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Causality Between Carbon Dioxide (CO2) Emissions and Economic Growth in Indonesia

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ABSTRACT: Economic growth and environmental protection are two goals that are often considered contradictory. Strong economic growth tends to require high energy consumption, which is often obtained from fossil fuel sources. The aim of this research isthe relationship between carbon dioxide (CO2) emissions and economic growth in Indonesia. This type of research is descriptive qualitative with a quantitative approach, the data source in this research uses 41 year time series data in the period 1980 - 2021 in Indonesia, the research was attempted using Multivariate Time Series Analysis Panel Information on Vector Auto Regression (VAR) combined with Vector Error Correction Form (VECM) uses the statistical application EViews 9. 0. Economic development is the progress of activity in the economy which causes the creation of goods and services in society to increase and the abundance of society to increase, carbonium dioxide (CO2) is a colorless, odorless gas compound that obtained from incomplete combustion of materials containing charcoal or organic matter. Research results show that this lack of connection is also due to the high dependence on fossil fuel sources, which is almost 2 thirds of total energy use, so that increasing energy use can affect carbonium dioxide (CO2) emissions in Indonesia. The ever-increasing number of means of transportation also greatly influences the increase in the use of natural oil, which in the future could disrupt the balance of the area's ecosystem which has an impact on other living creatures.

KEYWORDS: Causality, Carbon Dioxide Emissions, Economic Growth, Indonesia

I. INTRODUCTION

Economic development is a marker or the best dimension of economic capacity. Neoclassical economists such as Solow-Swan or endogenous development economists, such as the AK model of Sergio Rebelo, emphasize the existence of capital, activity power and technology to increase economic development. However, this neo-classical form of development has been criticized by regional economists, rooted in basic economic problems, namely limited or scarcity of energy resources (scarcity). The neoclassical development philosophy by regional economists focuses on limitations on replacement plans and limitations on development plans or technological change as a method to reduce the scarcity of energy resources (This form is expected by neoclassical economists, the Solow-Swan Form and the Endogenous Development Model), (Titi, 2019).

One of the first neoclassical economic growth theorists was Robert Solow. Robert Solow was an American economist who developed a model of economic growth in 1956 known as the Solow Model (Neoclassical Growth Model). The Solow Model provides an analytical framework for understanding the factors that influence long-term economic growth. In this model, Solow identifies three main factors that influence economic growth, namely capital (availability of investment), labor, and technological progress.

According to Solow, in the short term, increased investment and workforce growth can contribute to economic growth. However, in the long run, the most important factor is technological progress. Technological advances enable higher production efficiency and innovation in production processes, thereby increasing productivity and long-term economic growth. Solow's contribution to economic growth theory is significant because it provides a better understanding of the factors that drive economic growth in the long run. The Solow model became the basis for much subsequent research and development of economic growth theory. Economic growth theory has developed rapidly since Solow, and many other economists such as Paul

Romer, Douglass North, and Robert Barro have also made significant contributions to understanding the factors that influence economic growth and economic growth theory.

Economic growth is an important indicator in measuring the success of a country or region in achieving prosperity and prosperity. Energy consumption, on the other hand, has a crucial role in supporting economic activities and is a major factor in meeting energy needs in various sectors. The relationship between energy consumption and economic growth has become an important topic in economics, especially in the context of sustainable development and energy policy. In an effort to achieve sustainable economic growth, an approach is needed that considers energy efficiency, use of renewable energy, emission reduction and overall environmental sustainability. It is important to manage energy consumption wisely to achieve a balance between sustainable economic growth and environmental protection.

Indonesia is a country that has experienced significant economic growth in the last few decades. The country of Indonesia has experienced rapid economic transformation and recorded a high increase in growth. However, based on World Bank national account data, and the OECD (Organization for Economic Cooperation and Development) National Accounts data files listed in Our World in Data (OWID), economic growth in Indonesia seen from GDP Growth in 2010 - 2014 experienced fluctuations from year on year where in 2010 Indonesia's GDP growth reached 6.89% and decreased by 4.73% in 2011 and 4.35% in 2012, then experienced an increase in 2013 of 4.42% and decreased again 4 % in 2014 which still does not exceed Indonesia's GDP growth in 2010.

