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Article

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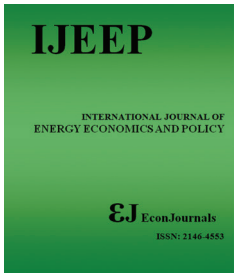

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Comparison of Energy Consumption to Economic Growth in Developing Asian and Developed Asian Countries

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ABSTRACT

This study will analyze the comparative use of Economic Stability Comparisons from the Consumption of Fossil and New and Sustainable Energy: Developed and Developing Countries in Asia, including developing countries Indonesia, Malaysia and Thailand and developed countries Japan, the United Arab Emirates and South Korea. This study uses a panel cross-section/observation form of 6 Asian countries by taking the category of 3 developing countries and 3 developed countries. The time series takes the period 2005-2021, using the ordinary least squares (OLS) method. The results of a study of 3 developing Asian countries namely Indonesia, Malaysia and Thailand GDP Per Unit Energy Use and consumption of sustainable energy have a positive and significant influence and consumption of fossil energy has no effect on growth. In the equation model of 3 developed Asian countries, namely Japan, the United Arab Emirates and South Korea, GDP per Unit Energy Use has a positive and significant influence, sustainable energy consumption has no effect on economic growth, fossil energy consumption has a positive and significant influence in region 3 developed Asian countries during 2005-2021.

Keywords: Sustainable Energy, Economic Growth, Energy Consumption
JEL Classifications: O1, O4, Q2

1. INTRODUCTION

The situation of governance and energy in Asia have produced conflicting results regarding how to manage the economy's environmental quality. In a long-term investigation of four South Asian economies, the Environmental Kuznets Curve (EKC) hypothesis was tested, but sustainable energy cannot alter CO_2 emissions (Koilo, 2019). In addition, the effectiveness of regulation both lowers CO_2 emissions and reveals the composition of the economy. This needs attention and adjustment to have a disciplined environmental effect, according to (Mahmood et al. 2022). South Asian countries should increase regulatory quality to support a clean environment. According to (Kasperowicz and Treimikien, 2016), theresa postive and significant correlation between energy consumption and economic growth for each of the 14 EU members, with an increase in energy consumption also stimulating these countries' economies. This suggests that the connection between energy use and economic growth is a crucial aspect of the development process. In this modern era, energy has become one of the important pillars in a country's economic development. Efficient and sustainable energy consumption is the key to achieving stable and sustainable economic growth Countries in Asia, both developing and developed, have significant differences in terms of energy consumption and its impact on the economy (Krkošková, 2021).

Developing countries in Asia, such as India, Indonesia and Vietnam, are facing challenges in meeting their increasing energy needs in line with their economic growth. Population growth, urbanization, and industrialization have driven the growing demand for energy in these countries. However, limited energy resources and immature infrastructure are obstacles in meeting these energy needs. As a

result, these developing countries often face energy crises, with frequent power outages and high dependence on fossil energy. On the other hand, developed countries in Asia, such as Japan, South Korea and Singapore, have achieved higher levels of energy consumption in a more efficient and sustainable way (Pattiruhu and Kriekhoff, 2022). These countries have developed advanced technology and infrastructure to increase energy efficiency and reduce dependence on limited energy resources. In addition, they have also turned to renewable energy sources, such as solar and wind power, to meet most of their energy needs. In this regard, these developed countries have taken important steps to maintain sustainable economic growth while reducing the negative impact on the environment. According to research by Raza et al. (2016), the impact of sustainable energy consumption on the economies of Pakistan, India, Bangladesh, and Si anka shows that these countries are benefiting significantly from it. Four separate sensitivity analysis supported the initial findings' robustness that the link was both positive and significant. In order to encourage economic progress in the region, it is advised that South Asian nations consider development efforts and low-cost electricity generating methods.

The difference in energy consumption between developing and developed countries in Asia also has a significant impact on their economies (Zhang et al., 2014). Developing countries that are facing an energy crisis and are dependent on fossil energy tend to experience instability in energy supply, which can hinder their economic growth. High energy costs can also cause inflation and reduce their competitiveness in global markets. On the other hand, developed countries that manage their energy consumption efficiently and use renewable energy sources have a competitive advantage in terms of production costs and innovation (Zeng et al., 2023). They can offer cheaper and greener products and services, which can increase their competitiveness and attract foreign investment. In this context, it is important for developing countries in Asia to learn from the experiences of developed countries in managing energy consumption and adopt sustainable best practices. Investing in sustainable energy infrastructure, developing energy efficiency technologies, and promoting the use of renewable energy sources can help developing countries overcome the challenges they face in meeting their energy needs while maintaining sustainable economic growth (Kang and Huang, 2023). In conclusion, the comparison of energy consumption between developing countries and developed countries in Asia illustrates the differences in the challenges and opportunities faced in achieving sustainable economic growth. In facing the energy crisis and dependence on limited energy resources, developing countries can take lessons from developed countries in managing their energy consumption efficiently and sustainably. Through investment and innovation, developing countries can reduce their dependence on fossil energy and adopt renewable energy sources to promote sustainable and environmentally friendly economic growth. Increased investment and understanding of modern technology are also expected to provide breakthroughs in developing alternative energy sources (Wahyudi et al., 2023).

