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The Relationship between Industrialization, Financial Inclusion, and Environmental Sustainability of Provinces in Java

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Abstract

Even though data on total CO2 emissions nationally shows a decreasing trend, provincially on the island of Java, it still shows fluctuations and even tends to increase. In theory, industrialization and economic growth are the main contributors to carbon emissions and environmental degradation. In contrast, the impact of financial inclusion on environmental extinction has no context among researchers. Several studies show that financial inclusion can provide more accessible and more affordable access to financial products that help invest in green technology and environmentally friendly practices. On the other hand, it increases manufacturing activities, which can increase carbon emissions and damage the environmental ecosystem. The research examines the relationship between financial inclusion and industrialization on environmental sustainability, specifically using provincial data on the island of Java for the period 2012 to 2022. Dynamic linkage analysis is used to understand how financial inclusion and industrialization affect environmental sustainability in the longer term, in addition to helping overcome endogeneity and simultaneity problems in panel regression models so that the analysis results become more accurate and reliable.

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Introduction

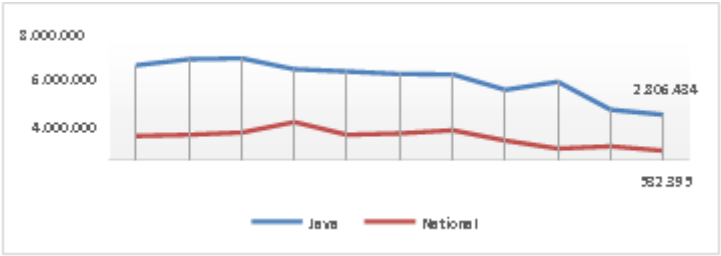
One of the environmental problems that has received special attention in the world in the last few decades is global warming. Several experts agree that the main cause of global warming is an increase in greenhouse gases (GHG), especially carbon dioxide (CO2) emissions (IPCC, 2014). Global warming which triggers climate change has a significant impact which indirectly affects the

economic performance of society. The reason is that climate change has a very broad impact on human life. The increase in the earth's temperature not only has an impact on increasing the earth's temperature but also changes the climate system which influences various aspects of changes in nature and human life. These changes also change the composition of the global atmosphere and natural climate variability in certain periods. The composition of the global atmosphere in question is the material composition of the Earth's atmosphere in the form of Greenhouse Gases (GHG), such as Carbon Dioxide, Methane, Nitrogen, and so on.

Overall, Java Island has great potential in various aspects, both economic, cultural and environmental. The ever-increasing population level shows that the island of Java has extraordinary attraction for the community. Of the total population of Indonesia in 2022, around 56 percent will live on the island of Java. According to Peacock (2020), increasing population numbers increase the occurrence of damage in every biological ecosystem, thus affecting environmental sustainability. The high population will increase production waste due to daily activities, such as household waste.

Since CO2 emissions were recorded in 1900, the highest record emissions occurred in 2022. This is a reaction that occurred in society following the recovery of air travel after the pandemic subsided and more people turned to coal as a source of low-cost electricity (Arif, 2023). Currently, Indonesia's dependence on fossil energy to meet domestic energy needs is still high, namely 4.42 percent from coal and 3.14 percent from petroleum (Sembiring, 2023). The dominance of coal in the national energy utilization market share also means that the resulting carbon emissions are also large, meaning it is not environmentally sustainable. The use of high fuel and electricity consumption can contribute to a high emissions footprint (Wulandari, 2016).

Based on data from the Forest Management Technical Personnel Information System (SIGANISHUT) (2023), CO2 emissions produced by Java Island will reach more than 2.8 million Gg tonnes in 2022, while nationally it is only 532 thousand Gg tonnes of CO2 (Picture 1). This shows that the contribution of Java Island's CO2 emissions is still higher than the national contribution. Apart from that, Java Island is one of the islands with a large contribution from the manufacturing industry sector to CO2 emissions.



