ISSN 2776-110X

Contents list are available at Journals.indexcopernicus.com

ASIAN Economic and Business Development

Journal homepage: aebd.tripleninecommunication.com

The Effects Energy Consumption, Export, GDP, and Import on Indonesia's Emission of CO2

Oky Lestari[1]

[1] Islamic Economics study program, Department of Economics, University of Jember, Indonesia

Abstract

The purpose of this study is to examine the connection between exports, imports, GDP, and energy consumption on Indonesia's CO2 emissions used the World Bank data. This research is a type of quantitative research using VAR (Vector Autoregression) estimation. The data used comes from secondary data in a time series from 1971-2014. The data analysis technique in this study used the Vector-Autoregression (VAR) method. The tests performed include the optimum lag, Granger causality test, cointegration test, stationary test, VAR stability test, Impulse Response Function, and Variance Decontamination test. This study found that an increase in economic activity, in general, will affect an increase in CO2 gas emissions, which is caused by the large energy consumption of the economy. The increase in CO2 emissions will cause climate change, thus causing environmental damage. The Granger causality test analysis demonstrates the exports no one has any effect on CO2 emissions.So with imports, there is also no causality to CO2. The VAR analysis test also explains that export and import activities have no significant effect on increasing CO2 because both variables' values are higher than with the t-statistics' values. So, international trade has no effect on increasing CO2 and environmental degradation. According to the study's findings, CO2 emissions can rise as a result of energy usage.

Keywords: CO2, Export, GDP, Import, and Energy Consumption
JEL Classification : F13, F15, F23

Received September 30, 2022; Revised October 11, 2022; Accepted October 20, 2022
© 2021 PT.Frost Yunior rights reserved.
DOI : 10.54204/AEBD/Vol5No1October2022001

Introduction

The concept of economic growth is an economic activity that can increase the production of goods and services by communities (Sukirno, 2006). Based on Adam Smith's theory that

population growth and total GDP are two indicators of economic growth through market expansion of output (Suryana, 2000). International trade through exports and imports is a product of emerging markets. According to Hecsker-Ohlin theory, exports have an impact on economic growth when production factors are cheaper than other countries. Import activities will also affect economic growth if a country does not have production factors (Appleyard et al., 2008).

An increase in a nation's production of products and services could be used to define economic growth.. Increased output would drive market expansion through international commerce. The relationship between international trade and CO2 emulation is negative for ASEAN state, which means increasing international trade openness will reduce CO2 emissions. This is because a country's comparative excellence improves environmental quality (Widyawati, Hariyani, Ginting, & Nainggolan, 2021). This statement corresponds with Li, Alharthi, Ahmad, Hanif, & Hassan (2022) explains that by absorbing renewable energy consumption and international trade has had negative effects on the declining CO2 emissions in Southeast Asia. However, this statement differs from research done by Mahmood, Alkhateeb, & Furqan, (2020) claims that increased CO2 emissions for Central Africa are positively impacted by increased international trade. Increasing expansion of international trade will result in an increase in CO2 produces. International trade and energy use have a long-term impact on China's positive emissions of CO2 (Danish, Wanga, & Wang, 2018).

According to data collected from 1992-2013, economic growth in the nation of Azerbaijan is positively correlated with rising carbon emissions (Mikayilov, Galeotti, & Hasanov, 2018). This statement concurs with research done by Esso & Keho (2016) of period 1971-2010 data using Ganger causality tests to explain this economic growth in some African countries causes CO2 gas emissions both long-term and short-term, such as Nigeria, Benin and Sinegal. This proves that economic expansion is without environmental degradation. However, this statement is in contrast with research conducted by Widyawati, Hariyani, Ginting, & Nainggolan (2021)who stated increasing the economy has a negative contribution to emission of carbon. The amount of CO2 that will be reduced when on a country's economic growth increased. This can be seen from the formation of environmental policies of a country that have high economic growth.

The GDP relationship with CO2 emissions in Indonesia in the 1977-2014 period saw an increase in trends (Alí, Venegas-Martínez, & Palafox-Roca, 2017). Increased CO2 emissions result from higher GDP per capita (Novianto & Prabowo, 2021). In the Turkish state, GDP has a large beneficial impact on CO2 emissions by using data in the 1960-2015 period (Halicioglu 2009). In the long run, increases in GDP will affect increased CO2 and thus have a positive relationship. Economic growth by GDP will cause increased energy consumption so as to increase CO2 emissions toward the environment (Abbasi & Riaz, 2016). However, this statement does not match the research done by Pejovic, Karadzic, Dragasevic, & Backovic (2021). the GDP and CO2 relations of European Union countries with data from 2008-2018 suggest CO2 emissions may decrease as countries increase significantly. This corresponds with the research done by Yang, Wang, Zhou, & Liu, (2012) the GDP and electricity consumption relationship to carbon emissions using data 1978- 2010 states shows that inverse correlation exists between emission of carbon and GDP of real. Increasing a nation's GDP can reduces CO2 gas. But increased energy consumption is affected by increased carbon emissions.