Economic growth and environmental protection are two goals that are often considered contradictory. Strong economic growth tends to require high energy consumption, which is often obtained from fossil fuel sources. However, the use of fossil fuels also causes carbon dioxide (CO2) emissions which contribute to global climate change.

Indonesia has experienced rapid economic growth, which can lead to increased energy consumption and carbon dioxide emissions. The main sources of CO2 emissions in this region come from the burning of fossil fuels such as coal, oil and natural gas, as well as deforestation and land use changes. However, the Government of the Republic of Indonesia has also taken steps to reduce CO2 emissions and face the challenge of climate change. Indonesia and several countries in the world have committed to achieving carbon neutral emissions targets in the coming years and participating in international agreements such as the Kyoto Protocol and the Paris Agreement, which aim to limit the increase in global average temperatures to below 2 degrees Celsius above the level. pre-industrial. This is an effort made by the government to reduce the impact of CO2 emissions both domestically and globally.

Based on the explanation above, it can be seen that there is a strong causal relationship between energy consumption, carbon dioxide (CO2) emissions and economic growth in Southeast Asia. This is confirmed by the results of research by Mohammad Al-Zuhair and Talal Al-Bazali (2022) which explains that there is a close relationship between oil exports and total GDP in Kuwait. The difference between total GDP and oil GDP is exactly equal to the contribution of non-oil economic growth to the country's economy. The findings of this research provide a reliable and suitable basis for policy making not only in Kuwait, but also in other single-source oil producing countries such as the GCC countries.

According to Sodik Dwi Purnomo, et al (2023), in his research, he explained that the results of this study showed that consumption of oil, gas and biomass fuels, as well as the average length of education had a positive and significant effect, while road infrastructure and the Life Expectancy Index (CPI) did not influence on economic growth in Indonesia in 1990 - 2019. Mohamed Al Shami (2023) in his research also explains that energy consumption and non-renewable energy consumption are positively correlated, depending on the country's economic growth and this relationship is optimal at a lag of 7 years. The same results were also presented by Faisal Irsan Pasaribu, et al (2023) who explained that economic growth, population growth, energy subsidies and fossil fuel energy consumption have a positive and significant impact on sustainable energy consumption in Indonesia. Research by Omar M. Alkasasbeh, et al (2023) also proves that alternative energy consumption sources must be used to achieve environmental and economic sustainability.

Previous studies of the relationship between CO2 emissions and economic growth have produced varying findings. Several studies show a positive relationship, where high economic growth is directly proportional to increased CO2 emissions. However, there are also studies that find a negative relationship or no significant relationship between these two variables. The implementation of energy utilization systems for sustainable development in several countries has not been fully realized, especially in Indonesia. This renewal of fossil energy is necessary for sustainable development because this energy resource may run out in the future, and the widespread impact of CO2 carbon dioxide emissions from the use of energy consumption must be immediately addressed to preserve the environment in Indonesia.

II. LITERATURE REVIEW

A. *Economic growth*

The neoclassical philosophy of development was published by Robert Meter. Solow and T. W Swan's Solow-Swan form as a form of economic development provides a static analysis of the dependence between capital accumulation, population growth, and technological progress and the impact of all three on the level of output creation. Economic development is related to the increase in the supply of factors of creation (society, activity capacity, and capital accumulation) as well as the level of technological development. This thinking is based on the assumptions that underlie classical analysis, namely that the economy will always experience full employment levels and the capacity of capital equipment will remain fully utilized over time. In other words, the extent to which the economy will grow depends on population growth, asset accumulation, and technological developments (Mankiw, 2007).

Economic development is the progress of activity in the economy which causes the creation of goods and services in society to increase and the abundance of citizens to increase. This increase is due to the fact that the factors of creation will continue to experience increases in quantity and quality (Sukirno, 2015). The marker in measuring economic development is by looking at the change in Gross Domestic Product (GDP) or Gross Domestic Product (GDP) of a country compared to a previous period of time. GDP itself can be viewed in two ways, namely the total income of each person in the economy and the total expenditure on the output of economic goods and services. GDP enumeration must follow development accounting principles where every business that influences expenditure must influence income and vice versa, every business that influences income must influence expenditure (Mankiw, 2007). Consuming energy is a way of using up all or part of exergy to carry out work, resulting in a lot of energy, namely when energy is used to heat or move something. This has an impact on the inevitable "depreciation of energy" in all natural systems to create entropy, (Kummel, 2021).