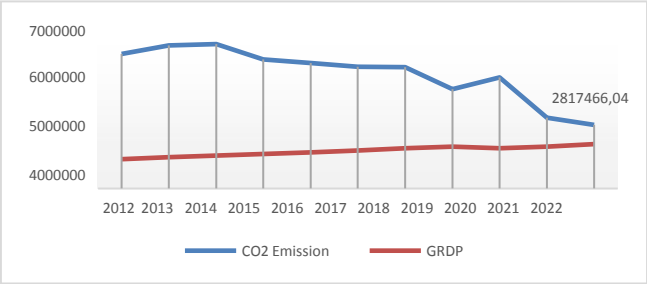
Picture 1. Total Carbon Dioxide (CO2) Emissions per Capita in the Manufacturing Industry Sector on the Island of Java
Source: SIGANISHUT (2023)

The environmental problems above will gradually affect the natural condition of the island of Java. Nevertheless, Java Island is one of Indonesia's economic centers with many large companies established, such as the textile, electronics and manufacturing industries (Anwar, 2023). Based on BPS data, Indonesia's economy in 2022 will grow by 5.31 percent, higher than the achievement in 2021 which experienced growth of 3.70 percent. The Indonesian economy is still dominated by the manufacturing industry business sector at 18.34 percent. This shows that the manufacturing industry is still the main driver of the national economy.

Apart from that, progress over time followed by technological developments creates new innovations as a form of environmental adaptation that occurs due to structural changes in society's economy. So this makes financial inclusion a more efficient financial intermediation and encourages customers to take loans and buy goods that increase people's consumption patterns, thereby increasing CO2 emissions which can affect environmental sustainability (Sadorsky, 2010). As according to Li et al. (2019), that theoretically there is no consensus (positive or negative) among researchers about the impact of financial inclusion on environmental sustainability. Intuitively, enabling firms and households to have more availability and access to financial and socio-economic services will increase consumption which in turn leads to greater CO2 emissions.

However, another school of thought argues that financial sector development will increase investment in energy-efficient technologies and thereby reduce CO2 emissions (Abbasi et al., 2016). Financial inclusion is a complex and important part of economic growth and financial development; this refers to the access of businesses and individuals to financial services and products including payments, credit, insurance, transactions and savings, to meet their demands in a convenient, sustainable, responsible and affordable manner (World Bank, 2018; Le et al al., 2019). Frankel & Romer (1999), argue that financial development in a region attracts more foreign direct investment and leads to higher levels of research and development which leads to a better environment. Talukdar & Meisner (2001); Meilnik & Goldemberg (2002); Wang & Jin (2007) and Bello & Abimbola (2010) found that financial development brought technological improvements which led to lower emissions. According to Tamazian et al. (2009), development finance helps companies improve energy efficiency by adopting new technologies. Thus, it is important to estimate the dynamic impact of industrialization and financial inclusion on environmental sustainability, especially as the relationship between them may be non-linear such as the Environmental Kuznets Curve (EKC) (Le et al., 2020).

The importance of paying attention to environmental factors in development for a sustainable economy. Sustainable economic development is an attempt to explain the highly desirable balance between economic growth on the one hand and environmental sustainability on the other (Todaro, 2006). The concept of sustainable economic development includes efforts to improve community welfare while considering the impact on the environment. Like the situation that occurred on the island of Java, where the increase in GRDP in each province actually reduced the level of CO2 emissions, which is an indicator of environmental sustainability (Picture 2).



Picture 2. Contribution of the Manufacturing Industry Sector to GRDP and CO2 Emissions on Java Island
Source: Badan Pusat Statistik (2023)

From the large amount of literature that researchers have read, currently there is no research or empirical evidence that examines the dynamic relationship between industrialization and financial inclusion on environmental sustainability on the island of Java. Several researchers who conducted similar research focused their objects on a broader scope, such as those carried out by Kurniawan (2019) with research objects in Indonesia and Amin et al. (2022) in South Asia. In addition, Kurnaiwan's (2019) research uses GDP indicators to represent economic development variables, while the author uses industrial sector investment financing indicators to represent financial inclusion variables. Therefore, in order to fulfill this empirical evidence, it is necessary to carry out further research regarding the dynamic relationship between industrialization and financial inclusion on environmental sustainability on the island of Java.

RESEARCH METHODS

This research approach uses a quantitative approach. The data used in this research is panel data, which is presented in annual form from 2012 to 2022, with the object being 8 provinces on the island of Java and using secondary data as contained in table 1.

Table 1. Secondary Data Sources

Notation	Variables	Indicators	Scale	Units	Sources
X_1	GRDP/ Industrialization	GRDP contribution from the manufacturing industry sector	Ratio	Billion Rupiah	Badan Pusat Statistik (BPS)
X_2	Labor/ Industrialization	Number of workforce in the manufacturing industry sector	Ratio	Population	Badan Pusat Statistik (BPS)
X_3	Expor/ Industrialization	Perkembangan nilai ekspor sektor industri manufaktur	Ratio	US$Million	Badan Pusat Statistik (BPS)