This study's major goal is to investigate how sustainable energy consumption (REC) affects ASEAN nations' economic development. The unprotected outcome is that consumption of renewable and non-renewable energy, increases in the labor force and capital stock, and capital stock growth all positively relate to the economic growth of ASEAN member states. As a result of their usage of both sustainable and non-sustainable energy, ASEAN nations have experienced rapid economic growth (Fadilah et al., 2020). These findings offer policymakers guidance for creating laws governing the usage of sustainable and non-sustainable energy that will boost global economic expansion. This study compares the economic stability of developed and developing nations in Asia, including developing nations Indonesia, Malaysia, and Thailand, and developed nations Japan, the United Arab Emirates, and South Korea. Here is a statistical comparison for developing Asia-Pacific nations:

Based on figure 1, in terms of per capita energy use, Japan leads Asian countries with advanced categories with a ratio of 11.8% PPP $ per kg of oil equivalent. In Japan, sustainable energy has the potential to grow to higher levels with 5.74% of the country's total final energy consumption. With an 89.48% share, the United Arab Emirates consumes a greater amount of fossil fuels than any other country. These results suggest that, of the three developed countries, Japan has the greatest potential for producing sustainable energy, while having a very high energy consumption. Energy efficiency is a must for economic progress. However, using fossil fuels excessively harms the ecosystem. Because using energy from sustainable sources produces little or negligible greenhouse gasses, mre and more countries are seeking to increase their use of it. The usage of renewable energy sources (threshold level) does not significantly inhibit the growth of the economy in either emerging or advanced countries, despite the fact that it is not a major factor. The use of sustainable energy boosts GDP in industrialized countries, as opposed to other resource variables taken into account in the model (Bhuiyan et al., 2022). This experiment, as opposed to the traditional econometric model, can show and pinpoint the input that will lead to the bst target. The best output is GDP percpita. In accordance with the four ITE prediction methods, the policy measures speeding up the process of changing the structure in its energy by pushing for more intense usage of sustainable energy to contribute for the positive variance (Magazzino et al., 2021):

In Asian countries with advanced categories in terms of per capita energy use, Japan is superior with a percentage of 11.8% PPP $ per kg of oil equivalent, in Japanese sustainable energy has the potential to achieve higher sustainable energy with 5.74% total final energy consumption. The United Arab Emirates' fossil energy is higher than other countries at 89.48%, the results of this data conclude that among the 3 developed countries, Japan has a lot of potential for creating sustainable energy, and the country uses a lot of energy (Figure 2). Economic progress requires energy use that is efficient. However, excessive fossil fuel consumption is bad for the environment. More and more nations are attempting to boost their usage of power from sustainable sources because it emits little or little greenhouse gasses. That the usage of environmentally friendly energy (threshold level) is not very significant, while sustainable energy does not impede economic growth in either emerging or wealthy countries. In contrast to other resource variables considered in the model, sustainable energy use

accelerates GDP in industrialized nations (Bhuiyan et al., 2022). In contrast to the conventional econometric model, the current study can demonstrate and identify the input that will result in the best target. GDP per capita is the best output. The positive variation, through the four ITE prediction process, is due to the acceleration of sustainable energy, policy measures intensifying the process of structural change in its energy by promoting more intensive use of sustainable energy, (Magazzino et al., 2021). By examining the side of influence between the use of sustainable energy and fossil energy on the country's economy, the comparison of three developing countries and three developed countries in Asia provides a comparative illustration of whether there is a positive relationship that will help economic activity in each country.

2. LITERATURE REVIEW

Sukirno (1995) defined economic growth as the expansion of economic activities that lead to a rise in societal output of goods and services as well as societal wealth. The reason for this increase is that the quantity and quality of the production factors will constantly rise. (Mankiw, 2007) asserts that the indication for determining economic growth is by examining gross changes. In discussing energy, it should be noted that there are several problems that can damage the environment, one of which is plastic pollution which is a major threat to our planet and ocean (Almiya et al., 2020). As our knowledge increases, more and more people are aware of the importance of environmental sustainability. They started trying to save the environment. In fact, it has started to become their new lifestyle since switching to eating organic food (Endyanti et al., 2021). Energy, on the other hand, is the capacity to act physically. Energy consumption plays a very important role in the economic development of a country. Countries in Asia, both developing and developed, have significant differences in terms of energy consumption and its impact on the economy (Khan et al., 2019). The energy crisis, especially the low access and affordability, demand-supply mismatch, energy inequality, and high dependence on non-renewable energy sources, was a challenge before achievement of clean energy goals for sustainable development (Moeldoko, 2022).