Simon Kuznet in Reksohardiprodjo (2016), said that economic development is limited by an absolute shortage of natural energy resources. Simon Kuznet's statement implies that countries poor in natural energy resources will have their economic development hampered. But energy economists have recently begun to allocate energy from the source of energy because of energy in their analysis of the impact of energy on economic development. Brendt and Wood were the first to look at the dependence of energy on other inputs and on economic development over the long term in the United States. This research led to the discovery that it is possible to substitute energy inputs with non-energy input even in limited situations. More specifically, this means that: (1) the demand for energy is very responsive to the flexibility of the price of energy itself, (2) energy and activity power have a slightly substitute relationship, (3) while energy and capital are in nature complementary, (Kummel, 2021).

According to Mankiw (2007), in measuring the economic development of a country, economists use the value of Gross Domestic Product (GDP) per person which shows the measurement of the total income of individuals in the economy. The level of economic development shows the percentage increase in real national income in a particular year compared to real national income in the previous year. The information used is the result of changes in goods and services that are converted into monetary terms based on consistent prices. There is also a method used to divide economic development, namely:

$$PE = \frac{GDP_t - GDP_{t-1}}{GDP_{t-1}} \times 100\,\%$$

Information:

P.E = Economic Growth

GDP =*Gross Domestic Product*

t = Time

B. *Carbon Dioxide (CO2) Emissions*

Emissions are pollutants that pollute the air obtained by exhaust gas from transportation equipment. The gas that is defined is the residual gas from the combustion process which is discharged into the air freely through the exhaust pipe of the means of transportation. Emissions are measured in grams per means of transport per kilometer of a journey and are related to several factors such as the type of transport, age of the transport, temperature threshold and altitude. Transportation equipment with different ages and types of fuel will produce different emission contents (Fauzi, 2017).

A dangerous type of gas, carbonium dioxide (CO2) is the single most active participant due to its relatively long period of existence (requiring a very long time to disintegrate naturally) in the atmosphere and its very high level of concentration. CO2 is a colorless, odorless gas compound obtained from incomplete combustion of materials containing charcoal or organic matter, either from factory activities or areas. CO2 consists of one carbonium molecule bonded to one acid molecule, (Todaro and Smith, 2021).

CO2 gas is a solution at temperatures below - 129℃. Most CO2 gas originates from the burning of fossil fuels in the form of waste gas. Exposure to CO2 in large, dense cities and routes contains greater CO2 than in rural areas. Because big cities produce a lot of CO2 gas, the CO2 content is relatively large (Todaro and Smith, 2021).

CO2 emissions from vehicle exhaust are an important source of carbon dioxide pollution in cities. Burning using fuel using kerosene, wood, charcoal and gas can produce carbonium dioxide. In congested areas, the level of pollution is quite large, leading to death problems. Cigarette smoke also contains CO2, but in a person who doesn't smoke generally no more than 1% of carboxy hemoglobin is produced and in heavy smokers it is generally greater, namely 5-10% (Lu, 2017).

Sources of CO2 emissions can be divided into two large types, namely factory production and other sources. These two sources respectively produce 77 percent and 23 percent of all CO2 emissions on earth. The income levels and consumption levels of many countries are much greater than those in developing countries (Todaro and Smith, 2021). Research into greenhouse gas emissions that can be tolerated by nature has been widely attempted. There is no collective agreement that determines threshold limits for greenhouse gas emissions. A researcher from NASA said that if people have the ambition to preserve nature, they must reduce CO2 emissions to 350 ppm (Fauzi, 2017).

Carbonium dioxide (CO2) emissions are a gas released from the combustion of compounds containing carbonium, or the release of carbonium into the natural atmosphere. Carbonium dioxide (CO2) emissions are the largest gas that can increase due to bad greenhouse gas emissions and can cause major changes in air (Arista and Amar, 2019). Carbonium dioxide (CO2) emissions are a gas created through various combustion methods. Home Gas Emissions This mirror is a very important contributor to global warming.

The common unit used to measure carbon dioxide (CO2) emissions is the metric ton or metric ton (MT) of carbon dioxide CO2. A metric ton is a unit equivalent to 1,000 kilograms or 1 megagram (Mg). A country's carbon dioxide (CO2) emissions can be calculated in metric tons per capita. Calculation of emission levels originating from combustion in the industrial, transportation, building and other emission combustion sectors.