X_4	Financial Inclusion	Development of the export value of the manufacturing industrial sector	Ratio	Million	National Single Window for Investment Portal (NSWI)
Y	Environmental Sustainability	CO2 emissions per capita	Ratio	Gg CO2	Sistem Informasi Tenaga Teknis Pengelolaan Hutan (SIGANISHUT)

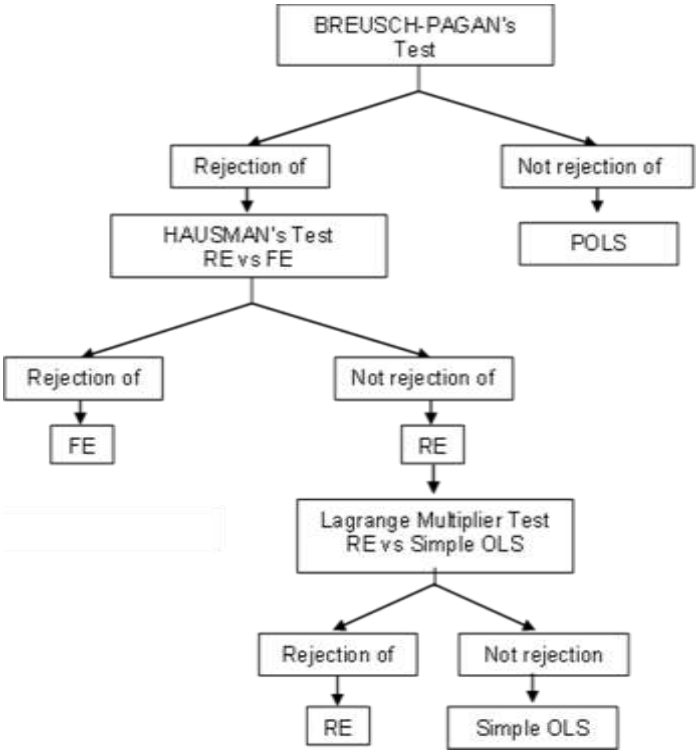
This research uses panel data regression analysis techniques. Panel data regression analysis is a regression analysis tool where data is collected between individuals (cross section) and over a certain period of time (time series). The usefulness of panel data is that it can capture individual heterogeneity, can capture the dynamics of adjustment, as well as more information and variation, which will help minimize the possibility of multicollinearity (Baltagi, 2021). The initial model to describe the relationship between industrialization and financial inclusion on environmental sustainability is as follows:

$$Yit = \alpha + \beta 1\ GRDPit + \beta 2\ LBRit + \beta 3\ EXPit + \beta 4\ FIit + \square it$$

Description of the model: Y is an environmental sustainability variable represented by the amount of CO2 emissions per capita. GRDP, LBR and EXP are independent variables which are proxies for the industrialization variable. FI is a financial inclusion variable which is represented by the amount of investment financing in the manufacturing industry sector. Meanwhile, ε is individual heterogeneity.

The first stage of analysis is to carry out descriptive statistics. The second stage is to find the best panel regression model, by estimating . There are three formulations that will be tested, namely Pooled Model, Random Effect Model, and Fixed Effect Model. The Breush-Pagan test was to choose between the Pooled Model or Random Effect Model, then the Hausman test was carried out to choose between the Fixed Effect Model or Random Effect Model, and finally the Lagrange multiplier test was carried out to choose between Random Effect and Simple OLS (Figure 2).

After obtaining a suitable model from the three models tested, a diagnostic examination was then carried out, namely (a) Multicollinearity, with detection of: variance inflation factor (VIF); (b) Heteroscedasticity, with detection: Modified Wald statistics for group heteroscedasticity; (c) Serial Correlation (Autocorrelation), with detection: serial correlation test. If there are still heteroscedasticity and/or serial correlation problems, model improvements will be carried out using certain commands (Hoechle, 2007).



Picture 3. Panel Model Stages
Source: Di Lascio (2011)

RESULT

To obtain the best panel data regression model for data on the amount of CO2 emissions per capita on the island of Java, a descriptive analysis was first carried out. Descriptive statistical analysis aims to describe the condition of the data such as average, standard deviation, minimum data, maximum data and the amount of data. The results of the analysis that has been carried out can be seen in the table 2.