In this literature review, we will analyze the differences and similarities between developing countries and developed countries in Asia in terms of energy consumption and the implications for economic growth. The difference in energy consumption between developing countries and developed countries in Asia has a significant impact on their economies (Joseph and Charles, 2021). Developing countries that are facing an energy crisis and are dependent on fossil energy tend to experience instability in energy supply, which can hinder economic growth. High energy costs can also cause inflation and reduce their competitiveness in global markets. On the other hand, developed countries that manage their energy consumption efficiently and use renewable energy sources have a competitive advantage in terms of production costs and innovation. Developed countries in Asia that have adopted renewable energy have the potential to create new jobs and strengthen energy-related industrial sectors. The comparison between the energy consumption of developing countries and developed countries in Asia shows that there are important lessons that can be taken by developing countries. One is the need to invest in sustainable energy infrastructure, such as reliable power grids and energy-efficient buildings. In addition, it is also important to develop policies that encourage the use of renewable energy and promote clean energy technology innovation. Developing countries can also learn from the experiences of developed countries in terms of diversifying energy sources. By reducing dependence on fossil energy and switching to renewable energy, developing countries can reduce the risk of fluctuations in global energy prices and increase their energy security. Fossil fuel is non-renewable energy so if it is used continuously it can cause scarcity (Wahyudi and Palupi, 2023).

In addition, developing countries can strengthen regional cooperation in facing common energy challenges. Collaboration on renewable energy research and development, technology exchange and shared energy policies can accelerate the transformation towards more sustainable energy consumption across Asia. Energy cannot be created, consumed, or destroyed according to the first law of thermodynamics, which also states that energy must be conserved. It is possible to change or convert energy into different forms. The energy expended in the cosmos will be wasted as heat energy. Entropy is a phrase used to describe energy that cannot be used to perform work (Anderson, 2010). Additionally, energy is made up of two parts: exergy (exergy), which is a helpful component that may be transformed to do a variety of useful tasks, and energy, which is a component that is not useful. Solar radiation energy, chemical energy contained in coal, oil, and gas, nuclear energy, potential and kinetic energy, and electrical energy are only a few examples of exergy. Therefore, "energy" is equivalent to "exergy" when referring to these energy carriers in general. Energy is created when exergy is converted to heat through friction or combustion:

Energy = exergy + anergy = constant

Therefore, energy consumption is described by (Kummel, 2011) as the act of losing all or portion of the energy needed to perform work, which results in a significant amount of energy, particularly when energy is utilized to heat or move anything. This leads to the inevitable "energy dissipation" that produces entropy in all natural systems. (Reksohardiprodjo and Pradono, 1988) cite Simon Kuznets assertion that a complete lack of natural resources is what prevents economic growth. According to Simon Kuznets assertion, nations with limited natural resources will see a slowdown in economic growth.

EKC stands for Kuznets's notion that the environment of the nation determines the per capita income. His supposition demonstrates that if the country's income is still low, attention will be focused on raising it, excluding concerns about environmental quality. Income growth is followed by an increase in pollution, and if income growth conditions continue, pollution will then begin to decline once more. This assumption is based on how much environmental quality affects social control and governmental regulations, which leads to greater prosperity for the populace

(Mason and Swanson, 2002). If this assumption is correct, the national product will be significantly increased. In summary, industrialization begins in tiny businesses and develops into huge corporations. When industrial activity increases gradually, the development stage takes control of industrialization by raising the share of its internal social goods. This is the period of middle-income level, where the intensification of using natural resources and environmental deterioration occurs. In this scenario, there will be less use for raw resources and more waste will be eliminated per unit of production.

Future predictions show that non-sustainable energy still dominates global economic activity. Energy forecasting aids in decision-making for nations. It aids in budgeting, production, consumption levels, risk management, and planning for both sustainable and unsustainable energy sources. Energy forecasting enables decision-makers to effectively manage production and consumption as well as resource allocation for future growth (Pandey et al., 2023). According to (Salman and Hosny, 2021), government support is the primary factor accelerating economic growth in the energy sector. Support from the government also significantly reduces CO_2 emissions from electricity produced from sustainable energy sources, which has a positive impact on the economy. Sustainability is still difficult to attain due to carbon dioxide's positive and important effects. There are policies in place to provide the necessary energy grid in the future. In this literature review, a comparison of the energy consumption of developing and developed countries in Asia and its impact on the economy has been analyzed. Developing countries in Asia face challenges in meeting their energy needs, while developed countries have succeeded in managing energy consumption efficiently and adopting renewable energy. Efficient and sustainable energy consumption is an important factor in sustainable economic growth. Therefore, developing countries need to learn from the experiences of developed countries and adopt policies that support the use of renewable energy, invest in sustainable energy infrastructure, and promote energy efficiency to achieve sustainable and environmentally friendly economic growth in the future.