III. RESEARCH METHODOLOGY

This type of research is quantitative descriptive research with a qualitative approach. Descriptive research is research that provides as accurate a reflection as possible of a particular person, condition, condition or group. Quantitative methods are a type of research method that uses surveys from existing information to explain the actions or opinions of respondents. Quantitative descriptive research procedures with a qualitative approach are used to define or explain incidents or events that occur in the form of meaningful numbers, (Sudjana and Ibrahim, 2019)

The type of data used in this research is secondary data, namely data obtained from various existing documentation sources that are relevant to this research, such as books, internet sites, or government documentation, (Sudjana and Ibrahim, 2019). Usually this data is in the form of a graph, diagram or label information. The data source in this research uses 41 year time series data for the period 1980 - 2021 in Indonesia. The data source was obtained from the World Bank Development Indicators (WDI) and Our World in Data (OWID) websites, to show the Gross Domestic Product (GDP) per capita of Indonesia as a representation of economic growth in Indonesia, as well as data on carbon dioxide (CO2) emissions in Indonesia. over a 41 year time series in the period 1980 to 2021.

Information analysis is a way of collecting and arranging information into patterns, types and basic explanations so that themes can be found and places for formulating ideas about activities as suggested by the information. Information analysis is one of the methods used to identify the extent to which elastics influence other elastics, so it must be analyzed first so that it can be used as an estimate when collecting decisions. The research was carried out using Multivariate Time Series Analysis Panel Information in Vector Auto Regression (VAR) combined with Vector Error Correction Form (VECM) using the EViews 9.0 statistical application, with the following analysis areas:

1. Unit Root Test (Unit Root Test)
   To see whether the information being monitored is stagnant or not, a baseline experiment is used (Widarjono, 2013).
2. Determination of Model Order
   The benchmark for determining peak order is done using FPE, AIC, SC, or HQ statistics. A good form is a form that is able to provide a very small level of residual error (Rosadi, 2011).
3. Cointegration Testing
   Cointegration experiments were carried out using the Johansen's Cointegration Test procedure. But before trying the cointegration test, first try a deterministic bias experiment, to see the bias of the information (Widarjono, 2013).

4. *Estimation of Vector Error Correction Model*(VECM)
   Whether or not the lag of one elastic to another endogenous elastic is important or not can be evaluated using the exact number from the t-statistic (the number in brackets[...]). As an analogy, the critical number t0 = 2 or 1.96 can be used (Widarjono, 2013).
5. Granger Causality Testing (Granger Causality Test)
   The Granger causality experiment is a very well-known method. This experiment can reveal whether something elastic has a 2-way bond or only one direction. In this Granger causality experiment, it can be observed that there are past effects on the current situation, as a result the information used is time series information (Widarjono, 2013).
6. VAR Stability Testing
   The stability of the VAR system can be identified from the inverse roots number, the polynomial character of the number, which can be observed from the modulus number at the bottom of the AR-roots chart. If all the modulus numbers are below one, the system is said to be normal. If the VAR system is normal, at the bottom of the test results the words will be printed: Root number lies outside the circle and VAR satisfies the stability condition, (Gustiani, 2010).
7. Impulse Response Function (IRF) Analysis
   Estimating the Impulse Response Function (IRF) is tried to see the reaction of fluctuations or shocks from the innovation elasticity to other variables. The shock that occurs in the i-elastic not only directly affects the i-elastic number, but is also "transmitted" to all endogenous elastics that exist in the energetic form of VAR, (Basuki and Yuliadi, 2015).
8. Analysis of Lag Values in the Granger Causality Test

Granger Causality is used to check whether the lag number of one elastic can be used to calculate another elastic. In other words, this cause-and-effect experiment is carried out to see how causality and elasticity are related, (Nasution, 2015).

IV. RESULTS AND DISCUSSION

A. Unit Root Test (Unit Root Test)

The root test (root test) aims to determine whether there is stationarity in the time series information. Stagnant information is information that has consistent generality, version and covariance over time. If information that is not stagnant is used in a regression meeting, it can give rise to illegal regression (spurious regression) which causes errors in understanding the results submitted. In this research, the method used for stationarity experiments is Augment-Dickey Fuller (ADF).