Emissions from import activities, energy consumption and industrialization in developing countries can increase pollution. CO2 emissions can be reduced if a country increases exports and thus improves environmental degradation (Appiah, Worae, Yeboah, & Yeboah, 2022). An increase in exports can reduce CO2 that results in environmental degradation of the BRI country, where there is an upside between exports and CO2 emissions. However, this is not the case for an Foreign Direct Investment to export would get a immediately connection to CO2. According to Jijian, Twum, Agyemang, Edziah, & Ayamba (2021) more increasing export of FDI can result more CO2 gas emissions will also increase. According to Hasanov, Liddle, & Mikayilov (2018) the formation of CO2 emissions is a form of energy consumption of import exports both short and long periods, but the territory base has no significant impact. Import activities can cause rise to CO2 emissions because in import products it has a carbon gas content. So imports have a positive relationship with increased CO2. The statement makes a difference with research conducted by the Danish, Wanga, & Wang (2018) import technology has no effect on environmental degradation in the short term, but it explains that Foreign Direct Investments affect carbon increases in China.

Economic growth is closely related to tax revenues and government spending (Alim, Setiyantono, & Zakiah, 2021). However, economic growth as an economic development goal is still receiving criticism (Sawitri & Widarni, 2021). One of the determinants of economic growth is international trade which consists of exports and imports (Harnani, Prabowo, Alim, Wulandari, 2022; Sasongko, Bawono, & Prabowo, 2021). Trade is inseparable from consumer decisions (Sudaryanto, Hanim, Pansiri, & Umama, 2021). International trade and the economy cannot be separated from the exchange rate (Bawono, Zainuri, & Wilantari, 2019). Economic activity is closely related to the impact of environmental sustainability (Yanto, 2022). Through this study will be discussed how international trade, energy use and economic expansion will affect Indonesia's emission of carbon.

Literature Review

Environmental deterioration and economic expansion have a nonlinear relationship by forming an inverted U. The meaning of the inverted U curve has a concept similar to the Environment Kuznets Curve, which clarivy that disparity among pollution emissions and income per capita, curve can also be applied to economic development relationships with environmental damage (Grossman & Krueger, 1995).

There could be a nonlinear correlation between of long and short terms period. The correlation can be illustrated such as inverted U curve consistent with Kuznets curve for the environment. The graph shows the connection among CO2 and economic growth which explains the grow economic's country will increase CO2 and then decrease after being at a certain point (Sephton & Mann, 2013). However, this is different from Mikayilov, Galeotti, & Hasanov (2018) explains effect of Aljerbaijan economic growth on carbondioxide not consistent and not valid with Environment Kuznets Curve on this country.

Exports play a key role in stabilizing economic growth that is in turmoil. Because by exporting it can give foreign exchange to a country (Rahmaddi, 2011). Based on research done by (Saputra & Kesumajaya, 2013) the highest rate of exports in Indonesia occurred in 2011, which was

originally 157,779 million US$ suffered an increase of 29% to 203,497 million US$. The drive to export growth is driven by global demand as the economic recovery of the economic crisis of the previous year. Policies need continually towards export growth, because through exports can be either driven by economic growth or called Export Led Growth (Salomo, 2007).

There are fluctuations in economic growth in Indonesia, from 2004-2014 Indonesia's highest GDP fluctuations of 7.98% occurred in 2014. Whereas the lowest fluctuations of 4.54% occurred in 2009. The global economic crisis of 2008 caused low economic growth in 2009 (Syahputra, 2017). This statement corresponds with research conducted by Pridayanti (2014) explaining that economic growth in 2002-2014 was fluctuating, but in 2009 there was a dramatic decline in economic growth from 6.01% to 4.23%. Besides that, in 2009 there was also a decline in the value of imports exports and the rupiah exchange rate. Export value decreased from 137,020.4 million US$ to 116,510.0 million US$, import value decreased from 98,664.3 million US$ to 96,892.2 million US$ and the rupiah's exchange value towards US$ fell to Rp. 10,000/US$.

Economic development can improve the quality of life of a country. But there are negative extractional effects felt from the economic development process, one of which is environmental degradation caused by CO2 emissions (Harnani, Rusminingsih, & Damayanti, 2022). The current problem solution is to find out how to deal with trade off between the process of country's economic expansion and effects it has environmental sustainability. According to data obtained from the world bank, climate change and global warming may be brought on by CO2 by 58.8%. Rising concentration Greenhouse Gas (GHG) also the reason for global climate change. Based International Panel on Environmental Issues, that energy use and economic activity are factors that increase GHG and CO2 can damage the environment. World Resource Institute stated that Indonesia ranks sixth as the world's CO2 emissions contributor. CO2 contributions can cause global warming to more than 60% (Fauzi, 2017).

