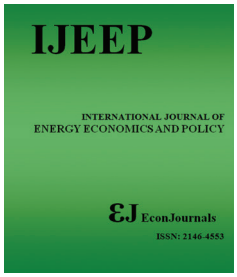

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The Effect of Energy Subsidy on the Environmental Quality in Indonesia

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ABSTRACT

Energy subsidy has boosted energy consumption and energy consumption has triggered high emissions of carbon dioxide (CO_2), which might reduce environmental quality. This problem occurs around the world, especially in the developing countries undergoing a period of industrialization, such as Indonesia. The aim of this study was to analyze the effect of energy subsidy, energy consumption, and population growth on CO_2 emissions in Indonesia. The method used was multiple linear regression analysis with ordinary least square approach using time series data within the period of 1990-2014. The results showed that energy subsidy, fossil energy consumption, and population growth have a positive and significant impact on CO_2 emissions in Indonesia. Meanwhile, the consumption of renewable energy has a negative effect on the emissions of CO_2 emissions produced.

Keywords: Carbon Dioxide Emissions, Fossil Energy Consumption, Energy Subsidy, Renewable Energy Consumption
JEL Classifications: Q42, Q43

1. INTRODUCTION

Developing countries apply a variety of systems to improve their economy to grow. The quality of the economic growth requires supports of science and technology as well as innovations of output creations. The increased output is influenced by capital and natural resources. The greater the potential of the natural resources that can be extracted and optimized their uses, the greater the movement of the countries' economy. However, the availability of abundant natural resources must be balanced with the provision of infrastructure in order for the countries' economy to move in a precise direction (Gupta et al., 2017). For example, the natural resources potencies of Persian Gulf countries prove to have a positive and significant relationship to economic growth as they have been well managed as the foundation to move the countries' economy (Asghar et al., 2014).

As one of the developing countries, Indonesia has abundant of natural resources potentials, some of which have been used as energy sources to fulfill and facilitate Indonesia to grow. The growth of Indonesia has been establishing by optimizing the use of both fossil and renewable energies. In term of using energy, the quantity of energy consumption is greatly influenced by the population growth. Realizing the interdependence among the number of population, the quantity of energy consumption, and the economic growth, the Government of Indonesia provides policies of subsidies on energy and non-energy in order to support business, investment, and consumption. The Indonesian government issued a subsidy for energy ±IDR. 350 trillion for economic development which was stated on 2014 national budget. The support of the Indonesian government on energy to its people is enormous that causes negative impacts, such as the declining of environmental quality as the amount of energy consumption is higher and higher.

The study of Awan (2013) in Pakistan concluded that the use of energy resources has two opposite effects. It is essential to reinforce economic activities of the people; however, it further aggravates the environmental conditions. Therefore, he suggests to use of the energy resources in a sensible and environmentally friendly manner to keep environmental economics sustainable. Furthermore, Sovacool (2017) argued that energy subsidy has a negative impact on environment. For example, coal subsidies in

EU and Japan release carbon dioxide (CO_2) emissions as many as 50 to 100 million tons per year; while, in Australia, cheap subsidy for coal-based electricity trigger the smelting industries release greenhouse gas emissions as higher as 2.5 times.

In term of assessing the negative implication caused by CO_2 emissions, the reduced environmental quality can be measured by the increased emission or pollutant contents such as air pollution, water pollution, and soil pollution as a result of energy explorations. The negative effects of pollution on water and soil can be directly identified, but that of air pollution needs time to be spotted. In calculating air pollution, one of the most common indicators used is to measure the levels of CO_2 emissions generated by exploration or energy use.

CO_2 is a colorless liquid, odorless, non-flammable gas, and slightly acidic. CO_2 gas is heavier than air and it dissolves in water. In their study, Rujiven et al. (2016) used CO_2 indicator to measure air quality for CO_2 produced from production processes in various industrial sectors including chemical and mining processing industries. In the cement industry for example, every kg of cement produced contributes 0.5 kg of CO_2 emissions into the air. Therefore, generally, to measure the level of air pollution, the indicator of CO_2 emission was used.

Based on the above research gap, the objective of this study is to analyze the influence of energy subsidy on CO_2 emissions in Indonesia. The novelty of this study is that Indonesia is a growing G20 member country with large populations, large energy subsidy, and inefficient use of energy.

