DIGITALES ARCHIV

ZBW – Leibniz-Informationszentrum Wirtschaft
ZBW – Leibniz Information Centre for Economics

Wahyudi, Heru; Palupi, Widia Anggi

Article

What is the short-term and long-term relationship between renewable energy and investment in economic growth?

Provided in Cooperation with:
International Journal of Energy Economics and Policy (IJEEP)

Reference: Wahyudi, Heru/Palupi, Widia Anggi (2023). What is the short-term and long-term relationship between renewable energy and investment in economic growth?. In: International Journal of Energy Economics and Policy 13 (3), S. 46 - 55. https://www.econjournals.com/index.php/ijeep/article/download/14081/7280/33202. doi:10.32479/ijeep.14081.

This Version is available at:
http://hdl.handle.net/11159/630221

Kontakt/Contact
ZBW – Leibniz-Informationszentrum Wirtschaft/Leibniz Information Centre for Economics
Düsternbrooker Weg 120
24105 Kiel (Germany)
E-Mail: *rights[at]zbw.eu*
https://www.zbw.eu/econis-archiv/

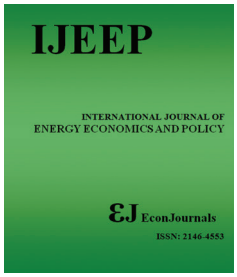
Standard-Nutzungsbedingungen:
Dieses Dokument darf zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden. Sie dürfen dieses Dokument nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, aufführen, vertreiben oder anderweitig nutzen. Sofern für das Dokument eine Open-Content-Lizenz verwendet wurde, so gelten abweichend von diesen Nutzungsbedingungen die in der Lizenz gewährten Nutzungsrechte.

https://zbw.eu/econis-archiv/termsofuse

Terms of use:
This document may be saved and copied for your personal and scholarly purposes. You are not to copy it for public or commercial purposes, to exhibit the document in public, to perform, distribute or otherwise use the document in public. If the document is made available under a Creative Commons Licence you may exercise further usage rights as specified in the licence.

ZBW Leibniz-Informationszentrum Wirtschaft
Leibniz Information Centre for Economics

Mitglied der Leibniz-Gemeinschaft



International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2023, 13(3), 46-55.

What is the Short-term and Long-term Relationship between Renewable Energy and Investment in Economic Growth?

Heru Wahyudi*, Widia Anggi Palupi

University of Lampung, Bandar Lampung, Indonesia. *Email: heru.wahyudi@feb.unila.ac.id

Received: 01 January 2023 **Accepted:** 22 March 2023 **DOI:** https://doi.org/10.32479/ijeep.14081

ABSTRACT

The topics of energy, environment, natural resources, and economics have recently remained a topic of conversation. Thus, this study aims to determine the short-term and long-term influence between sustainable energy, CO_2, oil rents, and investment on economic growth in ASEAN countries. Based on the purpose of the study, this study used the Vector Error Correction Model (VECM) method with the help of Eviews 10. All variables used in this study were cointegrated in the long term. So that renewable energy consumption helps economic growth in ASEAN countries; in other words, renewable energy consumption positively affects economic growth over time. Meanwhile, environmental damage proxied by CO_2 hinders economic growth in the long run. This study also shows that ASEAN countries do not experience the curse of natural resources. This can be seen from the value of oil rents has a significant positive effect on economic growth. Meanwhile, investment in ASEAN has not improved the economy, so collaboration from all parties is needed to realize the welfare of the people projected with increased economic growth.

Keywords: Renewable Energy Consumption, Oil Rents, CO_2, Investment, Economic Growth, Vector Error Correction Model
JEL Classifications: O4, Q2, Q4,

1. INTRODUCTION

The increase in economic growth is undoubtedly a benefit for every country. The state makes various efforts to realize economic growth for the welfare of its people. Consumption of energy and the growing economy has become a topic of study urgent in several years final (Bunnag, 2022). According to Khansa and Widiastuti (2022), the enhancement of consumption energy could push the growth economy, and more continued Žarković et al. (2022) disclose that point is key in growing the economy in many countries. However, there is problem new ones that arise related to the use of energy. This done energy originates from sources power natural, not renewable. Using animation in total many could raise enhancement emission in shape particles, sulfur dioxide (SO_2), Nitrogen oxide (NOx), and Carbon Dioxide (CO_2). This, of course, must be anticipated not to raise damage to more environment broad and severe.

The International Energy Agency (IEA) estimates that energy consumption will increase by 53% in 2030 and 70% from growth in developed countries such as ASEAN (Bunnag, 2022). Every country needed a source of power and energy to operate an economy suitable for the necessity of a house ladder or effort, especially for developing countries. Following this is the total supply data for primary energy-based ingredients fuel in Southeast Asia, 2000-2020.

Based on Figure 1, it can be seen that the provision of primary energy in Southeast Asian countries continues to experience an increase in panicles from coal, oil, natural gas, and renewables. The increase in renewable energy supply could be a breath of fresh air for countries in Southeast Asia over concerns about poor energy use on the environment. This was discovered by Bhuiyan et al. (2022), who found that renewable energy becomes the most attractive alternative for ingredients burning fossil and is very

This Journal is licensed under a Creative Commons Attribution 4.0 International License

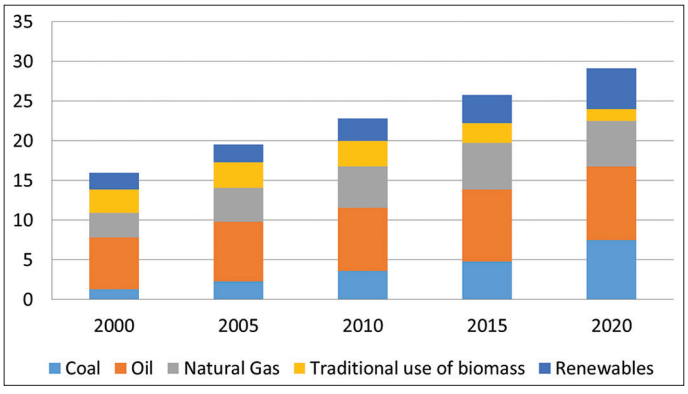
important in reducing emissions. However, the results differ from the research conducted by (Namahoro et al., 2021). Total energy consumption positively impacts the growth economy; however, renewable energy hurts the growing economy. The different results study make the background behind from existing study this how to influence renewable energy to grow the economy in ASEAN.

