidence from the panel ARDL approach. *Science of the Total Environment*, 837, 155795.
- Tang, Y., Zhu, H., & Yang, J. (2022). The asymmetric effects of economic growth, urbanization and deindustrialization on carbon emissions: Evidence from China. *Energy Reports*, 8, 513–521.
- Yang, X., Li, N., Mu, H., Pang, J., Zhao, H., & Ahmad, M. (2021). Study on the long-term impact of economic globalization and population aging on CO2 emissions in OECD countries. *Science of the Total Environment*, 787, 147625.
- You, W., & Lv, Z. (2018). Spillover effects of economic globalization on CO2 emissions: A spatial panel approach. *Energy Economics*, 73, 248–257.
- Zhu, H., Duan, L., Guo, Y., & Yu, K. (2016). The effects of FDI, economic growth and energy consumption on carbon emissions in ASEAN-5: Evidence from panel quantile regression. *Economic Modelling*, 58, 237–248.