While financial growth does not always result in an increase in environmental deterioration, the use of sustainable energy does cut CO_2 emissions. Second, it was discovered that financial trends influenced bilateral use of sustainable energy. Increased commerce activity may result in higher energy use and CO_2 emissions, which harm the environment. The importance of sustainable energy in the national energy portfolio must be taken into consideration in order to reap the ual benefits of trade agreements (Ismawati, 2017). Long-term demand for sustainable energy will be fueled by economic expansion and international trade. However, whether increasing the consumption of sustainable energy may help with environmental issues depends largely on how CO_2 emissions will change as the economy grows. As a long-term relationship, rising usage of sustainable energy is a result of global trade. This indicates that future economic growth, global trade, and technological advancements in the environmental field are anticipated to facilitate and promote the use of sustainable energy in every nation (Rakhel, 2020).

3. RESEARCH METHOD

This study uses data to solve a descriptive, quantitative problem by presenting, examining, and interpreting it. The data used is secondary data, which was collected through indirect sources including government data platform articles and literature on data gathering. In this study, cross-sectional data from six Asian countries—three of which are developing, namely Indonesia, Malaysia, and Thailand, and three of which are developed, namely Japan, the United Arab Emirates, and South Korea—are combined with time series data to create panel data. . The time series covers the years 2005 through 2021. The information is available on the official World Bank website at https://data.worldbank.org. A list of the study's variables, units, descriptions, and data sources is provided in table 1 as below:

3.1. Panel Data Econometric Modeling

The following equation is utilized within the context of a panel data regression model in order to determine the influence that the dependent variable has on the independent variable. The method of analysis was carried out utilizing time series data from 205 to 2021 and cross section data from 6 Asian countries. This was done by taking the category of 3 developing countries, namely Indonesia, Malaysia, and Thailand, and 3 developed countries, namely Japan, the United Arab Emirates, and South Korea. In order determine the effect of the dependent variable on the independent variable, a panel data regression model was used with the following question:

1. Mathematical models in 3 developing countries:

$$PE_{it} = \beta_0 + +\beta_1 PDBE\_NB_{it} + \beta_2 KET\_NB_{it} + \beta_3 KF\_NB_{it} + \varepsilon_{it}$$

2. Mathematical Models in 3 Developed Countries:

$$PE_{it} = \beta_0 + +\beta_1 PDBE\_NM_{it} + \beta_2 KET\_NM_{it} + \beta_3 KF\_NM_{it} + \varepsilon_{it}$$

Table 1: Data and data sources

Variable	Description
Economic growth (PE)	Improvement of income (GDP) from the total value of goods and services produced
GDP per unit of energy use (GDP)	GDP per kilo of oil is the PPP equivalent of GDP per unit of energy consumed. Gross domestic product is converted to constant 2017 foreign currency using the purchasing power parity rate to get PPP GDP. The purchasing power of the global dollar is equal to that of the US dollar in the US in terms of GDP
Consumption of sustainable energy (CET)	Consumption of sustainable energy is the proportion of sustainable energy in total final energy consumption
Fossil consumption (KF)	Coal, oil, petroleum, and natural gas byproducts are all examples of fossil fuels

Source: World bank energy data, 2022

Table 2: Panel data model estimation testing

Test summary	Chi-square statistic	hi-q. df	Probability	Concussion
Model 3 of developing countries in ASIA				
Fixed effects model	23.884580	2.45	0.0000	H_0 rejected
Random effect model	6.861348	2	0.0324	H_0 rejected
Model 3 of ASIA's developed countries				
Fixed effect model	14.552248	2	0.0007	H_0 rejected
Random effect model	4.51234	2	0.0255	H_0 rejected

Source: Eviews (2023). Description: Critical value at 0.05

Table 3: Multicollinearity test results

Variable	VIF	Conclusion
Model 3 of developing countries in ASIA		
GDP per unit of energy use	1.3106	Within tolerance level
Consumption of sustainable energy	1.0560	Within tolerance level
Fossil Consumption	1.7540	Within tolerance level
Model 3 of ASIA's developed countries		
GDP per unit of energy use	1.00841	Within tolerance level
Consumption of sustainable energy	1.09235	Within tolerance level
Fossil consumption	1.21032	Within tolerance level