The conclusions gathered in the root test (root test) or with the ADF method can be seen from the t-statistic numbers or probability numbers. When the t-statistic's absolute number is greater than the significance level, it shows that the information being tested is stagnant or has no root. If the probability is below α=1%, α=5% and α=10% then the information has no root cause the information is stagnant, conversely if the probability is greater than α=1%, α=5% and α=10% until the information has a root the result not stagnant.

TABLE AUGMENT-DICKEY FULLER (ADF) CALCULATION RESULTSAT THE FIRST DIFFERENCE LEVEL

Variable	Levels	Probability
LCO2	1st difference	0.0000
P.E	1st difference	0.0000

Based on the ADF test, it is concluded that the probability value at the alpha level is smaller than 5%, so the carbon dioxide (CO2) emissions and economic growth variables have a first difference and are suitable for use in VAR or VECM analysis. The next step in VAR analysis is to determine the optimum lag. Determination of lag in the VAR model is based on information criteria that recommend the lowest values of FPE, AIC, SC, and HQ. The E-views program provides an indication with an asterisk for the lag that is considered the optimum lag. The following are the results of the optimum lag test, (M. Julian Tama, tt).

TABLE OPTIMUM LAG TEST RESULTS

Lag	LogL	L.R	FPE	AIC	S.C	HQ
0	-72.74291	NA	0.012042	4.094211	4.224826	4.140259
1	29.49021	182.3618*	7.82e-05*	-0.945417*	-0.422957*	-0.761225*
2	35.09313	9.085817	9.50e-05	-0.761791	0.152514	-0.439456
3	39.34357	6.203347	0.000126	-0.505058	0.801092	-0.044579
4	48.31482	11.63837	0.000133	-0.503504	1.194491	0.095119
5	52.28217	4.503475	0.000191	-0.231469	1.858371	0.505298

Based on the results of this test, it shows that the lag length as seen from the LR, FPE, AIC, SC, HQ values has the lowest value, thus it can be concluded that the lowest value is in the AIC column for lag 3. Therefore, lag 3 is chosen as the optimum lag. and used in all subsequent stages of the VAR analysis.

B. Cointegration Testing

Cointegration experiments are used to examine the existence of long-time equilibration along with elasticity in the form. In cointegration testing, whether or not there is a long-time balance along with elasticity is identified by equating the estimated tracestatistic number and maximum eigenvalue with the critical number. If the trace statistic number and maximum eigenvalue are greater than the critical number at the 0.05 significance level or the probability number is smaller than the 0.05 significance level, this means that cointegration has occurred. One approach that can be used in cointegration experiments is to use the Johansen cointegration experiment. The following are the results of the cointegration test:

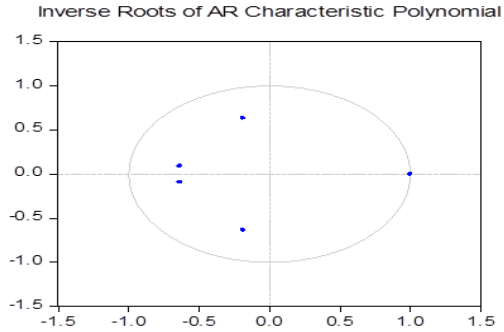
TABLE COINTEGRATION TEST CALCULATION RESULTS

Hypothesized No. of CE(s)	Eigenvalues	Trace Statistics	0.05 Critical Value	Prob.**
None *	0.423093	39.02944	29.79707	0.0033
At most 1*	0.212238	17.02644	15.49471	0.0292
At most 2*	0.170641	7.484087	3.841466	0.0062

Based on the results of the cointegration test, it can be concluded that the Trace Statistics value is greater than the critical value at the 5% significance level, indicating that there is at least one equation experiencing cointegration in the system. This indicates that there is a long-term or cointegrated relationship between the two variables, namely carbon dioxide (CO2) emissions and economic growth. Therefore, this research can apply VECM analysis.

C. VAR Stability Testing

Steadiness in the form of Vector Autoregression (VAR) is important because it can help ensure that estimates and analysis of the impact of shocks on economic variables remain unchanged and can be expected in the long term. This allows for better decision-making in economic and policy planning. Stability requires that the eigenvalues of the energetic matrix always lie within the basic circle or are less than 1, (M. Julian Tama, n.d.). Researchers have calculated the eigenvalues, and they were all found to fall within the circle we encounter in the image below:



Based on the circle image above, it can be seen that this point does not come out of the circle so that the VAR estimate is considered stable even though there is one point that is exactly on the circle line but the other three points remain inside the circle.

