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The Impact of Kyoto Protocol on Environment Quality in the Free Trade Era: Case of G20 Countries

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ABSTRACT

The impact of trade openness on environment is not easy to be figured out. The scale and technique effects of trade tend to have opposite direction, while the composition effect depends on the "comparative advantage" of a country. One way to avoid the world's emission level is the ratification of Kyoto Protocol in 1997. This study aims to analyze the impact of trade openness and Kyoto Protocol on CO_2 emission level. This research employs macroeconomics data in G20 countries from 1996 to 2008 by using ordinary least squares with gravity instrument variable model from G20 countries trade flows. The estimation results indicate that trade openness has positive and significant effect on CO_2 emissions level. Meanwhile, Kyoto Protocol has insignificant effect on CO_2 emissions level, thereby signifying the ineffectiveness of the Protocol's implementation.

Keywords: Trade Openness, Kyoto Protocol, CO_2 Emissions
JEL Classifications: F18, F53, Q54

1. INTRODUCTION

1.1. Background

The globalization has augmented the flow of trade among countries including the developing ones. Yet, increased trade can lead to environmental problems as production and trading activities surge. The expansion of world trade raises an issue of relationship between trade and the environment; whether trade gives a positive or negative impact on the quality of environment. The impact of trade liberalization on the environment cannot be known with certainty. Trade can also spur a country's economic growth which is in line with the increasing openness, investment, and technological development (ADB 2009).

Trade openness among countries is a direct consequence of the liberalization of trade. This has implications to the environmental conditions. Currently the global warming and climate change surface as the international issues, in which emissions of greenhouse gases (GHG) are considered the main trigger. On the global scale, greenhouse gas GHG emissions generated from human activities consist of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorine-containing gases (F-gases) such as hydro fluorocarbons. Fossil fuel combustion process and other industrial processes are major sources of emissions and contribute the highest proportion of the total global emissions of CO_2. Other sources come from environmentally damaging land use such as deforestation. As much as 5 million metric tons of CO_2 emissions or about 16% of the sources of emissions from the burning of fossil fuels come from deforestation. Tropical forest deforestation in parts of Africa, Asia, and South America globally is regarded as the largest contributor of CO_2 emissions from land-use change.

According to the Environmental Protection Agency in 2008, the highest emitters of carbon dioxide (CO_2) are China, the United States, European Union, India, Russia, Japan and Canada. These countries belong to the G20 economic group. This research is conducted by analyzing the relationship between trade openness and environmental impact in the G20 countries. G20 member states represent 66% of the global population, 85% of global GDP and 76% of the world's carbon emissions. The G20 group also represents diverse economic conditions, which makes it possible to analyze how the different stages of economic growth can affect carbon emissions. A number of large countries such as China and India are the ones with quite high emission and are classified as "emerging economies."

Economic activity that continues to increase with the openness among countries will ultimately affect the quality of environment. Climate change becomes a global challenge that will be faced by the international community together. International cooperation becomes an alternative that can be taken in an effort to mitigate the effects of climate change. One of the efforts to reduce the level of global emissions is the establishment of Kyoto Protocol in 1997. One of the main issues in Kyoto Protocol is an agreement which is binding for 38 industrialized countries and the European Union to reduce GHG emissions by about 5% lower than that produced in 1990 during a period of 5 years, between 2008 and 2012.

The level of global GHG emissions is still far behind the target set in Kyoto Protocol. According to a World Bank report, global emissions of carbon dioxide have increased by 19% from 1990 to 2007. Such increase will be getting out of control if it is not anticipated from the beginning. Therefore, the effort to anticipate the global threat requires role of all parties.

1.2. Problem Statement

The growing volume of international trade has led to a surge in energy consumption and GHG emissions. In 2008, more than a quarter of global carbon emissions are related to trade in goods and services in international markets. The role of international trade in global emission levels becomes one of the problems the international community is facing today.