2. LITERATURE REVIEW

Energy could be defined as an ability used to perform work or, scientifically, energy is an absolute amount of energy associated with the lowest intensity. Yusgiantoro (2000) divides natural resources into two; renewable and non-renewable resources. Renewable natural resources are resources available in infinite time such as water, forest, wind, solar heat and others. Non-renewable natural resources are resources that have limited stocks and within a certain timeframe like fossil energy. Non-renewable natural resources, especially fossil energy, are running low. Shukla et al. (2017) reported that developing countries in Southeast Asia are trying to shift to renewable natural resources by initiating efforts to switch to different types of renewable energy to reduce the dependence on fossil fuel use while managing the growing demand for energy.

In the developing countries, energy had a significant role in economic growth as their linkage could generally be found in macroeconomic components such as government revenue, export receipts, and balance of payments. Aside from government revenues and revenues from net exports, other macro components that greatly affected economic development were national energy consumption. In supporting the national energy consumption, the government provided subsidy policies on energy. Whitley (2013) defines energy subsidy as an act that keeps the price of energy sources below the market prices at the consumer level or keeps it higher than the market prices at producer level. The subsidies of energy can also mean reducing the costs used by consumer/producers to buy/produce energy sources.

Another factor triggering the increased energy consumption on a larger scale was population growth, due to the human nature of consumption. Rapid population growth increased the demand for greater natural resources. At the same time, the rising consumption caused by the population growth affected the diminishing productivity of natural resources. Population growth requires a variety of goods and services to which a process of reduction of energy resources takes place (Zeng et al., 2017). For example, the number of population of Malaysia has a significant and positive effect on the increase in energy consumption (Shaari et al., 2012). At the implementation stage, the population movement required transportation that needed energy resources such as fuel. In this case, the increasing energy consumption would reduce the stock that resulted in the productivity of the natural resources decreased.

Meanwhile, the impact of excessive use of energy was the increase of the CO_2 gas. The CO_2 gas is a chemical compound consisting of two oxygen atoms bonded covalently with a carbon atom. It is colorless, odorless, and gaseous at the state of standard temperature and pressure and exists in the Earth's atmosphere. The CO_2gas might be produced through various processes in the petrochemical industry or by burning natural gas in the cogeneration process. Yusgiantoro (2000) mentions energy externalities (ExternE) as an externality that can occur and link between greenhouse gases and energy consumption; the greater the energy consumption is, the greater the greenhouse gas will be produced.

Riyakad and Chiarakorn (2015) who examined the effect of energy consumption on greenhouse emissions found that energy consumption used in production processes proves to produce greenhouse gas emissions. The emission of greenhouse gas emitted from LPG, electricity consumption, and decomposition of calcium carbonate is 80.97, 18.62, and 0.41% respectively. Usenobong and Godwin (2012) identified that since the 1850s the global use of fossil fuels (coal, oil, and gas) has increased and dominated the world's energy consumption and supply. Meanwhile, the study of Sheinbaum-Pardo et al. (2012) in Mexico in the period 1990-2008 found that there were several important changes in the structural effects that could decrease the emissions on 10 manufacturing industry subsectors. The energy intensity and carbon index tested has a negative effect on all subsectors with the exception of cement and several other subsectors.

3. ANALYSIS METHOD

This study examined the effect of energy subsidy, fossil energy consumption, renewable energy consumption, and population growth on CO_2 emissions in Indonesia from 1990 to 2014. Secondary data used were obtained from various sources such as World Bank and Indonesian Finance Ministry. In analyzing the effect of the independent variables (energy subsidy, fossil energy consumption, renewable energy consumption, and population growth) on the dependent variable (CO_2 emission), multiple linear

regression analysis (ordinary least square [OLS]) with time series data was used. The research model is as follows:

$CO_2 = f(Subs, Pop, Fosil, R)$

$InCO_{2t}=a_0+a_1Subs_t+a_2Pop_t+a_3Fosil_t+a_4R_t+\mu_t$

Where,
CO_2 = CO_2 emissions generated from energy consumption in Indonesia
Subs = Subsidy on energy in Indonesian
Pop = Population growth
Fossil = Fossil energy consumption
R = Share of renewable energy consumption to total energy consumption
α_0 = Intercept
α = Value of variable coefficients
t = 1,2,3, ..., 25 (time series data from 1990-2014
ln = Natural log (Ln)
μ = Error term.