ASEAN has a huge contribution to the growth of CO2. It can be observed with CO2 measurements using metric ton percapita. The highest CO2 increase was 3.89% in 2011 from fluctuating in ASEAN's CO2 emissions in 2010-2014 period. The causes of this increased CO2 because energy use meets demand, thus affecting the release of emissions gas into the air. In addition, fluctuations also occur in ASEAN economic growth where GDP growth reached 7.78% in 2010 (Ariesta & Amar, 2019). Economic growth can affect environmental pollution and energy consumption. So that participation and responsibility in controlling the CO2 emissions that result in global warming are needed (Fan & Hao, 2020). The Environmental Kuznets Curve is a theory that explains how environmental pollution and economic growth are related. (Kartiasih & Setiawan, 2020). According to hypotheses on this theory, it explains that economic growth can increase environmental degradation to the highest incomes, after reaching a certain point the decline will occur in CO2 emissions (Kearsley & Riddell, 2010).

HI: International trade has an impact on CO2 that affects environmental degradation

H2: International trade has not effect on CO2 in the environment

Research Method

The study is a kind of quantitative study using the estimate of VAR (Vector Autoregression). The data used comes from a secondary data in a time series from 1971-2014. The research will investigate the relationship between export, import, consumption of energy, gross domestic product against Indonesia's carbon using world bank's data sources. Data will be treated with Eviews 9. VAR equations in this research are as follows:

$GDP_t = \beta_0 + \beta_1 EXP_t + \beta_2 IMP_2 + \beta_3 CO2_3 + \beta EC_4 + e_t$

$EXP_t = \beta_0 + \beta_1 GDP_t + \beta_2 IMP_2 + \beta_3 CO2_3 + \beta EC_4 + e_t$

$IMP_t = \beta_0 + \beta_1 EXP_t + \beta_2 GDP_2 + \beta_3 CO2_3 + \beta EC_4 + e_t$

$CO2_t = \beta_0 + \beta_1 EXP_t + \beta_2 IMP_2 + \beta_3 GDP_3 + \beta EC_4 + e_t$

$EC_t = \beta_0 + \beta_1 EXP_t + \beta_2 IMP_2 + \beta_3 CO2_3 + \beta GDP_4 + e_t$

Description:

GDP = Gross Domestic Product (%)

EXP = Exports (%)

IMP = Imports (%)

CO2 = CO2 emissions from gaseous fuel (%)

EC = Consumption of Energy (%)

e = Error term

t = Time period

Table 1. Description of Variable

Variabel	Description	Source	Unit of Analysis
GDP	Growth of per capita GDP in the form of a percentage is based on constant local currency. The idea of GDP per capita is that of dividing countries' GDP into people's mid-year population. Gross economic added value from all manufacturers is taxed by product taxes and reduced by category rather than product values will increase GDP on consumer prices. This calculation without reducing the depreciation of assets or natural resource degradation	World Bank	Percent
EXP	Local currencies always to be an indicator of the	World Bank	Percent

	annual rate of export and service growth. The US dollar was made at a constant value price in 2015. Goods and services at exports are marketed all over the world. The types of goods and services exported include transportation, royalty, insurance, construction, business, shipping, finance, government services and merchandise. Investment revenues, employee compensation, and transfer finance do not include exports.		
IMP	The constant local currency is used as an indicator in calculating the growth rate of imports of goods and services on an annual basis. The US dollar became the aggregate constant price in 2015. Merchandise and service prices from market is imported several countries around the world that receive them. Types of goods and services imported include construction, finance, transportation, insurance, communications, government services, royalties, travel, information, shipping and merchandise. There are exceptions to goods for commodities in payment imports, namely transfer payments, investment income, and employee compensation.	World Bank	Percent
CO2	The construction and manufacturing industries contain CO2 emissions that come from burning fuel. CO2 emissions are a source of category 1 A 2 IPCC (Intergovernmental Panel on Climate Change). Emissions from the automobile manufacturing industry that generate heat or electricity are also included in the IPCC category. Energy consumption is divided by end use as IEA data are not collected. so manufacturers show separate automatically. Coke and blast furnace gas emissions can be useful in several sectors such as the industrial sector, IPCC category 2 sourcing/sunk and transformation sectors in the manufacturing and construction industries	World Bank	Percent
EC	Energy consumption can be in the form of using fuel to carry out economic activities. The fuels used include coal, natural gas, and fossil fuels such as oil.	World Bank	Percent

Results and Discussion

Stationary test is the first test in VAR analysis for the Augmented Dickey Fuller method on root testing. Data can be stationary when critical value deficient from a significant or Prob < 0.05. The data is not stationary when value of probability exceeds the significant value. These are the outcomes of the research's stationary test.

Tabel 2. Unit Root Test with Augmented Dickey Fuller on CO2, EC, EXP, GDP, IMP in Indonesia

Variabel	Unit Root	Statistics for the Augmented Dickey Fuller	5% Critical Value	Description
Carbon Dioxide (CO2)	Level	-1.905560	0.3268	Not Stasioner
	First Different	-6.288841	0.0000	Stasioner
Energy Consumption (EC)	Level	-3.981409	0.0035	Stasioner
	First Different	-6.025347	0.0000	Stasioner
Export (EXP)	Level	-7.024338	0.0000	Stasioner
	First Different	-8.799483	0.0000	Stasioner
Gross Domestic Bruto (GDP)	Level	-4.782100	0.0003	Stasioner
	First Different	-7.153876	0.0000	Stasioner
Import (IMP)	Level	-5.703495	0.0000	Stasioner
	First Different	-7.891182	0.0000	Stasioner

According to results Augmented Dickey Fuller with Unit Root Test stationary, it can be concluded at Level, the CO2 variable is not stationary.. While variables EC, EXP, GDP and IMP are stationary at Level. After being tested using 1st Different all the variables are stationary. So in this study using 1st Different to test stationary. From the 1st different root test above, the probability values of CO2, EC, EXP, GDP, and IMP are below 5% or 0.05 significance. If the probability of the root test is less than 0.05 and the t statistic of the Augment Dickey Fuller more from critical values test, therefore result is stationary. For the 1st Different root test on the data above, the probability value of all variables is 0.0000 below 0.05.