A number of earlier studies provide various conclusions on the relationship between trade openness and environmental quality. Lucas et al. (1992) conducted a study on the effect of trade openness towards the rate of increase of production output that contains toxic materials and found that among developing economies increased trade openness could reduce the amount of output with toxic materials. Contrariwise, Gale and Mendez (1998) who analyzed the relationship between trade, revenue growth and the environment concluded that increasing revenue through increased volume of trade would have a detrimental impact on the environment. The effectiveness of multilateral agreements in the combat against climate change is also debatable. The current Kyoto Protocol is the only international treaty that is binding on the countries that are committed in the fight against global emissions. Although Kyoto Protocol has an important role in efforts to address global emissions, this agreement has limitations in reaching the global emissions reduction targets, considering there are still large emitters which are not bound by this agreement (Aldy and Stavins, 2008). Based on the notion, several issues that will be examined in this study is how far the level of trade openness in the G20 regions affects the level of country's CO_2 emissions in the region and how it impacts the application of multilateral environmental agreement, such as Kyoto Protocol, on emission levels in G20 countries before and after the period of ratification of the treaty.

2. LITERATURE REVIEW

2.1. Relationship between Trade Openness and Environment

The linkage between trade openness and environmental damage has been revealed in a study conducted by Frankel and Rose (2005). The openness of a country may allow the entry of technological and managerial innovations of foreign companies operating in the country. This technology diffusion process can introduce new production techniques that are more efficient and cleaner. Thus, trade openness is expected to become a positive influence on income per capita. The flow of foreign investment funds is also expected to stimulate economic growth. On the other side, a country's economic growth will also affect the environment so there is a common thread linking trade and the environment, which is through income per capita (Chebbie et al., 2010).

Grossman and Krueger (1993) noted inverted U-shaped relationship between income and environmental quality. Economic growth could have a negative impact on the environment, especially in the early phase of development. At a later stage when the construction is more established, the environmental conditions improve. A relationship in the form of an inverted U-shaped is later known as Environmental Kuznets Curve (EKC). EKC curve reflects the change in the demand for environmental quality driven by rising incomes. At low income level, the development process is directly proportional to pollution because the needs to consume are more important than the needs for environmental quality. With increasing incomes, public awareness of the importance of a clean environment is also increasing, while demand for consumption does not add much. In their next study, Grossman and Krueger (1993) and Copeland and Taylor (1994) elaborated the impact of trade on the environment and distinguished these impacts as scale effect, composition effect and technique effect.

Scale effect shows an increase of GHG emissions resulting from economic activity. According to Copeland and Taylor (2004), scale effect can be defined as the increase in value of production (measured in world prices) compared to the value of production prior to trade. Composition effect is able to explain how international trade can change the contribution of each sector to the production structure of a country as a response to changes in relative prices, which will result in most sectors experiencing expansion and others suffering from economic contraction. Changes in the structure of a country engaged in free trade will depend on the "comparative advantage" of each country. If a country has a comparative advantage in sectors that are less emission-intensive, the trade would tend to reduce GHG emissions. On the other hand, if a country has a comparative advantage in sectors that are more emission-intensive, trade liberalization would increase the emission of GHG. Meanwhile, technique effect refers to the development of the methods used in producing goods and services, where the use of more efficient and environmentally friendly production technologies can reduce the amount of CO_2 emissions.

Based on the above elucidation, scale effect and technique effect tend to have the opposite direction, while the composition effect depends on the "comparative advantage" of a country and pollution haven hypothesis, so the overall impact of trade in GHG emissions cannot be easily determined.