D. VECM Estimation Testing

Based on the results of previous tests in fulfilling the requirements for using the VECM method, this research has fulfilled the requirements so that it is suitable for using the VECM system. Therefore, this experiment was attempted to prove balancing in the short or long term along with elasticity, (M. Julian Tama, n.d.). To see whether these variables have a relationship, you need to look at the t-statistic number which shows a value greater than the t-table number, so that in this research the t-table number is 1,685, and the results obtained are estimated as follows:

TABLE. LONG TERM AND SHORT TERM VECM TEST RESULTS

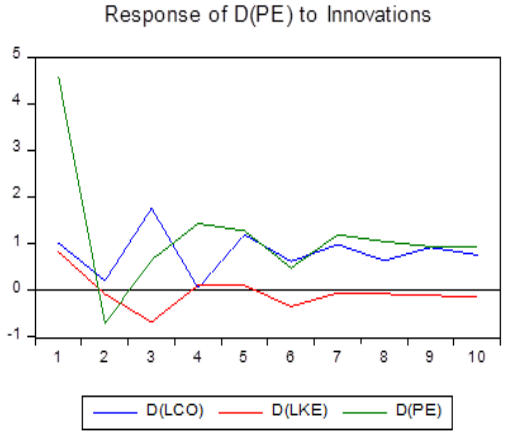
Cointegrating Eq:	CointEq1		
Long-term			
D(PE(-1))	1,000000		
D(LCO2(-1))	-26.54263		
	(7.36231)		
	[-3.60520]		
C	0.379646		
Short-term			
Error Correction	D(PE,2)	D(LKE,2)	D(LCO2,2)
CointEq1	-1.097584	0.003289	0.029272
	(0.26061)	(0.00234)	(0.00480)
	[-4.21157]	[1.40581]	[6.10190]
D (PE(-1),2)	-0.057843	0.000130	-0.014442
	(0.19550)	(0.00176)	(0.00360)
	[-0.29588]	[0.07417]	[-4.01307]
D(LCO2(-1),2)	-25.32339	0.076518	-0.198077
	(7.04301)	(0.06323)	(0.12965)
	[-3.59553]	[1.21022]	[-1.52783]
C	0.209968	-0.001091	-0.003945
	(0.76419)	(0.00686)	(0.01407)
	[0.27476]	[-0.15905]	[-0.28042]
R-squared	0.649295	0.357547	0.625826
Adj. R-squared	0.608036	0.281965	0.581806
F-statistic	15.73692	4.730544	14.21673

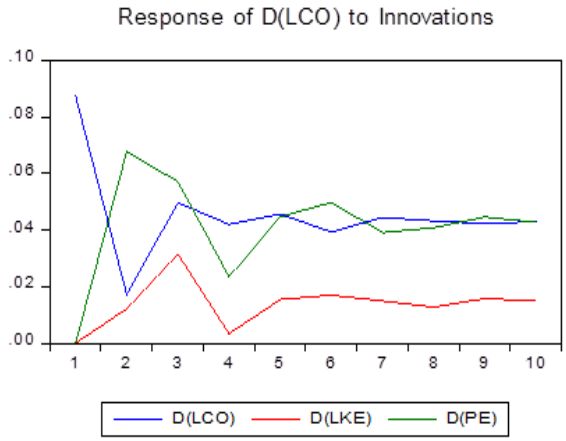
Long term relationship: The variable significance test was carried out by comparing the calculated statistical value of the VECM estimation results with the t-table value of 1.685 at a significance level of 5%, the results were obtained from the statistical table. Based on the results in the table, it shows that the carbon dioxide (CO2) emission variable at lag 1 has a long-term relationship with economic growth in Indonesia.

Short term relationship: Based on the table, it shows that energy growth in lag 2 has a short-term relationship with carbon dioxide (CO2) emissions in Indonesia. The carbon dioxide (CO2) emission variable at lag 1 has a short-term relationship with economic growth in Indonesia.

