ENVIRONMENTAL EFFICIENCY ANALYSIS

[1]MURYANI, [2]WISNU WIBOWO

[1,2] Airlangga University, Surabaya, East Java, Indonesia
E-mail: Muryani2008@yahoo.co.id

Abstract- This research aims to measure the efficiency of environment when the countries implement Kyoto protocol or not. By utilizing The DEA method, it will be analyzed. The developed and developing countries pay attention to the utilization of energy, including members of the G20. Some important conclusions have been concluded deal with energy, efficiency and productivity.

Keywords- Energy, G20, efficiency, Productivity

I. BACKGROUND

Energy utilization is the increased use of energy in the process of industrialization and urbanization. Both developed and developing countries pay attention to the utilization of energy, including members of the G20. G20 is a collection of developed and developing countries; they are co integrated into a most influential economic power in the world. They has focused on their economic growth. Increased GDP each year by the G20 has produced the bad output anyway, one of which is CO2. To decrease the growth of CO2 production by the G20, the United Nations (UN) issued one of environmental policy namely the Kyoto Protocol. It was initiated together in Kyoto Japan in December 1997. It is also to remain consistent G20 on economic development sustainable concept. It is the one approving the Kyoto Protocol as an environmental policy that is applied in each country. Yusgiantoro (2000) explained that to look at the efficiency of energy- planning and environmental policies on economic development can use one of these approaches, ie. input-output approach. Input consists of energy consumption as a factor of energy, labor force and FDI as a factor of non-energy and the output consists of GDP which represents good output, and CO2 emissions represent bad output. This research uses G20 selected countries as samples in 2004-2014. They interpret a wide range of coverage developed and developing countries. The method used is the Data Envelopment Analysis (DEA). DEA is a non-parametric method that measures the efficiency of using the Decision-Making Unit (DMU) (Charnes et al, 1978). Bhattacharayya et al. (1997, p.335) suggests that the regulatory and imperfect market in developing countries may change the price of inputs or outputs and can complicate the measurement of cost or profit function using a parametric approach. Several previous studies such as Peroni (2012), Li-Yang and Wang (2013) have used the technique DEA in measuring the level of environmental efficiency. Based on the background described above, the formulation of the problem posed in this study are:1). What level of environmental efficiency if the Kyoto Protocol is not implemented?,2). How big is the level of environmental efficiency is lost if the policy is not applied to the Kyoto Protocol?,3) How large is the estimated cost of each of the G20 countries when applied to the Kyoto Protocol?,4). How do changes in environmental productivity in G20 countries during the implementation of the Kyoto Protocol?,5). What policy advice for each country based on the input and output target?

II. LITERATURE REVIEW

Environmental efficiency score is used to measure the level of environmental efficiency due to the utilization of energy in order to accelerate the increase in output environmental policy. Fare et al (2004) stated that pollution is automatically attached to the production process, be it in the form of input or output. Environmental efficiency can also be defined as the ability to produce a state in generating more output but also can reduce the level of pollution generated during production. Therefore the technology is very important in the reduction of unwanted output. There are two important assumptions, firstly, to reduce the bad outputs required a lot of expenses. Secondly, the scale of return to scale is variable. This means that in this case the assumption of constant returns to scale is no longer appropriate, so that the measurement of efficiency is the most appropriate using Data Envelopment Analysis (DEA). It can compare each economic unit with other economic units and provides an overview of each unit frontier. It will be used to identify whether the unit can reduce the production of pollutants and produce more good output (Charnes et al. 1978). Economic, energy, and the environment is always related to one another. The relationship between economic-environmental, Pearce and Turner (1990) stated that economic activity only make the environment as a 'sink waste' or reservoir emissions from economic activity. This is because the economic system not as a system environment that can recycle 'waste' of the production process, and therefore the economic system in the environment as one of the inputs in the production