Using impact energy on CO_2 increases, of course, impact badly on the environment. In Figure 1, it is also known that the energy oil provision keeps increasing yearly. Oil rents should benefit exporters by improving living standards and increasing investment (Badeeb et al., 2021). Enhancement investments Bawuno et al. (2015) disclose that investment impact positively impacts a growth economy. Different fesearch conducted Fitria (2022) finds that investment hurts the growing economy. Difference results make the background behind writing this, p this aims to ensure that the policies taken by ASEAN countries are right to increase the well-being Public through enhancement of the growth economy without ignoring environmental factors. So the study aims to look at how to influence short and long-term energy renewables, CO_2, oil rents, and investments to grow the economy in ASEAN countries. Renewal from the study is the year analysis used, object research, and a selected combination of variables so that it differs from the previous survey.

2. LITERATURE REVIEW

The importance of energy for a growth economy but raises fewer externalities good for the environment makes many researchers discuss it; however, there are several different results of research. In research, this study, energy is renewable for a growth economy. Research conducted by Nurdin and Fuady (2021) finds that there is a causality in two directions between the consumption of energy renewal and the growing economy as well as energy renewable negative impact on the ever-increasing economy in a short period on term long influential positive significant. Research conducted by Ula and Affandi (2019) showed renewable energy's influence positive and considerable growth economy. The connection between consumption energy renewal and growth economics was also analyzed by (Chen et al., 2020). The connection between the positive among consumption of energy and renewable to growth economics is also found in research (Wang and Huang, 2022).

Figure 1: Total supply of prima energy-biassed ingredients fuel in Southeast Asia, 2000-2020



Source: International Energy Agency (IEA), (2023)

The growth economy and energy consumption, originating from source energy updates, are complex and have many questions related to national resilience, changing climate, and so on (Makieła et al., 2022). Research conducted by Venkatraja (2020) has a negative energy influence on renewable to growth economy in Brazil, Russia, India, and China (BRIC). The impact of negative energy renewable energy on the growth economy is caused because the use of renewable energy to accept costs is more extensive so that the funds can be used for development allocated for investment in renewable energy. Based on the literature estimated that if a country uses consumption energy relatively high renewal so the cost of repairing the environment could be lower and capable increase the growth economy. However, when a country uses consumption energy that is more recommendable quiet compared to power that is not renewable, then causing cost repair relatively environment big. Extensive, unsinkable energy negatively impacts economic growth (Bhuiyan et al., 2022).

Using energy could raise damage environmental consequences of the resulting emissions. The connection between carbon dioxide emission and the growing economy could be depicted through Environmental Kuznets inverted U-Shape Curve (EKC) (Khansa and Widiastuti, 2022). According to Nikensari et al. (2019), the EKC hypothesis shows the contribution of growth economy to more emissions tall, but the growth economy could lower the degradation environment. Condition this gets to happen consequence exists shift economy based service as well as andechnology (Galeotti, 2007).

There is a connection between the two directions between CO_2 and the growth economy, meaning that CO_2 affects the growth economy also; otherwise, the growth economy is influenced by CO_2 (Arista and Amar, 2019). Research by Acheampong (2018) finds that CO_2 positively causes growth economy. CO_2 increase can increase the growth economy because Keep will increase energy consumption followed by enhanced motorized vehicle use

Figure 2: Analysis procedure

(Zuldareva, 2017). Enhancement vehicle motorized could raise the income government through tax, so the tax could be used to fund the country's economy. Apart from that, machines tech tall causing enhancement CO_2 emissions so in a period short capable increase growth economy. A temporary study by Bakhsh et al. (2017) finds that CO_2 has hurt the growth economy. According to Mark (2006) in Zuldareva (2017) that CO_2 impacts the growth economy because of two things, namely: Sions change income and cause subtraction of price value yield production consequence change climate and resulting CO_2 emissions exist cost addition for reducing emissions.

Based on Figure 1, it is known that total energy from oil experiences enhancement every year. In research, this income from the oil sector using oil rents data. A study Matallah and Matallah (2016) finds that oil rents matter positively to the o growth economy in MENA countries. Connection positive between oil rents shows no happening curse source power nature in MENA countries. This means that oil rents can increase the country's economy. This corresponds with Adam Smith's theory, which states that acceleration relies on sources of power available in nature, sources of energy, people, and stock goods capital. Oil is one source of power that character plays a role in a country's economy. Based on Adam Smith's theory could conclude that when the available sources of energy are natural so could increase the growth economy.

However, there is something phenomenon called a curse source power nature. Where are the countries rich in resources, power natural own level of growth relatively more economically low compared to other inclined countries with no own source of power nature? Condition curse source power naturally occurs in developing countries with quality low institutional. The abundance of source power naturally is typically measured with export source power natural or natural resource rents. A study Motameni (2021) put forward that for periods d long there is a connection negative between oil rents and the growing economy in countries with weak institutions and relationships positive for countries with strong institutions. Andersen and Aslaksen (2008) His research found that natural resource rents hurt the growth economy. This negative influence shows a curse source of power in a country. If this phenomenon happens, the resulting products within that country tend to be limited, so there is no capable push growth economy.

The economic factor closely related to a growth economy is gross fixed capital formation (GFCF) or total investment. It is based on Harrod-Dommar's Theory, reaching a mature economy in a period of long-needed investment (Marselina, 2020). With so, Harrod-Domar believes that asset is essential to a growing economy. This is in line with research conducted by (Agma, 2015). Flow investment can create income and supply aggregate through the capacity-increased product (Saparuddin et al., 2015). A study Widianatasari (2021) finds that investment negatively impacts the growing economy. A study by Dinh et al. (2019) finds that investment in a short period has an adverse effect; however, in an extended period, influence is positive and significant to a growth economy.