Determination of the optimum lag length is needed to carry out further testing. Before doing Granger causality test and VAR analysis, the lag length must be known first. The lag length can be said to be optimum if the Akaike Information Criteria (AIC) value among the available lags is the smallest or minimum AIC value. The following are the results of the 6 lag long test on the CO2, EC, EXP, GDP, and IMP variables in time series data for 43 years

Table 3. AIC value at Lag 0 to 6 CO2, EC, EXP, GDP, dan IMP

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-546.4259	NA	6061599.	29.80680	30.02450*	29.88355
1	-512.9081	56.16496*	3880364.	29.34638	30.65253	29.80686
2	-491.3859	30.24733	5063348.	29.53437	31.92898	30.37859
3	-465.3928	29.50570	5931752.	29.48069	32.96376	30.70864
4	-429.1604	31.33617	5115285.	28.87353	33.44506	30.48521
5	-393.7495	21.05509	7426538.	28.31079	33.97077	30.30619
6	-318.1393	24.52223	3783182.*	25.57510*	32.32354	27.95424*

Considering the outcomes of the analysis of lag duration table 2 above, explained that the CO2, EC, EXP, GDP, and IMP variables have the best lag length at lag 6. This is because of all the lag tests in the table above, the smallest or minimum value from Akaike Information Criteria (AIC) is located at lag 6 with a value of 25.57510. Thus the optimum lag length used to perform the next test is lag 6.

The VAR stability test is used to determine whether the data used using the lag is stable or not. Stability test was used as a condition for further analysis. The data is said to be stable if the Root Test stability test produces a modulus value of less than 1 or modulus < 1. If the modulus value is more than 1, therefore not stationary. The stability of the Root Test results are as follows on CO2, EC, EXP, GDP, and IMP variables in this study

Table 4. AR Root Test's Stability CO2, EC, EXP, GDP, dan IMP in Indonesia

Root	Modulus
0.796698 - 0.484601i	0.932505
0.796698 + 0.484601i	0.932505
-0.511209 + 0.764803i	0.919923
-0.511209 - 0.764803i	0.919923
0.386503 - 0.834184i	0.919373
0.386503 + 0.834184i	0.919373
-0.840089 - 0.364767i	0.915863
-0.840089 + 0.364767i	0.915863
0.195561 - 0.891637i	0.912831
0.195561 + 0.891637i	0.912831
-0.255428 + 0.861511i	0.898579
-0.255428 - 0.861511i	0.898579
-0.051742 + 0.889039i	0.890543
-0.051742 - 0.889039i	0.890543
0.678713 - 0.561587i	0.880927
0.678713 + 0.561587i	0.880927
-0.624887 - 0.617691i	0.878651
-0.624887 + 0.617691i	0.878651

0.855968	0.855968
-0.834657	0.834657
-0.683438 - 0.282617i	0.739567
-0.683438 + 0.282617i	0.739567
0.392670	0.392670
0.048109 + 0.367593i	0.370728

Based on the Root Test stability test in table 3 above, it can be explained that all modulus values are less than 1 or modulus < 1, meaning that the data stability test on the CO2, EC, EXP, GDP, and IMP variables above can be said to be stable. So that it can be used for further testing.

To establish whether there is a causal connection between the variables under study, the Granger causality test is utilized.. Causality relationships can be in the form of two-way and one-way causality relationships. Because it is not known the influence between the variables studied, then with Granger causality it can be identified the variables which are endogenous and exogenous variables. If the probability value < 0.05 then there is a causal relationship between variables. The following is Granger causality test on CO2, EC, EXP, GDP, and IMP variabel variables

Table 5. Analysis of Granger Causality

Hypothesis	F - Statistic	Probability
EXP does not Granger Cause CO2	2.46155	0.0522
CO2 does not Granger Cause EXP	2.39627	0.0574
EC does not Granger Cause CO2	1.69777	0.1631
CO2 does not Granger Cause EC	3.23215	0.0172
GDP does not Granger Cause CO2	2.29311	0.0669
CO2 does not Granger Cause GDP	0.50497	0.7986
IMP does not Granger Cause CO2	0.39201	0.8771
CO2 does not Granger Cause IMP	0.78435	0.5903
EC does not Granger Cause EXP	3.75976	0.0084
EXP does not Granger Cause EC	2.62075	0.0413
GDP does not Granger Cause EXP	3.31275	0.0154
EXP does not Granger Cause GDP	0.31692	0.9220
IMP does not Granger Cause EXP	0.56105	0.7570
EXP does not Granger Cause IMP	1.63671	0.1786
GDP does not Granger Cause EC	0.75906	0.6086
EC does not Granger Cause GDP	2.00794	0.1024
IMP does not Granger Cause EC	0.24981	0.9548
EC does not Granger Cause IMP	1.77529	0.1452
IMP does not Granger Cause GDP	0.18885	0.9772
GDP does not Granger Cause IMP	4.90339	0.0019