Source: Eviews, data will be processed in 2023. VIF: Variance inflation factor

Where:

PE	=	Economic Growth (PE)
PDBE_NB and PDBE_NM	=	GDP per unit of energy use (GDP)
KET_NB and KET_NM	=	Consumption of sustainable energy (CET)
KF_NB and KF_NM	=	Fossil Consumption (KF)
i	=	Observation of 3 Developed Countries and 3 Developing Countries in Asia
t	=	Research Period 2005-2021 (Time Series)
β_0	=	Intercept constant coefficient
$\beta_1 \beta_2 \beta_3$	=	Regression coefficient or slope of each variable
et	=	Standard error in mathematical models, (Error Term)

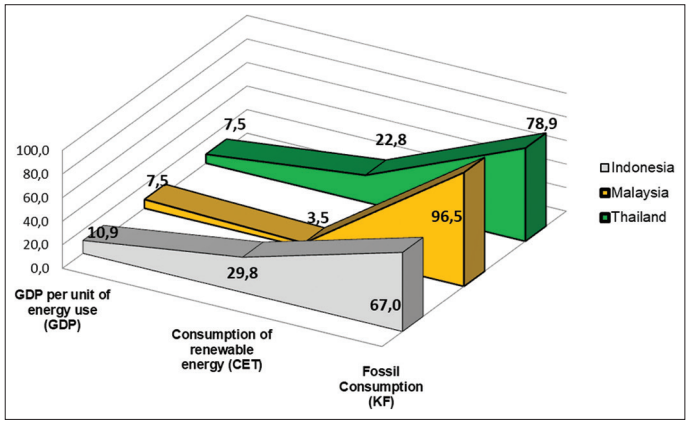
The mathematical model above is the comparative model of equation 1, showing the model of 3 developing countries and the model of equation 2, showing the model of developed countries. These two models will be tested respectively in a series of panel data.

4. RESULTS

The Chow Test and the Hausman Test were utilized in order to determine which model would be the most useful in determining which model would be the most effective in assessing whether the Pooled Least Square (PLS) model, Fixed effect, or Random Effect Model (RM), were evaluated using the panel data approach. The following is a condensed list of the most effective panel data regression models:

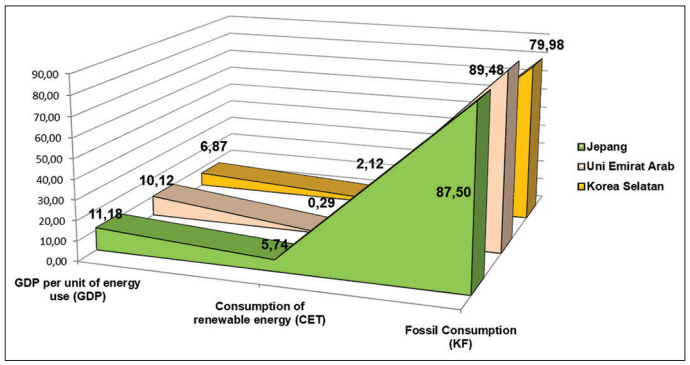
According to table 2, on the basis of the findings of the Fixed Effect/Chow Test performed on the Developing Country Model, the statistical Chi-square value of (23.884580) is found to be greater than the Chi-square table of (5.991) when df = 2.45 is used. This results in Ho rejected with a probability level of 0.0000 0.05. The conclusion drawn from the findings of the random Effect Test and the Hausman Test as that Ho should not be accepted since the statistic Chi-square value (6.861348) as more than the chi-square

Figure 1: The average yield of 2005-2021 energy data for developing countries in Asia



Source: https://databank.worldbank.org/source/sustainable-energy-for-all/preview/on, data obtained, 2023

Figure 2: The average yield of 2005-2021 energy data for developed countries of Asia



Source: https://databank.worldbank.org/source/sustainable-energy-for-all/preview/on, data obtained, 2023

table (5.991) hen df = 2 and the probability level as 0.0324 0.05.

Ho is rejected because the results of the Fixed Effect/Cow Test on the Developing Country Model showed that the statistical Chi-square value (14.552248) was greater than the Chi-square table (5.991) at df = 2.45 with a probability threshold of 0.0000 0.0007; this caused the Chi-square value to be greater than the Chi-square table. As a result of the findings of the random Effect Test and Fixed Test, which yielded a statistical Chi-square value of (4.51234) and a Chi Square table of (5.991) with a degree of freedom of (2) and a probability level of (0.0255 0.05), the hypothesis of Ho not supported.