3. RESEARCH METHODS

Data used in a study is secondary data from combined time series data and cross-section, commonly called panel data. The coherent time used in the study is 1995-2019, which includes 6 ASEAN member countries. Study this uses a population of ASEAN countries, and six countries have availability of the necessary data to study this. Variables used in the study this is economic growth (EG), carbon dioxide (CO_2), oil rents (OILR), Renewable energy consumption (REC), and Groff Fixed Capital Formation (GFCF). EG, OILR, REC, and GFCF data are sourced from World Bank, while CO_2 data is sourced from the Energy Information Administration (EIA).

Study this using the EViews 10 application. The analysis model used in the study is the Vector Error Correction Model (VECM). According to Sulistiana (2017), VECM is expected to be able to explain short-term and long-term relationships and show the magnitude of the contribution of each variable. Several processes are used in the VECM method, namely, as follows.

Based on Figure 2, the first step in doing the VECM test is a stationarity test. In testing, this must confirm that the data is stationary before conducted stages next (Faizin, 2020). Stationary tests do not cause spurious regression between variable bound and variable free (Widarjono, 2018). The stability test is seen from the score of the probabilities being compared with level significance. According to Winarno (2017), if the scoring chance is more negligible than the energy level, then the data is stationary. Otherwise, if the scoring possibility greater reaches the level of relevance, then the data is not static.

After data is confirmed stationary, step second is choosing the optimum lag. Optimum lag determination is required to ensure that the capable model's estimation interprets dynamically, efficiently, and comprehensively (Faizin, 2020). In determining the optimum lag, two chosen approaches can be used based on the value of the Akaike Information Criterion (AIC) and Minimum Schwarz Information Criterion (SIC). Take the score absolute. Suppose the selected lag is too long, causing the measurement model to be no efficient temporary setting. In that case, the lag is too short, causing the model measurements not to be capable of explaining in a manner dynamic.

After conducted selection of the subsequent optimal lag is a stability test. Stability tests need notice because VECM models exist forecasting with Impulse Response Function (IRF) and Variance Decomposition (VD). The second thing could be conducted if the model is stable. A model is said to be challenging if the score root has less modulus than one. Besides that, you can use a method graph. If dot, dot, dot modulus spread inside circle testing stability could escape.

The fourth step is the cointegration test. Two variable that is not stationary at the level but static at the first different level than a strong possibility that there is a long connection period between variable (Winarno, 2017). According to Winarno (2017), there are three methods for test cointegration, namely the Engle-Granger

Table 1: Statistical results descriptive

Variable	Means	Maximum	Minimum	std. Dev.	Skewness	kurtosis	Observations
EG	4.520791	14.51975	−13.1267	3.846562	−0.986273	6.013845	150
REC	22.65654	82.76629	0.000000	26.41360	1.010456	2.771535	150
CO2	153.4714	563.5430	1.400000	134.7326	0.632729	2.907648	150
OILR	4.161300	29.29572	0.000000	6.447807	2.033015	6.461387	150
GFCF	5.668743	86.21863	−44.0265	15.20958	0.415485	9.350117	150

Table 2: Unit root panel test

Variable	intercept		Interception and trend	
	Levels	1st different	Levels	1st different
EG				
LLC	0.0000*	0.0000*	0.0000*	0.0000*
Breitung	-	-	0.0000*	0.0000*
IPS	0.0000*	0.0000*	0.0000*	0.0000*
ADF-Fisher	0.0000*	0.0000*	0.0000*	0.0000*
PP-Fisher	0.0000*	0.0000*	0.0000*	0.0000*
REC				
LLC	0.9782	0.0116*	0.5834	0.0029*
Breitung	-	-	0.9348	0.0002*
IPS	0.9982	0.0001*	0.8837	0.0000*
ADF-Fisher	0.9867	0.0005*	0.9339	0.0002*
PP-Fisher	0.7421	0.0000*	0.5176	0.0000*
CO_2				
LLC	0.9988	0.0026*	0.9937	0.0037*
Breitung	-	-	0.9992	0.2137
IPS	1.0000	0.0003*	0.9406	0.0042*
ADF-Fisher	1.0000	0.0001*	0.4044	0.0055*
PP-Fisher	0.9999	0.0000*	0.9433	0.0000*
OILR				
LLC	0.9988	0.0026*	0.9937	0.0037*
Breitung	-	-	0.9992	0.2137
IPS	1.0000	0.0003*	0.9406	0.0042*
ADF-Fisher	1.0000	0.0001*	0.4044	0.0055*
PP-Fisher	0.9999	0.0000*	0.9433	0.0000*
GFCF				
LLC	0.9988	0.0026*	0.9937	0.0037*
Breitung	-	-	0.9992	0.2137
IPS	1.0000	0.0003*	0.9406	0.0042*
ADF-Fisher	1.0000	0.0001*	0.4044	0.0055*
PP-Fisher	0.9999	0.0000*	0.9433	0.0000*

*Significant at 5%

(EG) cointegrating test, Cointegrating Regression Durbin Watson (CRDW) test, and the Johansen test. Research this using the Johansen test. Provision from the cointegration test is when the scoring probability is smaller than the significance level. It means there is cointegration in the models, and the model used is VECM; however, when the scoring chance is more big compared to level significance, there is no cointegration in the variables used, and the model chosen is Vector Autoregression (VAR).

Next up is the ranger causality test. This test aims to see whether endogenous variables can play a role in being exogenous variables. Or it can be said whether the variables used are interconnected. The stipulation is that when the probability value is greater than the significance level, there is no causality between variables. Conversely, when the probability value is smaller than the significance level. There is causality between variables.

Testing next is VECM. The VECM model was used to look at the short and long connection period from dependent to independent. In the VECM model, there is Step forecasting using IRF and VD. To estimate one of the shock variables to other variables, use IRF. Temporary for look how long does it last happen consequence shock the until lost and happened balance return as well as could is known how much enormous contribution to all variable could use VD method.