process. Then, the reletionship between energy-environment, He stated that the production process of the economic system cannot be separated from the role of energy. Energy is used mainly primary energy such as petroleum, coal, natural gas, and others in the production process. They will leave the 'waste' on the environment if it exceeds the ambient quality will not be able to recycle by natural systems. This is in accordance with the laws of thermodynamics one, that energy cannot be created and destroyed by anything and anyhow, so the use of energy itself certainly end up somewhere in the system environment (Pearce and Turner, 1990). Conversely, the environment backs into 'recycler' for energy, but not all the 'waste' can be recycled (Kemfert.2009). It is relevant to the second law of thermodynamics: in the production process there are several reasons for the inability of nature in the process of 'recycling', because the 'material' which cannot be used in the economic process will be rejected by the economic system and it will remain a 'waste'. The relationship between energy-economy is the production process in the economic system need energy, energy for the economic system is the engine of economic growth that have a large role (Kemfert. 2009).

III. PREVIOUS STUDIES

Yang and Wang (2013) conducted a study in 28 provinces in China. Inputs used are labor, energy consumption and capital investment. This study uses a scenario in case no environmental policy then how efficiency loss of any province in China as well as calculate what the cost of the implementation of environmental policy. By using the DEA method with output approach - the VRS, they calculate the cost of the policy in 2007 for each province. It can be concluded that most of the provinces in China have the costs of implementing policies. This research is focused on the economic development capacity of the environment with a great environmental cost allocation for local economy growth. The other study is from Peroni (2012). He conducted a study in fifteen Western European countries which are members of the European Union. It is used the method Frontier DEA with output orientation - VRS. Input in this study are labor, energy consumption, and capital deepening rates. The output used is GDP and CO2. The result is that during the period 1995 - 2009 there were two countries that fully efficient and located right on the frontier line in the level of environmental efficiency, namely Luxembourg and Sweden. This research was conducted by using the non-parametric frontier (DEA and New DEA). The result is an efficient electrical industry on cost and technical but inefficient in environmental efficiency by using DEA and New DEA. So if the electricity industry in America want to be efficient at the level of neighborhood electric company, it must increase operating costs by 79% to 28% reduction in emissions. While, Cainelli et al. (2008) conducted a study in the Italian manufacturing industry. The purpose of this study was to examine the relationship between firm size oreconomic performances with the intensity of emissions by using technical indicators on the efficiency of the manufacturing industry in Italy. The increase in environmental efficiency encourages economic costs that led to the decline in the growth of the company, so that statistically significant trade - offs occur between environmental efficiency with the growth of the company. The study was conducted by using the method of Heckman two-step procedure. Then, Halkos and Nickolaos (2013) conducted a study on the G20 governments to see the effect on the level of environmental quality. Research carried out by non-parametric methods Nadaraya - Watson estimator. This study used a data sample of twenty G20 with seven variables, namely carbon dioxide emissions, voice and accountability, political stability, absence of violence, government effectiveness, regulatory quality, rule of law and control of corruption. The result is the relationship between carbon dioxide emissions and the government is non - linear, meaning that every percentage increase in the ability of people to choose the government in the G20 countries, the percentage of carbon dioxide emissions produced is decreased.

IV. RESEARCH METHODOLOGY

This study is conducted by purposive sampling method. Sample criteria used are as follows: 1) Decision-making unit or DMU selected are members of the G20 countries representing samples of developed and developing countries. 2) Countries are used as samples has been ratified and approved the Kyoto Protocol policy as one of the country's environmental policy. Based on the sample selection criteria are specified, the selected twenty countries are the G20 member includes Indonesia, Australia, South Africa, Argentina, USA, UK, Saudi Arabia, the European Union, Brazil, China, India, Italy, Japan, Germany, Canada, Korea, France, Mexico, Turkey, Russia. Twenty countries have ratified the Kyoto Protocol policies and start enforces the policy in different time. This study is in the year 2004-2014.