Table 4: Heteroscedasticity test results

Independent variable	Chi-square	χ^2 table	Result	Conclusion
Model 3 of developing countries in ASIA				
3	15.0195	7.815	Menolak H_0	Free from heteroscedasticity
Model 3 of ASIA's developed countries				
3	5.3118	7.815	Menolak H_0	Free from heteroscedasticity

Source: Eviews, data will be processed in 2023

Table 5: Autocorrelation Test Results

Variables	Chi-square	χ^2 table	Result	Conclusion
Model 3 of developing countries in ASIA				
1	15.9456	3.84	H_0 rejected	Autocorrelation free
Model 3 of ASIA's developed countries				
1	9.8928	3.84	H_0 rejected	Autocorrelation free

Source: Eviews, data will be processed in 2023. Description: Critical value at 0.0

Table 6: Calculation results of ordinary least square in the fixed effect model

Variable	Coefficient	SE	t-statistic	Probability
Model 3 of developing countries in ASIA				
C	−5.214517	1.819458	−2.865972	0.0063
PDBE	0.686660	0.135336	5.073746	0.0000
KET	1.002244	0.143205	6.998669	0.0000
KF	0.053543	0.058630	0.913242	0.3660
R^2	0.604856			
F-stat	13.77650			
Model 3 of ASIA's developed countries				
C	−0.636285	0.770888	−0.825393	0.4135
PDBE	0.034376	0.012007	2.862930	0.0064
KET	0.191472	0.181453	1.055217	0.2970
KF	0.037826	0.008539	4.429596	0.0001
R^2	0.537140			
F-stat	10.44431			

Soure: Evews, data will be processed in 2023. Description: Critical value at 0.05.
SE: Standard error

3.2. Multicollinearity Testing

The following are the test results:

Table 3 defines the findings as the test for the level of multicollinearity, the Variance Inflation Factor (VIF) value of all of the independent variables has a value that is less than 10, which explains why all of the variables have a value that is within the tolerance threshold.

3.3. Heteroscedasticity Testing

Model 3 Developing ASIA using Chi-square Count, which is equal to Total n * R-square (52 * 0.294562=15.0195), In the Chi-Square table, using a significance level of 5 percent, compute (15.0195) > Chi-Square Table (7.815) in df equal to the independent variable = 3. This will result in the rejection of H0, which indicates that there is no heteroscedasticity problem with the question. Model 3 Developed Countries ASIA Chi-square count=Total n * Rsquare (52*0.102157=5.3118), in the calculated Chi-square table (5.3118) Chi-square Table (5.591) at df equal to the independent variable=2 with a significance level of 5 percent, thus rejecting H0, which indicates that there is no heteroscedasticity problem in the equation. The following (table 4) contains the results of Heteroscedasticity Test:

In spite of the fact that there were problems with heteroscedasticity identification, the conclusions of multiple linear regression panel data could be derived using the final calculation model without any of these problems. The process entails switching the GLS Weights in the options panel to the Cross-section Weights first, so that the regression equation is free from heteroscedasticity worries, and then carrying out the healing white test using the Cross-section Weights in order to get rid of the heteroscedasticity issue (Widarjono, 2013). This will eradicate the heteroscedasticity issue.

3.4. Autocorrelation Testing

The equation does not suffer from any issues with autocorrelation. Developing Country Model with Chi-Square Cunt = Total n * R-square (48*0.332295 = 15.9456), In Chi-Square table count (15.9456) > Chi Square Table (3.84), at df autocorrelation humidity 1 with level 5 percent significance, hence rejecting H0 which signifies. Using the Developed Country Model, we find that the Chi-square count = total n * R-square (48*0.206124=9.8928), and we can rule out the null hypothesis of autocorrelation at the 95% confidence level because the count in the Chi-square table for df autocorrelation humidity = 1 (3.84). The following (table 5) contains the results of Autocorrelation test:

Although there were issues with autocorrelation detection, the final calculation model was clear of these issues in the results of multiple linear regression panel data. To change the regression equation so that it is free from autocorrelation issues, the coeficient covariance method of healing transforms the panel of choices into a white cross section (Widarjono, 2013).

3.5. Panel Data Regression Estimation Results with Fixed Effect Models

The mathematical model can be constructed using either one equation from the multiple linear regression model or the formula for the ordinary least squares. The results of this regression include finding the direction of the like between the independent and dependent variables as well as the real amount of the coefficient rate in terms of quantitatively determining the degree of increase or decrease. Other outcomes include determining whether or not there is a significant relationship between the independent and dependent variables. The following is a list of what the Fixed Effect mathematical model yields as its results:

Based on information of table 6, the model is explained as follows:

Model 3 of Developing Countries in ASIA:

$$PE_{it}=\beta_0++\beta_1 PDBE\_NB_{it}+\beta_2 KET\_NB_{it}+\beta_3 KF\_NB_{it+}\varepsilon_{it}$$

$$PE_{it}=-5.214517 + 0.686660 + 1.002244 + 0.053543 + \varepsilon_{it}$$

(−2.865972) (5.073746) (6.998669) (0.913242)