4. RESULTS AND DISCUSSION

4.1. Results

4.1.1. Statistical analysis descriptive

Based on the Table 1, the average value of growth in 6 ASEAN countries is 4.520791%. 6 ASEAN countries with above-average growth economies are Indonesia, Malaysia, Singapore, and Cambodia. At the same time, Brunei Darussalam and Thailand have a growth economy below average during the range 1995-2019. The country with the highest growing economy in Singapore in 2010, 14.51975%, while the state with the growth economy Lowest was Indonesia in 1998, which only reached −13.1267%.

The average renewable energy consumption (REC) in 6 ASEAN countries is 22.65654. A country with renewable energy consumption above average is Indonesia and Cambodia, while Malaysia, Singapore, Brunei Darussalam, and Thailand have renewable energy consumption below average. Use highest renewable energy consumption in Cambodia reached 82.76629 in 1996 interim renewable energy consumption Lowest was Brunei Darussalam in 1998.

The average CO_2 in 6 ASEAN countries is 153.4714. Countries with above-average CO_2 are Indonesia, Malaysia, Singapore, and Thailand. At the same time, Brunei Darussalam and Cambodia's CO_2 are below average. The highest CO_2 among six other ASEAN countries was Indonesia in 2019, 563,543, while the lowest CO_2 happened in 1995 in Cambodia, i.e., 1.4.

The average oil rents in 6 ASEAN countries are 4.161300%. Malaysia and Brunei Darussalam have oil rents above the average, while Indonesia, Singapore, Thailand, and Cambodia have below-average oil rents. The most extensive use of oil rents was Brunei Darussalam in 2006, amounting to 29.29572% temporary use of the lowest oil rents was Cambodia in 2010.

The relative level of investment with variable Gross Fixed Capital Formation (GFCF) in 6 ASEAN countries during the range 1995-2019 years have a score of 5.668743%. A country with a level of investment above the average only Cambodia. While Indonesia, Malaysia, Singapura, Brunei Darussalam, and Thailand have below-average assets. Acquisition highest occurred in 1996 in Brunei Darussalam for 86.21863% temporary investment Lowest happened in 1998 in Thailand only reached −44.0265%.

4.1.2. Stationary test

Stationary test on research displays several methods such as LLC, Breitung, IPS, ADF-Fisher, and PP-Fisher. The following are fixed test results on the research model.

Based on Table 2, the whole variable is stationary at the first different level. This scene from the score shows that the probability of each variable used in the study is more negligible than $\alpha = 0.05$. This testing could be next through the cointegration test.

4.1.3. Optimum lag length determination

Testing this is conducted to determine the optimal lag position of the model. Results are shown in Table 3. The length selected slack is based on the AIC value or the minimum with absolute take score. Following are the results determination of optimum lag length.

The optimum lag in a study is 1. It means that together, variable exogenous affect endogenous variables in the equation model for one period of the growth economy.

4.1.4. VAR stability test

After determining the lag length, the next is to confirm that the estimation model is stable. Testing stability in research data served in Table 4, as follows.

Based on Table 4, the IR and VD analysis estimate is already stable on lag one because whole roots have the same modulus with more minor from one (range between 0.122789 and 0.873811). In addition, the stability test could is known with the use method graph. As presented in Figure 3, it is shown that data spread still is at in circle. This show that the stability test was fulfilled in a study. Next Cointegration test was carried out.

4.1.5. Cointegration test

The output of the cointegration test in this study is presented in Table 5. Based on the results of Table 5 that have been carried out, it can be seen that the value of the trace statistic is greater than the Critical Value, namely 236.0768 >69.81889 at □ = 5%. The trace statistic's value indicates a significant cointegration rank indicated by the centric sign (*). This explains that all research variables have a long-term balance relationship. Thus the selected model is the Vector error correction model (VECM).

4.1.6. Causality test

Furthermore, a causality test is carried out, as presented in Table 6. The causality test is used to see the reciprocal relationship of the variables used.

Based on Table 6, it can be seen that there is a 2-way relationship between investment and economic growth in 6 ASEAN countries. This study's results align with the research (Amalia, 2013). At the same time, CO_2 has no causality relationship to economic growth and vice versa. This result is in line with research conducted by (Kim et al., 2010). Oil rents have a connection n one direction with growth economic. This result aligns with the study research (Aimer, 2018). Renewable energy consumption has a one-way causality relationship with economic growth. Renewable energy consumption has a one-way causality relationship with economic growth. These results align with the research conducted by (Alfisyahri et al., 2022).

4.1.7. VECM results

Based on Table 7, it can be seen that the results of the VECM. The VECM output is divided into two: the upper part indicates the long-term relationship, and the lower part shows the short-term relationship. In the long run, renewable energy consumption positively and significantly affects economic growth in 6 ASEAN countries. This can be seen from the t-statistical value (2.63133) more significant than the t-table (1.28742) at alpha 1%. The value of the renewable energy consumption coefficient is 0.045919, meaning that if renewable energy consumption increases by one quadrillion Btu, economic growth in 6 ASEAN countries will increase by 0.045919%, cateris paribus. Meanwhile, renewable energy consumption only affects economic growth in the short term.

Meanwhile, variable CO_2 in both the long and short term does not affect economic growth in 6 ASEAN countries. Furthermore, with a t-statistical value (3.48624) more significant than the t-table (1.28742), variable oil rents positively and significantly affect economic growth in 6 ASEAN countries. The value of the oil rents coefficient is 0.244731, meaning that if oil rents increase by 1%, economic growth will increase by 0.244731%, cateris paribus.

Investment variables with a t-statistical value (−15.8800) more significant than the t-table (1.28742) have a negative and significant influence on ASEAN economic growth. The value of the investment coefficient is −0.561910, meaning that if investment increases by 1%, economic growth will decrease by 0.561910%, cateris paribus. While in the short term, economic growth is influenced by economic growth itself.