Analytical Technic

The steps used in the analytical techniques for the study are: The first step is to measure the environmental efficiency value of twenty G20 using three inputs, namely labor, Stock traded (current US $) and energy consumption (KT). There are two output namely GDP (US $) and CO_2 (KT). By the time the Kyoto Protocol enacts policies use input and output-oriented. The research uses existing VRS scenario Kyoto Protocol by using optimization. It is used CRS if there is no Kyoto Protocol. DMU which has a value of 1 until 100 is an efficient, while DMU efficiency values of less than 1 means that the DMU is not efficient. DEAP 2.1is utilized to run the data of

inputs and outputs. The second step is to measure the level of environmental efficiency if the countries - the G20 member states not to impose the Kyoto Protocol policies and to calculate efficiency loss that occurs if there is no environmental policy with a view of environmental efficiency assuming CRS. The third step is to calculate the cost of environmental policy manually using excel by multiplying the efficiency loss that already known, to the GDP average of the years 2004-2014.The fourth step is to measure changes in productivity during the implementation of the Kyoto Protocol policy in the twenty-G20 by using Malmquist Index (MI) that in the run using the DEAP 2.1.

V. RESULT AND DISCUSS

Based on the results of the run efficiency and using input and output-oriented CRS and VRS, some countries increased environmental efficiency than if the country does not implement the Kyoto Protocol during the years 2004-2014. Countries that managed to increase its efficiency by implementing a package of measures in the country's Kyoto Protocol are Russia, Argentina, Germany, China, and the European Union. While some other countries were able to improve the environmental efficiency but cannot at the full efficient frontier line. Those are France, UK, South Africa, Canada, Japan, India, Indonesia, South Korea, and Brazil. The inefficiency scores are calculated through the equation model scenarios, it can be seen in the six DMUs namely Australia, Italy, Turkey, USA, Mexico and Saudi Arabia. They operate efficiently during the implementation of the Kyoto Protocol policies. More over they are in the condition that with or without policies these countries are always found on the production frontier. And they always allocate funds for environmental regulation cost.

Score most efficiency loss if there is no Kyoto Protocol occurs in Indonesia, which have added environmental inefficiency level of 9.75 percent if the case does not implement the Kyoto Protocol policies. By participating in the Kyoto Protocol, during the years 2004 – 2014, Indonesia is able to reduce its environmental inefficiencies although it has not yet reached full efficiency. It is shown by the cost of implementation of emission reduction policies on the ratings of seven of more than 5 trillion dollars of total average GDP for the year 2004 – 2014.

It means that Indonesia is able to suppress the bad growth rate of their output in the form of emissions and still be able to raise the level of their GDP which is a good output, but has not been able to efficiently improve its environmental efficiency. Other countries that succeeded in reducing the level of environmental inefficiency to zero and maximize its efficiencies are Russia, Argentina, Germany, China, and the European Union. While, Malmquist Index calculation based on the assumption that VRS automatically assume technology is always changing either between countries or between times (Zhou et al, 2014). There are some countries such as India, Indonesia, Germany, EU , Argentina, Australia, France, Italy, Japan, Mexico, Russia, Saudi Arabia, Turkey, England, America has an environmental productivity growth rates shown by the Malmquist Index greater than or equal to 1. This indicates they improve the quality of environmental performance in their country and can efficiently control the production rate of their emissions. In countries with low productivity growth rate shown by Malmquist Index below 1 percent such as South Korea, Canada, China, South Africa, and Brazil. This indicate that the presence of the Kyoto Protocol in their countries has not been able to improve the performance quality of the environment in their country, though some countries such as China have a score of 100 percent efficiency but not necessarily in the country's environmental performance maximum

Table 1: Environmental Efficiency scores with and without the Kyoto Protocol and Policy Implementation Cost Estimation Based on Output Oriented.