1. Model 3 of ASIA's Developed Countries:

$$PE_{it}=\beta_0++\beta_1 PDBE\_NB_{it}+\beta_2 KET\_NB_{it}+\beta_3 KF\_NB_{it+}\varepsilon_{it}$$

$$PE_{it}=-0.636285+0.034376+0.191472+0.037826+\varepsilon_{it}$$

(−0.825393) (2.862930) (1.055217) (4.429596)

The three developing Asian countries of Indonesia, Malaysia, and Thailand have an R-square score of 0.604856. Accordingly, 60% of the variance in the model's ups and downs of the economy can be attributed to things that are included in it, while the other 40% can be attributed to factors that are excluded. Japan, the United Arab Emirates, and South Korea make up the three developed Asian countries included in the mathematical model, and their R-square value is 0.537140. This shows that 53% of the elements included in the model's comprehension of the fluctuations that occur in economic development are influenced by those factors, while the other 47% are influenced by variables that are not accounted for in the model.

5. DISCUSSION AND CONCLUSION

According to statistical data, GDP per unit energy usage has a positive and substantial effect in the equation model involving three developing Asian countries, namely Indonesia, Malaysia, and Thailand, improving economic growth by 0.6% for every 1% rise in energy use in these three countries. In addition to having a favorable and large impact on energy consumption, sustainable energy use boosts revenue growth by 1.02% for every 1% increase. In the equation model of three developed Asian countries, namely Japan, the United Arab Emirates, and South Korea, GDP Per Unit Energy Use has a favorable and significant effect. For every 1% rise in energy consumption in these three countries, economic growth will increase by 0.34%. The three industrialized Asian nations will see 0.37% greater economic growth from 2005 to 2021 for every 1% increase in their fossil energy use, demonstrating the positive and significant influence of this energy source.

(Constantia, 2022) states that excessive fossil fuel use, particularly for the combustion process, will raise atmospheric emission levels and is exceedingly unfavorable to the environment, resulting in CO_2 emissions. Given that the manufacturing sector is the primary consumer of fossil fuels in Indonesia and the growth of its manufacturing industry, the demand for fossil fuels is still high in many nations, including Indonesia (Bhuiyan et al., 2022). This is due to the positive long- and short-term effects of added value from manufacturing and international trade on CO_2 emissions in Indonesia. Strong economic activity harms the environment. (Muhammad Ferro Berlianto and Setya Wijaya, 2022). From 2000 to 2019, the use of sustainable energy had little to no impact on Indonesia's GDP growth due to a lack of attention given to the country's development and regulations, as well as the fact that Indonesia still meets all of its energy needs from non-sustainable sources.

In the third model, whilst the use of fossil fuels has no effect on growth, the utilization of renewable sources of energy has a significant and beneficial effect on GDP per unit of energy utilized. Thailand, Indonesia, Malaysia, and other developing Asian countries are among them. The GDP per unit of consumed energy has a positive and significant impact in the equation model of three developed Asian countries—Japan, the United Arab Emirates, and South Korea—during the period 2005–2021, whereas the use of sustainable energy has no effect on economic development and the use of fossil fuels does.

REFERENCES

Agus, W. (2013), Econometrics: Introduction and Applications. Jakarta: Econosia.

Almiya, M.S., Kee, D.M.H., Bin Haron, M.Z., Bin Nasharudin, M.I., Bin Mohd Nasruddin, M.M., Bin Mohd Johari, M.E.W. (2020), Consumption of plastic and sustainability efforts of nike towards green environment. International Journal of Applied Business and International Management, 5(1), 60-73.

Anderson, M.A., Cudero, A.L., Palma, J. (2010), Capasitive deionization (CDI) as an electrochemical means of saving energy and delivering clean water. Electrocimia Acta, 55, 3845-3856.

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, 1-21.

Constantia, M. (2022), Detertminants of CO_2 emission intensity: Manufacturing firm-level evidence in Indonesia. Jurnal Perencanaan Pembangunan: The Indonesian Journal of Development Planning, 6(3), 402-419.

Endyanti, S.A., Kusmantini, T., Wahyuningsih, T. (2021), The analysis of the influence of green supply chain management and low-cost strategies on environmental performance. International Journal of Applied Business and International Management, 6(1), 40-48.

Fadilah, S., Lestari, R., Sahdan, M.H., Khalid, A.Z.A. (2020), The impact of Renewable energy consumption on the economic growth of the Asean countries. International Journal of Energy Economics and Policy, 10(6), 602-608.

Ismawati, L. (2017), Determinan kebijakan dividen pada perusahaan telekomunikasi di Indonesia. Jurnal Inspirasi Bisnis Dan Manajemen, 1(1), 11-18.