Figure 3: Stability test

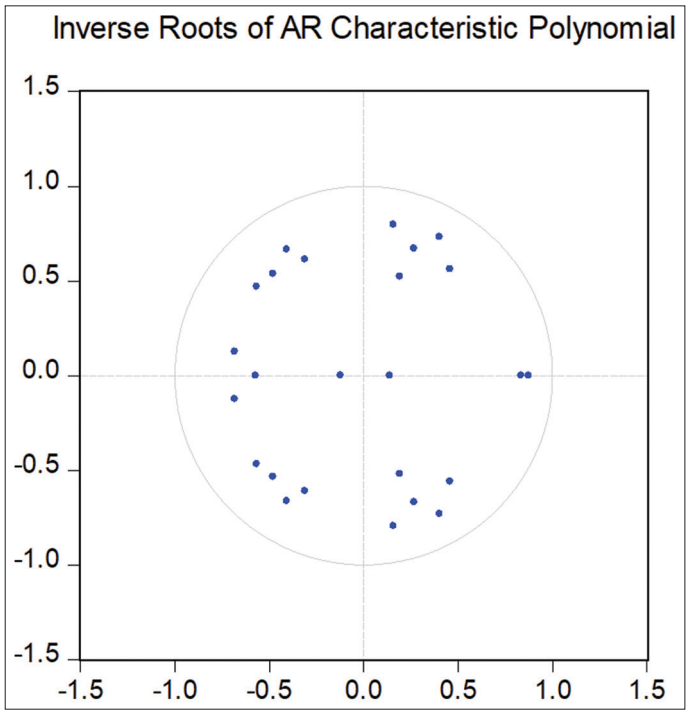


Table 3: Optimum lag length

Lag	LogL	LR	FPE	AIC	SC	HQ
1	−1316.161	NA	181368.4*	26.29728	26.94065*	26.55780*
2	−1296.247	35.92423	200941.1	26.39699	27.68374	26.91804
3	−1280.135	27.48503	241017.5	26.57127	28.50140	27.35284
4	−1265,947	22.81186	302431.9	26.78327	29.35677	27.82537
5	−1236012	45.19505	281549.1	26.68652	29.90340	27.98914
6	−1214.005	31.06995	310303.4	26.74519	30.60544	28.30834
7	−1180429	44.10924	277262.9	26.57704	31.08067	28.40071
8	−1138,987	50.38013*	216893.2	26.25465*	31.40166	28.33885

Table 4: Stability test results in roots of characteristic polynomial

Roots	Modulus
0.873811	0.873811
0.835215	0.835215
0.402674+0.731567i	0.835067
0.402674−0.731567i	0.835067
0.158601+0.795920i	0.811568
0.158601−0.795920i	0.811568
−0.406320−0.664620i	0.778984
−0.406320+0.664620i	0.778984
−0.565706+0.468726i	0.734661
−0.565706−0.468726i	0.734661
0.458672+0.560066i	0.723915
0.458672−0.560066i	0.723915
0.268432−0.670094i	0.721860
0.268432+0.670094i	0.721860
−0.478862−0.535210i	0.718163
−0.478862+0.535210i	0.718163
−0.681652+0.124373i	0.692905
−0.681652−0.124373i	0.692905
−0.309355+0.611345i	0.685159
−0.309355−0.611345i	0.685159
−0.570329	0.570329
0.191542+0.520910i	0.555010
0.191542−0.520910i	0.555010
0.137898	0.137898
−0.122789	0.122789

Table 5: Cointegrity test

Unrestricted cointegration rank test (trace)				
Hypothesized No. of CE (s)	Eigen value	Trace Statistics	0.05 Critical values	Prob.**
None*	0.549393	236.0768	69.81889	0.0000
At most 1*	0.410787	126.0687	47.85613	0.0000
At most 2*	0.190120	53.07131	29.79707	0.0000
At most 3*	0.119565	23.97130	15.49471	0.0021
At most 4*	0.045308	6.398541	3.841466	0.0114

The R-squared value of 0.150056 means that the variable renewable energy consumption, CO_2, oil rents, and gross fixed capital formation affects economic growth in 6 ASEAN countries by 15.0056%. At the same time, the rest is influenced by other variables not included in this study.

4.1.8. Impulse test response

Table 8 shows that renewable energy consumption is favorable for economic growth from 1 to 10. Variable CO_2, oil rents, and investments responded positively to economic growth in period one, while period 2 to period ten reacted negatively.

Table 6: Causality test results

Null Hypothesis	Obs	F-statistics	Prob.
CO_2 does not granger cause EG	144	0.00497	0.9439
EG does not granger cause CO_2		0.39026	0.5332
GFCF does not granger cause EG	144	4.55270	0.0346*
EG does not granger cause GFCF		15.4199	0.0001*
OILR does not granger cause EG	144	13.6627	0.0003*
EG does not granger cause OILR		0.33483	0.5638
REC does not granger cause EG	144	9.48228	0.0025*
EG does not granger cause REC		0.20672	0.6501

*Significant on the level effective 0.05

4.1.9. Variance decomposition test

In Table 9, it is known that in period 1 of the growth economy affected by growth economy previously that alone at 100% and on decrease until with per to 10. Variable renewable energy consumption, CO_2, oil rents, and investment in period one have not contributed to the growth economy. Still, in the 2nd to the 10th period, they continue to enhance their contribution to a growth economy.

5. DISCUSSION

In terms of the length of renewable energy consumption effect temporary positive and significant growth economy. In a short period no influence in 6 ASEAN countries. This result is in line with research conducted by (Wang and Huang, 2022), in which renewable energy consumption has an effect positively significant to the growth economy. When renewable energy consumption increases, many intend to reduce energy scarcity, thus pushing activity and boosting the growth economy (Bhuiyan et al., 2021).

CO_2 over a long period has a negative and significant effect on the economy's growth. In a short period, CO_2 did not influence the growing economy in 6 ASEAN countries. Research results in this are in line with a study conducted by (Bakhsh et al., 2017). The more significant CO_2 value inside a nation shows the damaged environment in the country. They are then needed costs more to repair the environment, and of course Thing this impact on reduction budget for more productive sectors. So the proverb "better prevent than cure" also applies to the sustainable environment and economy in ASEAN countries.