There is a one-way causation, as shown by table 4's findings from the Granger causality analysis relationship between CO2 and EC, this is because the probability value is 0.0172 less than 0.05. EC and EXP have a two-way causality relationship because the probability value is below 0.05. The EC variable statistically affects EXP 0.0084 and the EXP variable statistically affects EC with a probability value of 0.0413. GDP has a one-way causality with EXP having a probability value of 0.0154. GDP has a one-way causal relationship with IMP with a probability value of 0.0019. Granger causality results above also explain that EXP has no causal relationship with CO2 because the probability value is more than 0.05 so it is not significant. IMP also does not have a causal relationship with CO2 because the probability value of more than 0.05 is not significant. So that international trade in export and import activities does not affect the increase in CO2 emissions on environmental sustainability.

The balancing interaction between variables is determined using the cointegration test can be valid in the long term or short term only. In this study, the cointegration test was conducted using Johansen's Cointegration Test analysis.. If all probability values > 0.05 from the Cointegration Rank Test (Trace), afterward the data are cointegrated and have a lengthy causal connection.The following is the cointegration value of the CO2, EC, EXP, GDP, and IMP variables in this study.

Table 6. Cointegration of Rank

Hypothesized At most	Trace Statistic	Value of Critical 0.05	Probability
None	100.4966	69.81889	0.0000
1	60.80924	47.85613	0.0019
2	31.74275	29.79707	0.0295
3	14.93770	15.49471	0.0605
4	4.558725	3.841466	0.0327

The cointegration test results are shown in table 6 above explain that not all probability value is below 0.05. It means there is an insignificant probability value located At most 3 with a value of 0.0605. Because the data above is not integrated, variables of CO2, EC, EXP, GDP and IMP do not have long term causality relationships.

Analysis of VAR for identify connection among the researched variables studied that have influence of one variable with other variables in the short term. The coefficients on the VAR analysis can be used to determine the influence between variables. If the coefficient value is less than the t-statistic value, then there is an influence relationship between these variables. The following is a VAR analysis on CO2, EC, EXP, GDP and IMP variables.

Table 7. Vector Autoregressive Model Analysis

	CO2	EC	EXP	GDP	IMP
CO2	0.336602	0.501685	1.359565	1.446023	-0.108269
	(0.43342)	(0.28106)	(1.71216)	(0.84855)	(1.98784)
	[0.77662]	[1.78497]	[0.79406]	[1.70411]	[-0.05447]

EC	0.190136	-0.191136	-1.188569	-0.385484	1.392477
	(0.48606)	(0.31519)	(1.92011)	(0.95161)	(2.22926)
	[0.39118]	[-0.60641]	[-0.61901]	[-0.40509]	[0.62464]
EXP	-0.036443	0.047575	-1.158882	0.087139	-1.258417
	(0.08737)	(0.05666)	(0.34513)	(0.17105)	(0.40070)
	[-0.41713]	[0.83973]	[-3.35779]	[0.50944]	[-3.14053]
GDP	-0.316130	0.100574	1.587102	0.162175	2.439999
	(0.24762)	(0.16058)	(0.97821)	(0.48480)	(1.13571)
	[-1.27665]	[0.62633]	[1.62246]	[0.33452]	[2.14844]
IMP	-0.026717	-0.046966	0.228946	-0.187221	0.008159
	(0.11273)	(0.07310)	(0.44532)	(0.22070)	(0.51702)
	[-0.23700]	[-0.64248]	[0.51412]	[-0.84831]	[0.01578]
C	-0.428590	-0.158762	1.390565	0.344403	0.086930
	(0.88496)	(0.57387)	(3.49593)	(1.73259)	(4.05881)
	[-0.48430]	[-0.27665]	[0.39777]	[0.19878]	[0.02142]
R-squared	0.839376	0.946454	0.776761	0.790600	0.943234
Adj. R-squared	0.036256	0.678721	-0.339436	-0.256397	0.659403
Sum sq. resids	33.98781	530.3922	14.29236	130.2750	714.9389
S.E. equation	2.380049	9.402058	1.543392	4.659667	10.91588
F-statistic	1.045143	3.535075	0.695899	0.755112	3.323225
Log likelihood	-50.92978	-101.7607	-34.90366	-75.78722	-107.2844
Akaike AIC	4.428637	7.176252	3.562360	5.772282	7.474832
Schwarz SC	5.778325	8.525940	4.912048	7.121970	8.824520
Mean dependent	-0.078822	-0.575518	0.709327	-0.054434	-0.542293