4. DISCUSSION

4.1. Description of Research Object

Indonesia a country with more than 13,466 islands, the largest in the world, lays in a strategic geographical location. In 2016, the population of Indonesia was 263,846,946 people; the fourth in the world. These conditions make Indonesia has both advantages and challenges in the future. At the same time, Indonesia also has abundant of natural resources that support the need for both infrastructure development and economic growth. In the last 30 years, the average rate of economic growth of Indonesia was 5%. This high rate of economic growth was in line with the development of industrialization which grew annually by 3.2% on average from 1998 to 2015. Similarly, the consumption of primary energy has also been developed. U.S. Energy Information Administration noted that there was a substantial increase in Indonesia's primary energy consumption between 1995-2014 by 3.29-7.38 Btu; in 2014 it increased by 4.8%.

The greater the use of the energy consumption, the greater the emissions or pollution generated will be, one of which is CO_2. The emissions of the CO_2 gas generated from energy optimization process continued to increase as the rate of industrialization in Indonesia increased. In 1990-2014, the increase of CO_2 emissions generated from energy optimization was 4.5% per year or equivalent to 0.045 million metric tons.

Realizing the importance of energy in pushing the country's economy forward, the government of Indonesia provided a policy of subsidy on energy. Indonesian State Budget data showed that the average growth of energy subsidy by the Indonesian government every year in the last 20 years was IDR 2,815,544,579. The amount of energy subsidy provided by the government reflected the quantity use of energy.

4.2. Variable Description

Table 1 shows that the standard deviation among variables has a wide variant. The average CO_2 emissions in Indonesia is 301.821 million metric tons, of which the average energy subsidy is IDR 87,809,863,000, while the average population growth is 1.42%. In addition, the average fossil energy consumption is 62.1% and the average consumption of renewable energy is 45.45%.

Table 1: Descriptive statistics of variables

Variable	Mean±SD	Minimum	Maximum
CO_2 emission	301.821±92.468	157	447
Energy subsidy	87.810±102.638	161.6	350.380
Population growth	1.424±0.152	1.260	1.781
Fossil energy consumption	62.108±3.627	53.430	67.154
Renewable energy consumption	45.457±6.543	38.066	58.597

Source: Secondary data processed. SD: Standard deviation

4.3. Discussion of the Research Results

In this study, four independent variables and one dependent variable were used. The independent variables were energy subsidy, population growth, fossil energy consumption and renewable energy consumption, while the dependent variable was CO_2 emissions. These variables were analyzed using multiple linear regression or OLS. The estimation result of the independent variables to the dependent variable is shown in Table 2.

Based on the estimation results presented in Table 2, the following equation was obtained:

CO_2 emissions = 4.983 + 6.620Subs + 0.794Pop + 0.024Fossil – 0.044R

The hypothesis of the influence of energy subsidy on CO_2 emissions is positive and significant. The result of the regression estimation showed that if energy subsidy increases by 1%, the CO_2 emissions will rise by 6.620%. This finding was in line with the previous explanation which stated that the greater the government support for energy exploitation and its use in the form of subsidy, the greater the potential emissions of CO_2 generated can be.

The result of this study was also in line with the finding of Mundaca (2017) who stated that energy subsidy have a positive effect on CO_2 emissions. Reducing energy subsidy (gasoline and diesel) by US $ 20 cents per liter causes a significant reduction of CO_2 emissions. For example, in Iran reducing the energy subsidy of gasoline decreases CO2 emissions by 90% of the total CO_2 emissions, while reducing the energy subsidy of diesel drops CO_2 emissions by 50% of the total CO_2 emissions. Meanwhile, Grafton et al. (2014) concluded that fuel subsidy has a positive effect on CO_2 emissions. For example, biofuel subsidies provided by US government from 1981 to 2011 proved to increase CO_2 emissions. In addition, Abouleinein et al. (2009) found that in Egypt energy subsidy has a significant positive effect on CO_2 emissions. The previous findings discussed showed that fuel subsidies was automatically lower the prices of fuels that resulted in the increase of oil consumption. The increased use of fuels for transportation and industrial purposes caused the increase of CO_2 emissions.