Country	Malmq. Index	Rank	Tech. Index	Rank	Country	Malmq. Index	Rank	Tech. Index	Rank
Argentina	1.000	5	1.098	1	China	0.991	8	0.993	11
Brazil	1.000	5	1.029	2	India	1.021	1	0.993	12
England	1.000	5	1.024	3	Saudi Arabia	1.000	55	0.993	13
South Africa	0.991	9	1.004	4	Australia	1.000	5	0.989	14
Japan	1.000	5	1.003	5	South Korea	0.998	6	0.989	15
France	1.000	5	1.001	6	Mexico	1.000	5	0.985	16
USA	1.000	5	1.001	7	Canada	0.993	7	0.982	17
Italy	1.000	5	1.000	8	Germany	1.003	3	0.982	18
EU	1.002	4	0.999	9	Indonesia	1.006	2	0.969	19
Turkey	1.000	5	0.997	10	Russian Fed.	1.000	5	0.995	20

Table 2 : Malmquist Productivity Index Environment and Technology Index in G20 countries

Country	Efficiency Score (KP not exist)	Rank	Efficiency Score (KP exist)	Rank	Efficiency Loss	GDP's Mean 2004-2010 ($)	Estimated Cost	Rank
Australia	100.00	1	100.00	1	0.00	Na	Na	0
Italy	100.00	1	100.00	1	0.00	Na	Na	0
Mexico	100.00	1	100.00	1	0.00	Na	Na	0
Saudi Arabia	100.00	1	100.00	1	0.00	Na	Na	0
Turkey	100.00	1	100.00	1	0.00	Na	Na	0
USA	100.00	1	100.00	1	0.00	Na	Na	0
France	99.84	2	99.98	2	0.15	2,607,470,843,483.09	379,268,486,325.00	14
England	99.13	3	99,66	4	0.53	2,572,453,411,354.91	1.356.384.525.987	11
Russian Fed.	98.39	4	100.00	1	1.61	1,466,292,960,234.18	2.359.398.672.377	10
Argentina	97.67	5	100.00	1	2.33	420,449,859,642.59	978,501,491,532.00	13
Germany	97.10	6	100.00	1	2.90	3,393,302,138,750.82	9,840,576,202,377.00	5
China	96.01	7	100.00	1	3.99	5,396,786,316,934.95	21,538,083,573,950.00	3
South Africa	94.77	8	97.91	5	3.14	312,654,784,049.41	980,599,095,428.00	12
Canada	94.49	9	97.38	6	2.89	1,520,878,010,651.73	4,396,720,067,157.00	8
Japan	93.30	10	99.69	3	6.39	5,048,833,745,952.95	32,266,637,485,499.00	2
India	92.65	11	94.57	7	1.92	1,411,359,910,212.77	2,707,244,918,681.00	9
EU	85.37	12	100.00	1	14.63	16,818,739,226,770.90	246,012,285,598,858.00	1
Indonesia	82.02	13	91.76	8	9.75	596,548,838,598.73	5,813,639,530,708.00	7
South Korea	72.28	14	78.60	9	6.32	1,071,785,867,814.50	6,771,737,983,010.00	6
Brazil	65.03	15	74.22	10	9.19	1,694,257,002,633.55	15,571,762,087,841.00	4

Brazil cannot achieve a perfect score 100 percent, in line with the level of the environmental efficiency, Brazil also cannot improve performance or productivity environment during

the year 2004-2014 with Malmquist score of Index below 1, it was 0.990. In contrast to China during the years 2004-2014 have value environmental efficiency of 100 percent. The country actually has a low environmental performance with demonstrated by Malmquist index is below 1, with 0991. This may indicate Chine is able to suppress the growth rate of CO2 during the production increase, but the use of environmentally friendly technology, especially technology in China is still low. This is shown by the index of Chinese technology which is still below 1 by 0.993.