Considering what the VAR analysis revealed, could be said that relationship between CO2 and CO2 has impact positive significant because value's coefficient 0.336602, this is less than the t-0.7766 statistic's value. Insignificant correlation exists between CO2 and EXP, meaning that the two variables do not have a relationship and are related to each other because the coefficient value is 1.359565 more than the t-statistic value is 0.79406. Significantly positive correlation exists between EC and CO2., meaning the more energy consumption, can increase the CO2 emissions. Because the coefficient value is 0.501685 less than the t-value statistic's of 1.78497, the association between EC and CO2 is significant.. Connection among CO2 and GDP are significantly positive or directly proportional, meaning that increase in GDP produced can be increases CO2 emissions. the significance between GDP and CO2, as a result of the coefficient's value being 1.446023 less than the t-value statistic's of 1.70411. Meanwhile, relationship between IMP and CO2 does not have a significant relationship. because between IMP and CO2 the coefficient value is -0.108269 more than the t-statistic value -0.05447. From the VAR analysis it can be concluded that EC consumption and GDP can encourage a short-term rise in emission of carbon. When EC increases it causes CO2 to increase as well. The resulting increase in GDP

could increase CO2 emissions. However, utilizing the results of the previous VAR analysis that export import activities or international trade have not effect on increasing CO2 emissions.

The response impulse is used to estimate between the variables studied with the assumption that the variables have a correlation, so that it can be examined for the influence of shocks from several periods. The following is the response impulse in the form of a table on the CO2, EC, EXP, GDP and IMP variables.

Table 8. Impuls Respon

Response of D(CO2)					
Period	D(CO2)	D(EXP)	D(EC)	D(GDP)	D(IMP)
1	2.380049	0.000000	0.000000	0.000000	0.000000
2	0.753465	0.066827	0.960392	-1.321361	-0.142229
3	-0.026350	1.029064	-0.559308	0.169337	-0.095368
4	1.645354	-0.336141	-0.692611	0.479360	-0.145872
5	-0.009196	-0.865505	-0.018976	0.162827	-0.072361
6	-0.474129	0.423323	-1.369204	0.868844	-0.148690
7	-0.567359	-1.369767	0.443464	0.650050	0.196017
8	-0.651584	-0.512283	-0.303450	0.313512	-0.159446
9	-1.035173	-0.360737	1.528437	-0.680623	-0.193503
10	0.141007	0.210667	0.008247	0.057763	0.285595

In the first period until the second period, the contribution of EC to CO2 increased to 0.960392. then in the third period to the sixth period the EC contribution decreased with a negative trend to -1.369204. The increase again occurred in the seventh period to 0.443464. In the eighth period, the EC variable began to respond to CO2 and decreased with a negative trend of -0.303450. In the ninth period, EC increased to 1.528437 with a positive trend. The contribution of GDP to CO2 in the second period is -0.142229 with a negative trend. Then in the third to eighth period GDP responded with a positive trend. In the ninth period the contribution of GDP responded with a negative trend of -0.680623. In the tenth period the GDP response returned with a positive trend to 0.057763.

Analysis of Variance Decomposition is used as a measuring tool for the contribution of the exogenous variables studied to the endogenous variables. The following is the Variance Decomposition on the CO2, EC, EXP, GDP and IMP variables.

Table 9. Variance Decomposition

Variance Decomposition of D(CO2)						
Period	S.E.	D(CO2)	D(EXP)	D(EC)	D(GDP)	D(IMP)
1	2.380049	100.0000	0.000000	0.000000	0.000000	0.000000
2	2.987539	69.82716	0.050035	10.33403	19.56212	0.226646
3	3.214911	60.30620	10.28904	11.95066	17.17038	0.283717
4	3.726474	64.38023	8.471690	12.34922	14.43446	0.364400

5	3.829869	60.95156	13.12751	11.69389	13.84635	0.380687
6	4.209943	51.71129	11.87529	20.25528	15.71834	0.439796
7	4.536455	46.09949	19.34453	18.40007	15.59044	0.565469
8	4.634891	46.13850	19.75321	18.05545	15.39279	0.660049
9	5.051805	43.03619	17.13727	24.35208	14.77214	0.702317
10	5.066554	42.86345	17.21053	24.21078	14.69926	1.015976

In the first period all independent variables have no effect on CO2. Starting from the second period, there is a contribution from each variable to CO2 as shown in the table above, the contribution of the EXP variable 0.050035 will form CO2, then EC is 10.33403, GDP is 19.56212, and IMP is 0.226646. After the fifth period the trend is not much different. Then in contribution's tenth period of EXP 17.21053, EC 24.21078, GDP 14.69926 and IMP 1.015976. From the Variance Decomposition table above, the variables that affect CO2 are EC and GDP. The contribution of EC to CO2 forms a fluctuating trend, as can be seen the EC contribution climbed from the first through the fourth periods, but dropped to 11,69389 in the fifth.. In the sixth period, it increased by 20.25528, then EC continued to increase until the tenth period. The contribution of GDP also fluctuated, it can be seen that in the first to third periods it increased to 17,17038, then in the next period until the fifth period it decreased to 13,84635. After that, in the sixth period it increased to 15,71834. for the next period until the tenth period the trend of GDP continued to decline to 14,69926.