Table 7: Vector error correction estimates

Cointegrating Eq:	CointEq1				
EG(−1)	1.000000				
REC(−1)	0.045919				
	(0.01745)				
	(2.63133)				
CO_2(−1)	−0.003700				
	(0.00367)				
	(−1.00688)				
OILR(−1)	0.244731				
	(0.07020)				
	(3.48624)				
GFCF(−1)	−0.561910				
	(0.03538)				
	(−15.8800)				
C	−2.993975				
Error correction:	**D (EG)**	**D (REC)**	**D (CO_2)**	**D (OILR)**	**D (GFCF)**
CointEq1	0.188217	−0.019571	−0.006849	0.096575	2.404275
	(0.07689)	(0.02176)	(0.16487)	(0.03681)	(0.23043)
	(2.44785)	(−0.89932)	(−0.04154)	(2.62354)	(10.4339)
D (EG[−1])	−0.379740	0.051621	−0.228889	−0.044679	−0.176140
	(0.10719)	(0.03034)	(0.22984)	(0.05132)	(0.32123)
	(−3.54269)	(1.70157)	(−0.99586)	(−0.87065)	(−0.54833)
D (REC[−1])	0.186080	0.298455	−0.355306	−0.020617	0.997669
	(0.31084)	(0.08798)	(0.66652)	(0.14881)	(0.93154)
	(0.59863)	(3.39248)	(−0.53308)	(−0.13854)	(1.07099)
D (CO_2[−1])	0.005430	−0.005580	0.336011	0.007699	0.100332
	(0.04165)	(0.01179)	(0.08931)	(0.01994)	(0.12482)
	(0.13038)	(−0.47332)	(3.76226)	(0.38608)	(0.80380)
D (OILR[−1])	−0.179967	−0.020644	−0.054349	−0.010006	−0.634520
	(0.18098)	(0.05122)	(0.38806)	(0.08664)	(0.54237)
	(−0.99441)	(−0.40303)	(−0.14005)	(−0.11548)	(−1.16991)
D (GFCF[−1])	0.027771	−0.009002	0.002757	0.036792	0.113278
	(0.02862)	(0.00810)	(0.06138)	(0.01370)	(0.08578)
	(0.97023)	(−1.11117)	(0.04491)	(2.68493)	(1.32057)
C	−0.124200	−0.260723	3.638092	−0.096835	−1.004293
	(0.43266)	(0.12245)	(0.92772)	(0.20713)	(1.29660)
	(−0.28706)	(−2.12917)	(3.92152)	(−0.46750)	(−0.77456)
R−squared	0.150056	0.109219	0.123321	0.070616	0.621685
Adj. R-squared	0.111127	0.068420	0.083168	0.028048	0.604358
Sum sq. resids	2295.204	183.8525	10552.87	526.0539	20613.26
SE equation	4.185767	1.184675	8.975313	2.003916	12.54405
F-statistics	3.854622	2.677006	3.071273	1.658921	35.87873
Likelihood logs	−389.7948	−215.6083	−495.0596	−288.1459	−541.2576
Akaike AIC	5.750650	3.226207	7.276226	4.277476	7.945763
Schwarz SC	5.899134	3.374691	7.424710	4.425960	8.094247
Mean dependent	−0.116600	−0.422037	5.822008	−0.052511	−0.832580
SD dependent	4.439715	1.227409	9.373565	2.032625	19.94281
Determinant residual covariance (of adj.)		694811.8			
Determinant residual covariance		535584.8			
Likelihood logs		−1889.254			
Akaike information criterion		27.96021			
Schwarz criterion		28.80869			
Number of coefficients		40			

In term short there are several capable efforts to save cost however raises more emissions prominent, however when the activity involves technology, low expensive-looking carbon inside period fast, qualified push cost over a period long, p this show that cost mitigation period long possible lower than cost period short (International Monetary Fund, 2019). CO_2 is not significant to the growth economy because ASEAN countries are developing countries medium growing in the transfer process energy not renewable to point renewable. So that still separates CO_2 emissions in the process so that CO_2 has not, in a natural manner, influence a growth economy.

The length of the oil rent matters positively significant to the growth economy. Meanwhile, in a short period, oil rent did not influence the growing economy in 6 ASEAN countries. A deep oil rent study using a ratio to GDP p was conducted to examine the significance of state dependence on oil rents. The connection positive between oil rents and the growth economy identifies that

no happen phenomenon curse source power nature in ASEAN countries. Research results align with a study conducted by (Paton, 2018). Even though oil rent has contributed to the enhancement economy, ASEAN countries must be capable of increasing the economy's diversification. According to Matallah and Matallah (2016), diversification economy is a pillar of a growth economy sustainable, where governments are rich in resources and power and naturally capable of solving problems, unemployment, and increasing the quality of institutions, where the second is the foundation of the peace process.

Total deep investment study use proxies for gross fixed capital formation. Research results find that investment in period long negative and significant effect on the growth economy temporarily in periods of short investment has no influence on the growing economy in 6 ASEAN countries. Research results in this are in line with a study conducted by (Fitria, 2022).

The negative influence of investment on the growth economy caused because of not even investment in each region of the country. Puteraperdana (2012) Discloses that availability of facilities, infrastructure, and supplies of adequate energy constitute the reason height of investment in the part of the island of Java. This causes deployment results development Becomes no evenly and so on will impact on no even growth economy between provinces in Indonesia. In terms of short investment, no influential the growth economy because investment no is the only factor that plays a role significant in the enhancement of the growth economy (Astuti, 2018).

Table 8: Impulse value of economic growth variable responses

Response from EG					
period	EG	REC	CO_2	OILR	GFCF
1	4.185767	0.000000	0.000000	0.000000	0.000000
2	2.780981	0.199068	−0.140755	−0.091638	−0.771009
3	3.062786	0.161240	−0.195342	0.024640	−0.687332
4	2.990497	0.165124	−0.176728	−0.038948	−0.552921
5	3.047452	0.172920	−0.182692	−0.025823	−0.604709
6	3.016104	0.174708	−0.185507	−0.026672	−0.607875
7	3.025828	0.173783	−0.185373	−0.026038	−0.601594
8	3.024137	0.174288	−0.185148	−0.027081	−0.601592
9	3.024706	0.174404	−0.185379	−0.026642	−0.602726
10	3.024245	0.174392	−0.185381	−0.026729	−0.602383

6. CONCLUSION

Based on the results of the causality test shows that there is cointegration in the variables of economic growth, renewable energy, CO_2, oil rents, and gross fixed capital formation in ASEAN countries. In the short term, variable renewable energy, CO_2, oil rents, and gross limited capital formation do not influence economic growth. This is due to the lag of each variable and requires a much longer time to affect economic growth in ASEAN. Meanwhile, in the long run, renewable energy and oil rents positively affect economic growth. For variable CO_2, negative influence is not significant on economic growth. And gross fixed capital formation, a proxy for investment, has a negative and significant effect on economic growth.