Subsequent findings in this study was that population growth had a positive and significant impact on CO_2 emission level. The result

Table 2: Estimation results of the dependent variable: CO_2 emissions

Independent variable	Coefficient	Standard error	t-statistic	Probability	Conclusion
Constanta	4.983	1.092	4.565	0.000	Significant
Subs	6.620	1.702	3.889	0.000	Significant
Pop	0.794	0.363	2.187	0.040	Significant
Fossil	0.024	0.012	1.998	0.059	Significant
R	−0.044	0.012	−3.645	0.001	Significant
Adjusted R^2	0.975				
F-statistic	240.59				
N	25				

Source: Secondary data processed, CO_2: Carbon dioxide

of this study indicated that the increase of the population growth by 1% multiplied CO_2 emissions by 0.794%. This was in line with the previous explanation stating that the greater the population of a country, the greater the potential of the increased CO_2emissions due to the high energy consumption of the population and the inevitably human consumptive nature.

Furthermore, this result was also in line with the one of Hang and Yuan (2011) that population growth in China has a positive influence on CO_2 emissions. An increase in the population leads to an increase in demand for goods and services, which in turn leads to a greater energy consumption. In addition, population growth has resulted in forests switching to settlements causing more CO_2 emissions. The study of Yeh and Liao (2017) also concluded that population growth has a positive effect on CO_2 emissions due to human activities. The activities such as production and transportation to meet people's needs require fuel energy that is likely to increase the amount of CO_2 emissions in the air. The greater the population is, the more activities the people done will be, and the more the CO_2 emissions released will be.

The study of Shi (2001) in 93 countries concluded that a 1% increase in population rises CO_2 emissions by 1.28%. With such magnitude, global emissions tend to grow substantially over the next decade. Therefore, international negotiations and cooperation to limit the rapid growth of CO_2emissions should be considered with the dynamics of the population growth in the future.

The third finding in this study was that fossil energy consumption has a positive and significant impact on CO_2emissions. The estimation result indicates if fossil energy consumption increases by 1%, CO_2 emissions will rise by 0,024%. This finding was in line with the existing theory that the consumption of fossil energy such as petroleum, coal, and natural gas can increase the production of CO_2emissions, because in it there are various activities that trigger the side effects of combustion of these energy sources. If a country could optimize both, then the country was considered to have successfully touched one of the goals of sustainable development. The result of this study was also in line with the study conducted by Mercan and Karakaya (2015). They concluded that fossil energy consumption has a positive relationship with CO_2 emissions. Danish et al. (2017) also found that fossil energy consumption has a positive effect on CO_2 emissions. Fossil energy consumption is the major cause in generating CO_2 emissions. Meanwhile, the study of Chibueze et al. (2013) in Nigeria during the period of 1971-2009 found that fossil energy had a positive and significant effect on CO_2 emissions. These empirical results provided a useful insight into the formulation and implementation of policies especially as the country aspires to move forward into an advanced industrial economy in the near future.

The fourth finding of this study was that renewable energy consumption has a negative and significant impact on CO_2. This result showed that if the consumption of renewable energy increases by 1%, the CO_2 emissions will fall by 0.044%. This finding was in line with the theory that the optimization of using renewable energy can lead to a decreased production of CO_2 emissions. Bilgili et al. (2016) found that the consumption of renewable energy negatively affects CO_2 emissions. Renewable energy is considered more environmentally friendly and can reduce pollution so that its impact on CO_2 emissions is negative. Zoundi (2017) study also found that renewable energy consumption has a negative effect on CO_2 emissions. In the long term, the increased consumption of renewable energy would replace the use of fossil energy. However, according to Zoundi (2017), the impact of renewable energy consumption is proportional to the impact of fossil energy consumption; therefore, synergized policies to control CO_2 emissions and other environmental problems were needed.

5. CONCLUSIONS AND SUGGESTIONS

Based on the research results discussed, some conclusions can be drawn:

1. The results of this study show that the variable of energy subsidy, population growth, and fossil energy consumption has a positive and significant impact on CO_2 emissions in Indonesia in 1990-2014.
2. There is an alignment of the consumption variable of fossil energy to the theory of energy externalities (ExternE), which states that externalities can be linked to greenhouse gases and energy consumption.
3. The consumption of renewable energy has a negative and significant impact on CO_2 emissions in Indonesia from 1990 to 2014.

Based on the conclusions, several suggestions are proposed:

1. The Government of Indonesia should provide a more environmentally sound policies for sustainable development by reducing fossil fuel subsidy and transferring them to renewable one.
2. The Government of Indonesia should increase incentives for the development of technological innovations to increase the use of renewable energy. Along with the transfer of

main energy sources (fossil energy) to renewable energy, the government might issue a policy that impacts on fossil energy usage savings first.

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