Conclusion

This study's findings lead to the following conclusion international trade have not impact to increase CO2. This can be seen from the Granger causality test which shows that exports do not have a causal relationship with CO2. Imports also do not have a causal relationship with CO2 because the probability value is not significant. According to the Granger causality test, an increase in CO2 and energy use are causally related in only one direction. In addition, there is also a VAR analysis which explains that export activities have no significant effect on CO2 in that the coefficient value exceeds the t-statistic value. The VAR analysis also shows that import activities have no effect on the formation of CO2 because the t-statistic value is smaller than the coefficient value. However, GDP and energy use have positive significant impact to CO2 levels, meaning that increasing GDP has an effect on increasing CO2. This is the same as energy consumption, the more energy consumption can increase CO2 gas emissions.

References

Abbasi, F. & Riaz, K. (2016). CO2 emissions and financial development in an emerging economy: An augmented VAR approach. Energy Policy, 90(1), 102-114. https://doi.org/10.1016/j.enpol.2015.12.017

Alí, A. B., Venegas-Martínez, F., & Palafox-Roca, A. O. (2017). Impact of energy consumption on economic growth in major OECD economies (1977-2014): A panel data approach. International Journal of Energy Economics and Policy, 7(2), 18-25.

Alim,M.B., Setiyantono,A.P., & Zakiah,S.N. (2021). Analysis of the relationship between Tax Revenue and Government Expenditures in Indonesia.Journal of International Conference Proceedings,4(3),62-68

Appiah, K., Worae, T. A., Yeboah, B., & Yeboah, M. (2022). The causal nexus between trade openness and environmental pollution in selected emerging economies. Ecological Indicators, 138. https://doi.org/10.1016/j.ecolind.2022.108872

Appleyard, D.R., Field, J.F. & Cobb, S.L. (2008). International Economics. New York: McGraw-Hill

Ariesta, T.R. & Amar, S. (2019). Analisis kausalitas emisi CO2, konsumsi energi, pertumbuhan ekonomi, dan modal manusia di ASEAN. Jurnal Kajian Ekonomi dan Pembangunan, 11(1),519-532. http://dx.doi.org/10.24036/jkep.v1i2.6262

Bawono,S., Zainuri,Z., Wilantari,R.N.(2019).Dynamics Of Real Exchange Rate And Three Financial Crisis: Purchasing Power Parity Relative Approach In Indonesia And Thailand,International Journal of Scientific & Technology Research,8(5),58-62

Danish, Wanga, B., & Wang, Z. (2018). Imported technology and CO2 emission in China: collecting evidence through bound testing and VECM approach. Renewable and Sustainable Energy Reviews, 82(3), 4204-4214. https://doi.org/10.1016/j.rser.2017.11.002

Esso, L. J., & Keho, Y. (2016). Energy consumption, economic growth and carbon emissions: cointegration and causality evidence from selected African. Energy, 114, 492-497. http://dx.doi.org/10.1016/j.energy.2016.08.010

Fan, W., & Hao, Y. (2020). An empirical research on the relationship amongst renewable energy consumption, economic growth and foreign direct investment in China. Renewable energy, 146(1), 598-609.

Fauzi, R. (2017). Pengaruh Konsumsi Energi, Luas Kawasan Hutan Dan Pertumbuhan Ekonomi Terhadap Emisi Co Di 6 (Enam) Negara Anggota ASEAN : Pendekatan Analisis Data Panel. Ecolab, 11(1).1-52. https://doi.org/10.20886/jklh.2017.11.1.14-26

Grossman, G. M. & Krueger, A. (1995). Economic growth and the environment. The Quarterly Journal of Economics, 110(2), 353-377.

Halicioglu, F. (2009). An econometric study of CO2 emissions, energy consumption, income and foreign trade in Turkey. Energy Policy, 37(3), 1156–1164. https://doi.org/10.1016/j.enpol.2008.11.012

Harnani,S., Prabowo,B.H., Alim,M.B., Wulandari,M.W. (2022). Exchange Rate, Export, and Import in the Indonesian Economy: VAR Approach. Tamansiswa Accounting Journal International,5(1),64-69

Harnani,S., Rusminingsih,D., & Damayanti,L.(2022).The Role of Human Capital in Education, Environment, and Economic.Asia Pacific Journal of Management and Education,5(2),87-99.

Hasanov, F. J., Liddle, B., & Mikayilov, J. I. (2018). The impact of international trade on CO2 emissions in oil exporting countries: territory vs consumption emissions accounting. Energy Economics, 74, 343-350. https://doi.org/10.1016/j.eneco.2018.06.004

Jijian, Z., Twum, A. K., Agyemang, A. O., Edziah, B. K., & Ayamba, E. C. (2021). Empirical study on the impact of international trade and foreign direct investment on carbon emission for belt and road countries. Energy Reports, 7, 7591-7600. https://doi.org/10.1016/j.egyr.2021.09.122

Kartiasih, F. & Setiawan, A. (2020). Aplikasi error correction mechanism dalam analisis dampak pertumbuhan ekonomi, konsumsi energi dan perdagangan internasional terhadap emisi co2 di indonesia. Media Statistika, 13(1), 104-115. https://doi.org/10.14710/medstat.13.1.104-115

Kearsley, A. & Riddel, M. (2010). A further inquiry into the pollution haven hypothesis and the environmental kuznets curve. Ecological Economics, 69(4), 905-919 https://doi.org/10.1016/j.ecolecon.2009.11.014.