The study results identified that ASEAN countries have become aware of environmental sustainability. This can be seen from the positive relationship between renewable energy and economic growth. The effect is still minimal, which is 0.045919, so governments, academics, private agencies, and the public should collaborate on one vision of using sustainable energy. Using sustainable energy in the long term can reduce the cost of environmental improvement to improve the communit's economy.

The process of switching from non-renewable energy to renewable energy still causes CO_2 emissions, so it has yet to have a tangible impact on economic growth. The increase in CO_2 certainly increases costs for environmental improvement, so the budget that should be for the productive sector is allocated for environmental improvement, which is relatively not cheap. The government can implement a carbon tax for large companies that cause CO_2. In addition, the government can optimize the use of renewable energy, where ASEAN countries have excellent prospects in increasing the use of renewable energy. This is because ASEAN has abundant natural resources. One of the natural resources owned is oil. Oil rent has a significant positive effect on economic growth. This should be accompanied by an increase in product divestment so that the industry is focused on more than just natural resources. Efforts to diversify products with the availability of natural resources are certainly one of the advantages of ASEAN countries in improving the economy.

The availability of natural resources is one of the investor's interests in investing in a country. However, the results show that the investment received has yet to be able to increase economic

Table 9: Variation decomposition results

Variance decomposition of EG						
Period	SE	EG	REC	CO2	OILR	GFCF
1	4.185767	100,0000	0.000000	0.000000	0.000000	0.000000
2	5.090854	97.44454	0.152905	0.076445	0.032402	2.293708
3	5.986204	96.65273	0.183136	0.161772	0.025128	2.977234
4	6.718888	96.53279	0.205771	0.197600	0.023307	3.040535
5	7.406756	96.36377	0.223830	0.223441	0.020394	3.168564
6	8.024467	96.22625	0.238098	0.243807	0.018480	3.273364
7	8.600864	96.13767	0.248080	0.258676	0.017003	3.338569
8	9.140436	96.06876	0.256013	0.270068	0.015932	3.389225
9	9.650139	96.01265	0.262346	0.279195	0.015056	3.430752
10	10.13408	95.96728	0.267501	0.286629	0.014348	3.464239

growth. This is due to the uneven investment distribution in each region of ASEAN countries, which impacts economic inequality. Thus, when capital flows have been obtained, they must be allocated effectively, efficiently, and evenly so that existing investments can increase economic growth in ASEAN. In the end, to improve the economy, cooperation from various parties ranging from the government, academia, the private sector, and the community to realize sustainable development through the use of renewable energy to reduce CO_2, innovative products to reduce dependence on natural resources to increase investor interest in investing, and in making investment funds must be carried out evenly so that they can felt by all circles and ultimately improved the welfare of the community.

REFERENCES

Acheampong, A.O. (2018), Economic growth, CO_2 emissions and energy consumption: What causes what and where? Energy Economics, 74, 677-692.

Agma, S.F. (2015), Peranan foreign direct investment terhadap pertumbuhan ekonomi Indonesia. Jurnal Ilmiah, (3), 1-14.

Aimer, N.M. (2018), Estimating the impact of oil rents on the economic growth of the OPEC countries. European Journal of Management and Marketing Studies, 3(1), 110-122.

Alfisyahri, N., Prawira, I.A., Burhanuddin, B., Harmain, I. (2022), Renewable energy consumption and economic growth: New evidence from Ghana. Energy, 248(2), 123559.

Amalia, F. (2013), Hubungan kausalitas investasi dengan pertumbuhan ekonomi Indonesia. Signifikan, 2(1), 1-16.

Andersen, J.J., Aslaksen, S. (2008), Constitutions and the resource curse. Journal of Development Economics, 87(2), 227-246.

Arista, T.R., Amar, S. (2019), Analisis kausalitas emisi Co2, konsumsi energi, pertumbuhan ekonomi, Dan modal manusia Di asean. Jurnal Kajian Ekonomi Dan Pembangunan, 1(2), 519.

Astuti, P.W. (2018), Analisis pengaruh investasi terhadap pertumbuhan ekonomi (Studi Pada 33 Provinsi di Indonesia). Jurnal Ilmiah Mahasiswa FEB, 6(2), 11.

Badeeb, R.A., Szulczyk, K.R., Lean, H.H. (2021), Asymmetries in the effect of oil rent shocks on economic growth: A sectoral analysis from the perspective of the oil curse. Resources Policy, 74, 102326.

Bakhsh, K., Rose, S., Ali, M.F., Ahmad, N., Shahbaz, M. (2017), Economic growth, CO2 emissions, renewable waste and FDI relation in Pakistan: New evidences from 3SLS. Journal of Environmental Management, 196, 627-632.

Bawuno, E.E., Kalangi, J.B., Sumual, J.I. (2015), Pengaruh investasi pemerintah dan tenaga kerja terhadap pertumbuhan ekonomi di kota manado (studi pada kota manado tahun 2003-2012). Jurnal Berkala Ilmiah Efisiensi, 15(04), 245-254.

Bhuiyan, M.A., Zhang, Q., Khare, V., Mikhaylov, A., Pinter, G., Huang, X. (2022), Renewable energy consumption and economic growth nexus-a systematic literature review. Frontiers in Environmental Science, 10, 878394.

Bhuiyan, M.R.A., Mamur, H., Begum, J. (2021), A brief review on renewable and sustainable energy resources in Bangladesh. Cleaner Engineering and Technology, 4, 100208.

Bunnag, T. (2022), Causality relationship between electric power consumption and economic growth in Malaysia and Thailand: Autoregressive distributed lag bound testing approach. International Journal of Energy Economics and Policy, 12(1), 17-22.