E. Impulse Response Function (IRF) Analysis

Impulse Response Function(IRF) is needed to understand what impact an elastic shock has on the elastic itself and other variables in the system. IRF describes how to estimate the impact of an elastic shock on other variables so that it can be known how long the shock or fluctuation of an elastic thing on other variables will be experienced, and which elastic will give the greatest response to the shock (M. Julian Tama , tt). The following is a display of the Impulse Response Function (IRF) graph, as below:



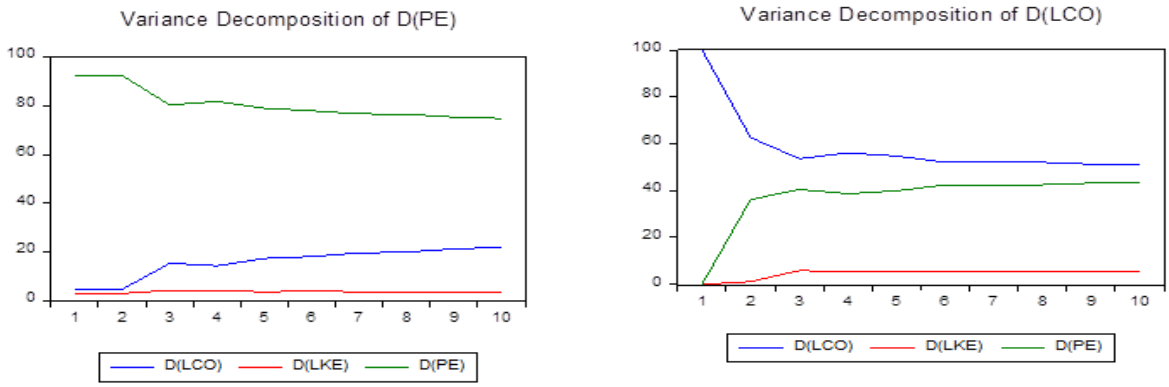


Causality Between Carbon Dioxide (CO2) Emissions and Economic Growth in Indonesia

The results of the Impulse Response Function (IRF) analysis with economic growth as a response show that in the next 42 years, the highest response will be economic growth responding to itself, and this is expected to remain stable at the 10th standard deviation level. Meanwhile, in the Impulse Response Function (IRF) analysis, the highest response was carbon dioxide (CO2) emissions. Impulse Response Function (IRF) analysis with carbon dioxide (CO2) emissions as a response shows that the highest response is economic growth in response to an increase in carbon dioxide (CO2) emissions, stable at the 7th standard deviation level.

F. Variance Decomposition Analysis

Variance Decomposition(VD) is part of the VECM analysis which aims to support the findings from the previous analysis. VD provides an estimate of the extent to which an elastic functions in creating changes in the elastic itself and other elastics in the future, measured in the form of a percentage. This allows us to determine which elastic is expected to provide the most participation to a particular elastic, (Meter. Julian Tama, n.d.). On the other hand, if we look at the diagram, the results of the Variance Decomposition (VD) experiment are as follows:



The picture above shows that the movement of the graph in Variance Decomposition (VD) will mutually influence the contribution between variables per year. The Variance Decomposition (VD) results in the image above for the next 10 years provide a different picture, but each variable contributes to each other. Economic growth is influenced by itself with a contribution of74.75% which means it shows internal stability in economic growth in the next 10 years. Economic growth also contributed as much as50.95% of carbon dioxide (CO2) emissions in Indonesia.

G. Granger Causality Test Analysis (Granger Causality Test)

Quality experiments are carried out to identify reciprocal bonds between elastics or it can also be said that elastics can be limited or free elastics. There are various methods for conducting cause-and-effect experiments. One of the methods used is the Granger causality test (Meter. Julian Tama, n.d.). To see whether the variables have an effect or cause-effect is to look at the f-statistic number which shows that the value is greater than the t-table number. In this research, the t-table number was 1.685, the following are the results of the Granger causality test:

TABLE. GRANGER CAUSALITY TEST RESULTS

Null Hypothesis	Prob.	Conclusion
LCO2 does not Granger Cause PE	0.3995	There is no relationship between carbon dioxide (CO2) emissions and economic growth
PE does not Granger Cause LCO2	0.0019	There is a relationship betweeneconomic growth with carbon dioxide (CO2) emissions

Based on the results from the table above, the results of the causality test betweenCarbon dioxide (CO2) emissions with economic growth show no significant relationship. There is no relationship between these two variables due to high dependenceon fossil energy sources, which is around two-thirds of total energy use. This is also legal in Indonesia, which can be seen from the fact that more than 70 percent of energy consumption in Indonesia uses fossil energy, namely natural oil, 35 percent and coal, 37 percent. The increase in energy use can affect carbonium dioxide (CO2) emissions in Indonesia. The number of means of transportation that continues to increase also greatly influences the increase in the use of natural oil, which in the future could disrupt the balance of the area's ecosystem which has an impact on other living creatures (Pratiwi, 2021).