Joseph, T.E., Charles, A.C. (2021), Renewable energy consumption, environmental sustainability, and economic growth in developing countries. Asian Bulletin of Energy Economics and Technology, 6(1), 43-49.

Kang, J., Huang, D. (2023), Examining the effect of privatization on renewable energy consumption in the digital economy under economic patriotism: A nonlinear perspective. Sustainability, 15(7), 5864.

Kasperowicz, R., Štreimikienė, D. (2016), Economic growth and energy consumption: Comparative analysis of V4 and the "old" EU countries. Journal of International Studies, 9(2), 181-194.

Khan, M.Z.U., Bin Dost, M.K., Akram, M.W., Sabri, P.S.U. (2019), Energy consumption in agriculture sector, environmental cleanliness and economic growth: An empirical evidence of south Asian countries. Review of Economics and Development Studies, 5(3), 429-435.

Koilo, V. (2019), Evidence of the environmental kuznets curve: Unleashing the opportunity of industry 4.0 in emerging economies. Journal of Risk and Financial Management, 12(3), 122.

Krkošková, R. (2021), Causality between energy consumption and

economic growth in the V4 countries. Technological and Economic Development of Economy, 27(4), 900-920.
Kummel, R. (2011), The Second Law of Economics. New York: Springer.
Mankiw, N.G. (2007), Macroeconomics. 6th ed. Jakarta: Erlangga.
Magazzino, C., Mele, M., Morelli, G. (2021), The relationship between renewable energy and economic growth in a time of COVID-19: A machine learning experiment on the Brazilian economy. Sustainability, 13(3), 1285.
Mahmood, H., Hassan, S., Tanveer, M., Ahmad, A.R. (2022), The effects of rule of law, regulatory quality, and sustainable energy on CO_2 emissions in South Asia. International Journal of Energy Economics and Policy, 12(6), 16-21.
Mason, R., Swanson, T. (2002), The costs of uncoordinated regulation. European Economic Review, 46(1), 143-167.
Moeldoko, M. (2022), The innovation of Indonesia's resource empowerment program to accelerate the national capacity in facing global challenges. Inovasi program pemberdayaan sumber daya Indonesia untuk percepatan kapasitas nasional menghadapi tantangan global. Jurnal Dinamika Manajemen, 13(85), 282-293.
Muhammad Ferro Berlianto, D., Setya Wijaya, R. (2022), Pengaruh transisi konsumsi energi fosil menuju energi baru terbarukan terhadap produk domestik bruto di Indonesia. E-Jurnal Perspektif Ekonomi Dan Pembangunan Daerah, 11(2), 105-112.
Pandey, A.K., Singh, P.K., Nawaz, M., Kushwaha, A.K. (2023), Forecasting of non-sustainable and sustainable energy production in India using optimized discrete grey model. Environmental Science and Pollution Research, 30(3), 8188-8206.
Pattiruhu, J.R., Kriekhoff, S. (2022), Energy consumption impact on economic management: Evidence from Indonesian economy. International Journal of Energy Economics and Policy, 12(3), 270-279.
Rakhel, T.M. (2020), Renewable energy consumption in emerging countries and developed countries article information. Economics Development Analysis Journal, 9(3), 233-244.
Raza, S.A., Jawaid, S.T., Siddiqui, M.H. (2016), Electricity consumption and economic growth in South Asia. South Asia Economic Journal, 17(2), 200-215.
Reksohadiprodjo, S., Pradono. (1988), Natural Resources and Energy Economics. Yogyakarta: BPFE.
Salman, D., Hosny, N.A. (2021), The nexus between Egyptian sustainable energy resources and economic growth for achieving sustainable development goals. Future Business Journal, 7(1), 1-12.
Sadono, S. (1995), Introduction to Microeconomic Theory. Yogyakarta: PT. Raja Grafindo.
Wahyudi, H., Lestasi, W.R., Septiyanti, R., Palupi, W.A. (2023), Walking as an alternative to Indonesia's oil consumption problem. International Journal of Energy Economics and Policy, 13(4), 111-119.
Wahyudi, H., Palupi, W.A. (2023), Relationship between energy consumption, foreign direct investment, and labor force participation using the VECM model: Empirical study in OECD countries. International Journal of Energy Economics and Policy, 13(2), 157-165.
Zeng, Y., Xu, X., Zhao, Y., Li, B. (2023), Impact of digital economy on the upgrading of energy consumption structure: Evidence from Mainland China. Sustainability, 15(7), 5968.
Zhang, L., Hu, Q., Zhang, F. (2014), Input-output modeling for urban energy consumption in Beijing: Dynamics and comparison. PLoS One, 9(3), e89850.