Table 2. Descriptive Statistical Analysis

Variable	Highest Score/Year	Lowest Value/Year
CO2 Emission	6.408.521,19/ 2014	2.817.466,04/ 2022
GRDP	1.968.566/ 2022	1.302.180/ 2012
Labor	14.083.010/ 2019	11.717.771/ 2016
Export	97.691,90/ 2022	35.636,00/ 2012
Financial Inclusion	76.465.461,4/ 2022	32.328.982,5/ 2014

Based on Table 2, it can be seen that from 2012 to 2022 the highest value for CO2 emissions occurred in 2014 at 6.8 Gg tons of CO2 and the lowest in 2022 at 2.8 Gg tons of CO2. The highest GRDP amount in 2022 was 1.9 million billion rupiah and the lowest in 2012 was 1.3 million billion rupiah. The highest number of

labor absorption was more than 14 million people in 2019 and the lowest was 11.7 million people in 2016. The highest export value was in 2022 and the lowest in 2012. And for financial inclusion the highest occurred in 2022 and the lowest in 2014.

The second stage is to find the best regression model by carrying out the Breusch Pagan's test to choose between a Pooled Model or a Random Effect Model, then a Hausman test is carried out to choose between a Fixed Effect Model or a Random Effect Model as shown in Appendix 1. And finally, the Lagrange multiplier test is carried out to choose between Random Effect and Simple OLS as shown in Appendix 2. Based on the results of the best regression model test, the best regression model is obtained, namely the Random Effect Model with a probability value < α = 0.05%, which means it fails to reject H0 so it is the best model for analysis. The influence on CO2 emissions is a random effect.

Because the model results obtained were random effects, the classical assumption test was not carried out because the random effect model is a generalized least squares (GLS) estimation method. The GLS technique is believed to overcome the presence of time series autocorrelation and correlation between observations (cross section). However, because there is still a problem with estimating standard errors, we will improve the model using certain commands as in Appendix 3. So that the results obtained are each variable is more significant, as can be seen in the following table.

Table 3. Significance Test Results

Parameter	Coefisient	Standard Error	z	P value
GRDP	0,2363834	0,0829755	2,85	0,004
LBR	-0,4385072	0,1768456	-2,48	0,013
EXP	0,033205	0,1037879	0,32	0,749
FI	0,2243146	0,160109	1,40	0,161

Table 3 shows that there are two independent variables, namely GRDP and LBR, which have a significant effect on CO2 emissions on the island of Java, where the Pvalue of both is < α = 0.05%, which means this variable has a significant effect. Meanwhile, the Pvalue of EXP and FI > α =0.05%, which means it does not have a significant influence on CO2 emissions on Java Island.

The relationships that occur between variables and their influence on CO2 emissions are:

The relationship between the elasticity coefficient of GRDP and CO2 emissions is positive. So if GRDP increases it will produce a positive value for CO2 emissions. The GRDP elasticity coefficient value is 0.2363, meaning that every time the GRDP value increases by 1%, the CO2 emission value will significantly increase by 0.236% assuming the LBR, EXP and FI variables remain constant.

The relationship between the elasticity coefficient value of LBR and CO2 emissions is negative. This explains that the decreasing amount of LBR will have a negative value on the amount of CO2 emissions. The EXP elasticity coefficient value is 0.4385, meaning that every time the LBR coefficient value increases by

1%, it will significantly reduce the CO2 emission value by 0.4385% with the assumption that the GRDP, LBR and FI values are constant.

The relationship between the elasticity coefficient of EXP and CO2 emissions is positive. So, if EXP increases it will produce a positive value in the CO2 emission value. The EXP elasticity coefficient value is 0.0332, meaning that every time the GRDP value increases by 1%, the CO2 emission value will increase by 0.0332% assuming the LBR, EXP and FI variables are constant. However, the relationship between these variables is not significant.

The relationship between the elasticity coefficient of FI and CO2 emissions is positive. So, if FI increases it will produce a positive value for CO2 emissions. The FI elasticity coefficient value is 0.2243, meaning that every time the GRDP value increases by 1%, the CO2 emission value will significantly increase by 0.2243% assuming the LBR, EXP and FI variables are constant. However, the relationship between these variables is not significant.

DISCUSSION

Based on Kaldor's theory defines that the manufacturing industrial sector is part of the growth of a region in increasing the growth of several other sectors as well as having an impact on increasing economic growth. In Kaldor's theory there are three aspects, namely economic growth has a positive relationship to industrial growth, secondly, industrial labor productivity has a positive effect on the growth of the industrial sector itself. In this case the industrial sector is considered to be able to produce increasing returns to scale (increasing returns to scale). Third, the growth of the non-industrial sector has a positive relationship with the growth of the industrial sector. This is motivated by the tendency of the processing industry sector towards diminishing returns to scale.