Based on the results, by using the CRS and VRS input oriented, some countries increased environmental efficiency than if the country does not implement the Kyoto Protocol during the years 2004-2014. Countries that managed to increase its efficiency by implementing a package of measures perfectly with the Kyoto protocol namely Russia, Argentina, Germany, China, and the European Union. While some other countries were able to improve the environmental efficiency but cannot at the full efficient frontier line. It means that the country has not been able to suppress the growth rate of CO2 in order to increase their GDP in those countries. Those countries are France, UK, South Africa, Canada, Japan, India, Indonesia, South Korea, and Brazil. The scores are calculated through the equation model scenarios can be seen that six DMU namely Australia, Italy, Turkey, USA, Mexico and Saudi Arabia operate efficiently during the implementation of the Kyoto Protocol policies. They always allocate funds for environmental regulation cost. Score most efficiency loss if there is no Kyoto Protocol occurs in Indonesia, which have added level of environmental inefficiency of 7.25 per cent in case the Kyoto Protocol does not apply the policy. By participating in the Kyoto Protocol, during the years 2004 – 2014, Indonesia is able to reduce inefficiencies although it has not yet reached full efficiency. Countries that succeeded in reducing the level of environmental inefficiency to zero are Russia, Argentina, Germany, China, and the European Union. We Can compared from the use of input-oriented (reduction of inputs to produce the same output) to use output oriented (with the same input produces the maximum output), it can be concluded with some countries more input orientation can avoid the efficiency loss that can occur if not applied Kyoto protocol.

Table 3: Environmental Efficiency scores with and without the Kyoto Protocol and Policy Implementation Cost Estimation Based on Input Oriented

Country	Efficiency Score (KP not exist)	Rank	Efficiency Score (KP exist)	Rank	Efficiency Loss	GDP's Mean 2004-2010 ($)	Estimated Cost	Rank
Australia	100.00	1	100.00	1	0.00	Na	Na	0
Italy	100.00	1	100.00	1	0.00	Na	Na	0
Mexico	100.00	1	100.00	1	0.00	Na	Na	0
Sa Arabia	100.00	1	100.00	1	0.00	Na	Na	0
Turkey	100.00	1	100.00	1	0.00	Na	Na	0
USA	100.00	1	100.00	1	0.00	Na	Na	0
France	99.84	2	99.98	2	0.14	2,607,470,843,483.09	374,527,630,245.75	14
England	99.13	3	99,66	4	0.47	2,572,453,411,354.91	1,216,068,885,367.73	11
RussianFd.	98.39	4	100.00	1	1.61	1,466,292,960,234.18	2.359.398.672.377	10
Argentina	97.67	5	100.00	1	2.33	420,449,859,642.59	978,501,491,532.00	13
Germany	97.10	6	100.00	1	2.90	3,393,302,138,750.82	9,840,576,202,377.00	4
China	96.01	7	100.00	1	3.99	5,396,786,316,934.95	21,538,083,573,950.00	3
South Afrc	94.77	8	98.45	5	3.68	312,654,784,049.41	1,149,716,910,436.24	12
Canada	94.49	9	97.34	6	2.85	1,520,878,010,651.73	4,333,119,713,984.10	5
Japan	93.30	10	99,67	3	6.37	5,048,833,745,952.95	32,161,070,961,720.30	2
India	92.65	11	94.57	7	1.92	1,411,359,910,212.77	2,703,393,755,289.36	9
EU	85.37	12	100.00	1	14.63	16,818,739,226,770.90	246,012,285,598,858.00	1
Indonesia	82.02	13	89.27	8	7.25	596,548,838,598.73	4,326,063,714,092.76	6
South Kor	72.28	14	75.20	9	2.92	1,071,785,867,814.50	3,127,666,032,440.51	8
Brazil	65.03	15	67.21	10	2.18	1,694,257,002,633.55	3,698,100,966,657.41	7

Using input-oriented efficiency loss approach, Indonesia get about 9.75 percent, it can be reduced to 7.25 per cent. Some other countries are experiencing the same thing is South Korea which was originally used output-oriented efficiency loss that may occur by 6.32 percent, the figure could be reduced to 2.92 percent if the orientation was changed to input oriented. It is also happen in Brazil, if the switch to input oriented efficiency that originally had a loss of 9.19 per cent if it does not implement the Kyoto protocol. It can be pressed to figure 2.18 per cent by using input oriented. More decreasing the risk of efficiency loss may imply in the increased efficiency in cost of the policy. The cost of a policy for environmental improvements in some countries also decreased, which means the country can improve the efficiency of their environment without the increasing cost. Some countries experiencing decrease in the cost of policies are: India, Korea, Brazil, France, India, and Japan.