Chen, C., Pinar, M., Stengos, T. (2020), Renewable energy consumption and economic growth nexus: Evidence from a threshold model. Energy Policy, 139, 111295.

Dinh, T.H., Vo, D.H., Vo, A., Nguyen, T.C. (2019), Foreign direct investment and economic growth in the short run and long run: Empirical evidence from developing countries. Journal of Risk and Financial Management, 12(4), 176.

Faizin, M. (2020), Penerapan vector error correction model pada variabel makro ekonomi di Indonesia. Jurnal Ekonomi, 25(2), 287.

Fitria, E.A. (2022), Pengaruh ekspor, tabungan bruto, dan pembentukan modal bruto terhadap pertumbuhan ekonomi eka afridayani fitria kata kunci : Ekspor ; tabungan bruto ; pembentukan modal bruto ; Pertumbuhan ekonomi. Growth Jurnal Ilmiah Ekonomi Pembangunan, 1(2), 110-123.

Galeotti, M. (2007), Economic growth and the quality of the environment: Taking stock. Environment, Development and Sustainability, 9(4), 427-454.

International Energy Agency (IEA) (2023), Primary energy. International Energy Agency (IEA). https://www.eia.gov/international/data/world/total-energy/total-energy-production?pd=

International Monetary Fund. (2019), The True Cost of Reducing Greenhouse Gas Emissions. Vol 56. United States: International Monetary Fund.

Khansa, A.D.T., Widiastuti, T. (2022), Kausalitas pertumbuhan ekonomi, energi terbarukan dan degradasi lingkungan pada negara organisasi kerjasama islam. Jurnal Ekonomi Syariah Teori Dan Terapan, 9(1), 118.

Kim, S.W., Lee, K., Nam, K. (2010), The relationship between CO2 emissions and economic growth: The case of Korea with nonlinear evidence. Energy Policy, 38(10), 5938-5946.

Makieła, K., Mazur, B., Głowacki, J. (2022), The impact of renewable energy supply on economic growth and productivity. Energies, 15(13), 15134808.

Marselina, M. (2020), Sejarah Pemikiran Ekonomi Suatu Tinjauan. Indonesia: Fakultas Ekonomi dan Bisnis Universitas Lampung.

Matallah, S., Matallah, A. (2016), Oil rents and economic growth in oil-abundant MENA countries: Governance is the trump card to escape the resource trap. Topics in Middle Eastern and North African Economies, 18(2), 87-116.

Motameni, A. (2021), The impact of oil rent, currency overvaluation, and institution quality, on economic growth of oil-rich countries: A heterogeneous panel data study. International Journal of Energy Economics and Policy, 11(3), 483-493.

Namahoro, J.P., Nzabanita, J., Wu, Q. (2021), The impact of total and renewable energy consumption on economic growth in lower and middle-and upper-middle-income groups: Evidence from CS-DL and CCEMG analysis. Energy, 237(2021), 121536.

Nikensari, S.I., Destilawati, S., Nurjanah, S. (2019), Studi environmental kuznets curve di Asia: Sebelum dan setelah millennium development goals. Jurnal Ekonomi Pembangunan, 27(2), 11-25.

Nurdin, K., Fuady, M.S. (2021), Analisis hubungan kausalitas konsumsi energi (terbarukan dan tidak terbarukan) Dengan Pertumbuhan Ekonomi Indonesia. Jurnalku, 1(4), 379-389.

Paton, R. (2018), The Effects of Natural Resource Rents on FDI Inflows. United States: University of Colorado Boulder. p1-37.

Puteraperdana, B.R. (2012), Puteraperdana, Bagas rahmat pengaruh investasi terhadap pertumbuhan ekonomi dan penyerapan tenaga kerja serta kesejahteraan masyarakat di Pr. Jurnal Ekonomi Bisnis Dan Kewirausahaan, 3(1), 29-50.

Saparuddin, M., Yolanda, S., Sebayang, K.D. (2015), Effect invesment and the rate of inflation to economic growth in Indonesia. Trikonomika, 14(1), 87.

Sulistiana, I. (2017), Model vector auto regression (Var) and vector error correction model (Vecm) approach for inflation relations analysis, gross regional domestic product (Gdp), world Tin price, BI rate and rupiah exchange rate. Integrated Journal of Business and Economics, 1(2), 17-32.

Ula, T., Affandi. (2019), Dampak konsumsi energi terbarukan terhadap pertumbuhan ekonomi: Studi di Asia Tenggara. Journal of Economics Science, 5(2), 26-34.

Venkatraja, B. (2020), Does renewable energy affect economic growth? Evidence from panel data estimation of BRIC countries. International Journal of Sustainable Development and World Ecology, 27(2), 107-113.

Wang, Y., Huang, Y. (2022), Impact of foreign direct investment on the carbon dioxide emissions of East Asian countries based on a panel ARDL method. Frontiers in Environmental Science, 10, 937837.

Widarjono, A. (2018), Ekonometrika: Pengantar dan Aplikasinya Disertasi Panduan Eviews. 5th ed. Indonesia: UPP STIM YKPN.

Widianatasari, A. (2021), Pengaruh Kualitas Institusi, Government Size, Dan Foreign Direct Investment Terhadap Pertumbuhan Ekonomi. Indonesia: Diponegoro University.

Winarno, W.W. (2017), Analisis Ekonometrika dan Statistika Dengan Eviews. 5th ed. Indonesia: UPP STIM YKPN.

Žarković, M., Lakić, S., Ćetković, J., Pejović, B., Redzepagic, S., Vodenska, I., Vujadinović, R. (2022), Effects of renewable and non-renewable energy consumption, GHG, ICT on sustainable economic growth: Evidence from Old and New EU countries. Sustainability, 14(15), 9662.

Zuldareva, F. (2017), Analisis pengaruh konsumsi energi dan emisi CO_2 terhadap pertumbuhan ekonomi Di Indonesia periode 1981-2014. Jurnal Ilmiah Mahasiswa FEB Universitas Brawijaya, 5(1), 1-5.