Even though data on total CO2 emissions nationally shows a downward trend, provincially on the island of Java it still shows fluctuations and even tends to increase. In theory, industrialization and economic growth are major contributors to carbon emissions and environmental degradation. However, in contrast to existing theory, the empirical results based on table 3 show that of the four independent variables of industrialization and economic growth, namely GRDP, labor, exports and financial inclusion, none of the variables can have a significant effect on the dependent variable, namely CO2 emissions. . Where CO2 emissions are an indicator for measuring environmental sustainability variables. This means that the increase in CO2 emissions each year is not really affected by the presence of these variables on the island of Java.

Industrialization and financial inclusion have a complex relationship on the island of Java. Industrialization creates new jobs and increases incomes, which can increase financial inclusion by providing greater access to financial services. On the other hand, the development of financial inclusion can also support industrial growth by providing capital for small and medium enterprises (SMEs).

Industrial growth is often accompanied by exploitation of natural resources and increased pollutant emissions. The construction of factories and infrastructure can cause environmental damage such as deforestation, water pollution and increased industrial waste. Therefore, there is a need for a balanced policy between industrial development and environmental preservation.

Financial inclusion can be a catalyst for sustainable business practices. By providing financial access to the community, especially small businesses, we can encourage the adoption of environmentally friendly technology and practices. Increasing access to capital can also help sectors focused on environmental innovation.

Based on empirical results concluded from the research results of Tamazian et al. (2009) is presented in Table 8. Short-term and long-term influences on CO2 emissions, namely financial inclusion (FI) has a negative effect on the increase in CO2 emissions on the island of Java in both the short and long-term periods. This proves that every increase in the value of financial inclusion will reduce the amount of CO2 emissions on the island of Java. Development finance helps companies improve energy efficiency by adopting new and more environmentally friendly technologies. This is proven by the empirical results in Table 3 where the financial inclusion variable has a positive relationship with increasing CO2 emissions on the island of Java. This means that if there is an increase in the value of financial inclusion on Java, it will increase the amount of CO2 emissions on Java as well.

According to Arsyad (2010), in the Solow-Swan theory, the capital output ratio (COR) has a dynamic nature, meaning that producing a certain level of output requires a balanced combination of capital and labor. If the use of capital is high then the use of labor will be low, conversely if the use of capital is low then the use of labor will be high. Another main point of thought is that in the production function there is technology which is argued for production factors such as capital and labor, as seen in empirical Table 3 of the results of the significance test, namely that GRDP has a positive effect on increasing the amount of CO2 emissions. Meanwhile, the labor variable has a negative effect on increasing the amount of CO2 emissions on the island of Java. Which means, if there is a significant increase in labor absorption on Java Island, it will reduce CO2 emissions that occur on Java Island. This is not without reason, because the government has made efforts to develop a green industry which can be carried out with two strategies, namely greening existing industries (greening the brown industry) and creating new industries according to green industry principles (developing the new green industry) (Ministry of Industry , 2022).

CONCLUSION

The best panel regression model was obtained with a random effect model in which there were two significant GRDP and LBR variables on CO2 emissions on the island of Java with the following equation model:

$$Yit = \alpha + \beta 1\ GRDPit + \beta 2\ LBRit + \beta 3\ EXPit + \beta 4\ FIit + \square it$$

Based on the research results, it shows that the Gross Regional Domestic Product (GRDP) variable has a positive and significant effect on increasing CO2 emissions. Thus, the higher the increase in Gross Regional Domestic Product on Java Island, the more CO2 emissions on Java Island will also increase.

Based on the research results, it shows that the variable employment absorption in the manufacturing industry sector (LBR) has a negative and significant effect on increasing CO2 emissions. Thus, the higher the amount of labor absorption on Java Island, the lower the amount of CO2 emissions on Java Island. This is a new finding in the field of research because a number of existing theories have never found a similar incident which is a factor in reducing CO2

emissions due to increased labor absorption. This is the government's effort to develop a green industry which can be carried out with two strategies, namely greening existing industries (greening the brown industry) and creating new industries according to green industry principles (developing the new green industry) (Kemenperin, 2022).

Then, based on the research results, it shows that the other two variables do not have a significant effect on increasing CO2 emissions, however, the export and financial inclusion variables have a positive influence on CO2 emissions on the island of Java.

From the discussion above, it can be concluded that the dynamic relationship between industrialization, financial inclusion and environmental sustainability on the island of Java requires a holistic approach. There needs to be policies that support industrial growth without compromising the environment, while ensuring that economic benefits reach all levels of society through financial inclusion. Harmony between these three elements can be achieved through wise regulations, investment in environmentally friendly technology, and strengthening inclusive financial institutions. In this way, Java Island can achieve sustainable and inclusive development, ensuring economic prosperity without damaging the environment.

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