CONCLUSION

Based on the results of research and discussion in the previous chapter, it can be concluded as follow: 1) with the policy applied Kyoto Protocol was able to further improve environmental efficiency in several other countries. This shows that the policy of the Kyoto Protocol been successful in carrying out its role as the controlling emissions growth in developed and developing countries, especially G20. 2) Some countries experienced a loss in efficiency level of environmental efficiency if not enforced despite the Kyoto Protocol on the other side of some countries not affected if there is no Kyoto Protocol. 3) The estimated costs of implementing different policies in each of the G20 countries, some countries cannot be known because the cost of its environmental policy or not there is the Kyoto Protocol countries are already at its production frontier. 4) Efficiency is not the main standard to make a country becomes a standard for other countries, on the other hand the performance quality of the environment must also be taken into account. One of the countries may succeed in reducing the environmental inefficiency by ratifying the Kyoto Protocol and perfectly efficient performance of environmental quality and sustainable productive calculated through Malmquist index. 5) Based on the input and output targets, it can be seen that the G20 member states reach an optimal level when seen through GDP (output) and the stock traded (input). However, it is not optimal when viewed through energy use, emission, and the labor force.

REFERENCES

[1]. Bhattacharayya, et al. 1997. The Impact of Liberalization on the Productive Efficiency of Indian Commercial Bank. European Journal of Operational Research 98: 332-345.

[2]. Cainelli, G et al. (2008). The Relationship between Environmental Efficiency and Manufacturing Firms's Growth. Climate Change Modelling and Policy Working Paper. University of Ferrara. Milan.

[3]. Charnes, A., Cooper, W., and Rhodes, E. 1978. Measuring The Efficiency of Decision-Making Units. European Journal of Operational Research, 2: 429 – 444.

[4]. Fare, R. and Grosskopf, S. 2004. Modelling Undesirable Factors in Efficiency Valuation: A Comment. European Journal of Operational Research, 157:242–245.

[5]. Halkos, E George. Nickolaos G. (2013). Carbon Dioxide Emissions and Governance: A Nonparametric Analysis for The G–20. Energy Economics, 40: 110 – 118.

[6]. Kemfert, C. Truong T. 2009. Energy-Economy-Environment Modelling: a Survey. International Handbook on the Economics of Energy. Edward Elgar Publishing Limited. Cheltenham. United Kingdom.

[7]. Peroni, C. 2012. Environmental Efficiency Indices: Towards a New Approach to Green – Growth Accounting. Economie et Statistique, Working Paper du STATEC N 61, Ministre de l'economie e du commerce exterieur du Grand-Duch de Luxembourg.

[8]. Yang, Li and Ke-Liang Wang. 2013. Regional Differences of environmental Efficiency of China's Energy Utilization and Environmental Regulation Cost Based on Provincial Panel Data and DEA Method. Mathematical and Computer Modelling (58), 1074 – 1083.

[9]. Yusgiatoro, Purnomo. 2000. Ekonomi Energi Teori dan Praktek. Jakarta. Pustaka LP3ES

[10]. Welch, W Eric., Darold T. B. 2009. Joint Environmental and Cost Efficiency Analysis of The Electricity Production Industry: Applying the Materials Balance Condition. GCP – 09 – 03. College of Urban Planning and Public Affairs.University of Illinois. Chichago.

[11]. Zhou, P., Ang, B., and Poh, K. 2014. Total Factor Carbon Emission Performance: A Malmquist Index Analysis. Energy Economics, 32:194–201.

★★★