Causality Between Carbon Dioxide (CO2) Emissions and Economic Growth in Indonesia

The results of the causality test between economic growth and carbon dioxide (CO2) emissions show that there is a significant relationship. There is a relationshipshows that the greater economic growthSo carbon dioxide (CO2) emissions will increase, this is because rapid economic growth has good impacts and benefits for a country in the form of increasing living standards, increasing consumption, and so on. Apart from that, there is a strong, two-way causal relationship proving that increased factory activity during large economic developments is often accompanied by an increase in factory activity. Labor-intensive production methods, such as manufacturing, mining, and processing, can cause greater carbonium emissions. Therefore, even though economic development provides positive benefits to a country, unknowingly every effort made to increase economic development results in an increase in carbonium dioxide (CO2) emissions.

The results of the Granger causality test analysis prove that there is no significant relationship between carbonium dioxide (CO2) emissions and development. There is no connection between the two elastics due to the high dependence on fossil energy sources, which is close to 2/3 of all energy consumption. This is also legal in Indonesia, which can be seen from the fact that more than 70 percent of energy consumption in Indonesia uses fossil energy, namely natural oil, 35 percent and coal, 37 percent. The increase in energy use can affect carbonium dioxide (CO2) emissions in Indonesia. The number of means of transportation that continues to increase also greatly influences the increase in the use of natural oil, which in the future could disrupt the balance of the area's ecosystem which has an impact on other living creatures (Pratiwi, 2021).

These results are also in line with the results of Akram's research showing thatCarbon dioxide (CO2) emissions have a negative influence oneconomic growth, (Akram, 2012). Meanwhile, the results of research by Shahbaz et al stated thatcarbon dioxide (CO2) emissionshave a negative influence on economic growth, (Shahbaz, et al, 2013). The absence of an effect indicates thatThe resulting carbon dioxide (CO2) emissions are greater thenA country's economic growth will experience a decline, this happens because the country is unable to reduce itcarbon dioxide (CO2) emissions correctly and actually increase carbon dioxide (CO2) emissions even more, thus having a bad impact on environmental conditions because environmental conditions are no longer able to absorb carbon dioxide (CO2) emissions properly.

The results of this research are also confirmed by the results of research conducted by Kurnia Adi Chandra who explains that ASEAN is a region that contributes the largest carbon dioxide (CO2) emissions in the world. This happens because ASEAN on average has industries that produce carbon dioxide emissions (CO2). For example, the electricity generation industry is the main source of carbon dioxide (CO2) emissions, contributing as much as 37% of global carbon dioxide (CO2) emissions. This percentage figure tends to increase and it is predicted that in the next 20 years, countries in the ASEAN region will contribute 44% of global carbon dioxide (CO2) emissions (Chandra, 2018).

For information, British Petroleum explains that Indonesia, Thailand, the Philippines and Malaysia show the same results, namely that CO2 does not have a significant positive impact on GDP, this proves that the increase in energy use which results in carbonium dioxide (CO2) emissions is proven not to be an incentive for economic activity. in these countries, the reverse reduction in CO2 emissions risks reducing economic activity. This discovery addresses the challenge for countries in the ASEAN area to balance economic development targets with the target of reducing carbon dioxide (CO2) emissions

CONCLUSIONS

Based on the research results that researchers have described in the previous paragraph, the author can conclude that there is no connection, this is also due to the high dependence on fossil energy sources, which is almost 2/3 of all energy consumption, so an increase in energy consumption can affect carbonium dioxide emissions. CO2) in Indonesia. The ever-increasing number of means of transportation also greatly influences the increase in the use of natural oil, which in the future could disrupt the balance of the area's ecosystem which has an impact on other living creatures.

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