Li, Y., Alharthi, M., Ahmad, I., Hanif, I., & Hassan, M. U. (2022). Nexus between renewable energy, natural resources and carbon emissions under the shadow of transboundary trade relationship from South East Asian economies. Energy Strategy Reviews, 41. https://doi.org/10.1016/j.esr.2022.100855

Mahmood, H., Alkhateeb, T. T. Y., & Furqan, M. (2020). Exports, imports, foreign direct investment and CO2 emissions in North Africa: spatial analysis. Energy Reports, 6, 2403-2409. https://doi.org/10.1016/j.egyr.2020.08.038

Mikayilov, J.I., Galeotti, M., & Hasanov, F. J. (2018). The impact of economic growth on CO2 emissions in Azerbaijan. Journal of Cleaner Production, 97, 1558-1572. https://doi.org/10.1016/j.jclepro.2018.06.269

Novianto, I., & Prabowo, B. H. (2021). Green Human Resource Management, Employment and Social Corporate Responsibility in Asia.Splash Magz,1(2),17-20

Pejovic, B., Karadzic, V., Dragasevic, Z., & Backovic, T. (2021). Economic growth, energy consumption and CO2 emissions in the countries of the European Union and the Western. Energy Reports, 7(1), 2775-2783. https://doi.org/10.1016/j.egyr.2021.05.011

Pridayanti, A. (2014). Pengaruh ekspor, impor, dan nilai tukar terhadap pertumbuhan ekonomi di Indonesia periode 2022-2012. Jurnal Pendidikan Ekonomi, 2(2). https://doi.org/10.26740/jupe.v2n2.p%25p

Rahmaddi, R. (2011). Exports and economic growth in indonesia: a causality approach based on multi-variate error correction model. Economic Journal of International Development and Cooperation, 17(2), 53-73.

Salomo, R. (2007). Peranan perdagangan internasional sebagai salah satu sumber pertumbuhan ekonomi Indonesia. Jakarta: Program Pascasarjana Ilmu Ekonomi Universitas Indonesia

Saputra, I. G. & Kesumajaya, I. W. W. (2013). Pengaruh utang luar negeri, ekspor, dan impor terhadap pertumbuhan ekonomi indonesia periode 1996-2013. E-Jurnal Ekonomi Pembangunan Universitas Udayana, 5(4).

Sasongko, B., Bawono, S., & Prabowo, B. H. (2021). The Economic Performance of China in Trade War: The Case Study of Three Global Economic Crises in 1997–2020. In Environmental, Social, and Governance Perspectives on Economic Development in Asia. Emerald Publishing Limited.

Sawitri,R., & Widarni,E.L. (2021). Critical Analysis of the Organizational Framework of the Discipline-Based Economics Education Program in Indonesia. Tamansiswa Accounting Journal International,1(1),1-2

Sephton, P. & Mann, J. (2013). Further evidence of an environmental kuznets curve in spain. Energy Economics, 36(1), 177-181. https://doi.org/10.1016/j.eneco.2013.01.001

Sudaryanto, S., Hanim, A., Pansiri, J., & Umama, T. L. (2021). Impact of culture, brand image and price on buying decisions: Evidence from East Java, Indonesia. Innovative Marketing, 17(1), 130-142.

Sukirno, S. (2006). Pengantar teori makro ekonomi. Jakarta: PT Raja Grafindo Persada.

Suryana. (2000). Ekonomi pembangunan: problematika dan pendekatan. Jakarta: Selemba Empat.

Syahputra, R. (2017). Analisis faktor - faktor yang mempengaruhi pertumbuhan ekonomi di Indonesia. Jurnal Samudra Ekonomika, 1(2), 183-191. https://doi.org/10.1234/jse.v1i2.334

Widyawati, R. F., Hariyani, E., Ginting, A. L., & Nainggolan, E. (2021). Pengaruh pertumbuhan ekonomi, populasi penduduk kota, keterbukaan perdagangan internasional terhadap emisi karbon dioksida (CO2) di negara asean. Jambura Agribusiness Journal, 3(1),37-47. https://doi.org/10.37046/jaj.v3i1.11193

Yang, G., Wang, H., Zhou, J., & Liu, X. (2012). Analyzing and predicting the economic growth, energy consumption, and CO2 emissions in shanghai. Energy and Environment Research, 2(2), 83-91. https://doi.org/10.5539/eer.v2n2p83

Yanto,D.D.G.F. (2022). Green Economy and Sustainable Development in Indonesia: ARDL Approach. Tamansiswa Accounting Journal International,4(1),9-15.