2.2. Relationship between International level Environmental Agreements and Environmental Quality

Climate change is a global problem that everyone faces together given that all the countries inhabit the same earth with the same

atmosphere and hence a good environmental quality becomes public goods. The main factor of climate change is the GHG emissions resulting from numerous human activities. To cope with the increasingly widespread GHG emissions, it is necessary to remember the commitment of the international climate change mitigation efforts cannot be dealt with partially. The high cost of tackling global GHG emissions becomes a certain challenge: How to share this burden equally to all countries. The unequal distribution of the adverse impacts of climate change and the difference in ability to overcome it is another problem. In opposition, there is also an opportunity for countries to be free rider (Kemfert, 2006), in which a country can also enjoy the benefits of efforts to overcome the impact of climate change undertaken by other countries without any cost. Therefore, an international climate change impact mitigation agreement that can provide support and encouragement for each country to participate actively is required.

Kyoto Protocol which was adopted in 1997 and entered into force in 2005 is currently the only international treaty that is binding on the countries that are committed to combatting global emissions. Within the framework of Kyoto Protocol, in addition to commitment to reduce emission levels in each country, developed countries are also expected to go hand in hand with developing countries in minimizing the impact of climate change that transmits through trade. In a study conducted by Iwata and Okada (2010), the implementation of commitment to reduce GHG emissions, in compliance to Kyoto Protocol, has a significant impact in reducing the level of emissions of CO_2 and CH_4, but has no significant effect on the reduction of N_2O emissions and is actually positively correlated to the level of GHG emissions of other types. At the interim, Grunewald and Martinez-Zarzoso (2009) analyzed the effect of the implementation of Kyoto Protocol in reducing CO_2 emission levels by categorizing countries according to their income and found that Kyoto Protocol had a significant impact in reducing the level of CO_2 emissions in both the developed and developing countries.

Kyoto Protocol aims to maintain the concentration of GHGs at a level that does not harm the climate conditions on Earth. In achieving these objectives, Kyoto Protocol regulates the implementation of emission reduction from industrialized countries by 5%, below the 1990's levels in the period 2008-2012 through the Joint Implementation Mechanism, Emission Trading, and Clean Development Mechanism.

2.3. Empirical Review

Studies on the relationship between trade openness and the quality of environment carried out by Frankel and Rose (2005) by considering the issue of endogeneity between trade openness variable and income per capita used variables instrumental techniques approach. According to Frankel and Rose, by taking into account this endogeneity aspect, the negative effects of trade openness to CO_2 emissions is not statistically significant or in other words by including endogeneity effect into the calculation, trade openness does not actually affect the level of CO_2 emissions. Another study conducted by Managi (2008) suggested that the impact of trade openness might differ between developed countries, which in this study, is represented by data from OECD countries and developing countries. This study aims at estimating the overall impact of trade openness on the level of emissions of CO_2, SO_2 and Biochemical Oxygen Demand. The results reveal that trade openness can reduce the level of CO_2 emissions in OECD countries and increasing emissions of CO_2 in non-OECD countries.

Other study on the relationship between trade openness and CO_2 emissions was made by McCarney and Adamowicz (2005) using panel data from 143 countries with a range of time periods between 1976 and 2000. The results of the study indicate that the higher the level of openness of a country's, the higher the CO_2 emission level. The study also reveals that the high level of democracy can have a positive relationship to the level of CO_2 emissions. This might imply indirect relationships where low performance of the government may reduce welfare, so as to reduce the income per capita and as a consequence may increase emissions of CO_2.

On the contrary, the hypothesis of "pollution haven" implies that the composition of production in a liberal economy will also depend on the difference in environmental regulations among countries. If a country has more stringent environmental standards, increasing trade competition in the global market will more likely lead be emission-intensive than other countries with weaker environmental standards. In the context of GHG emissions, the effect of differences in environmental policy in the international sphere will bring up a "carbon leakage." This term indicates a situation in which an action taken by a country to limit the level of CO_2 emissions at the national level does not necessarily reduce the rate of global CO_2 emissions because industries that produce high level of CO_2 emissions move to other countries that implement looser environmental policies. Pollution haven hypothesis predicts that in a free market situation, pollution-intensive production will shift from developed to developing countries. Developing countries in general will relax environmental standards in order to attract foreign investment and multinational companies will benefit from lax environmental standards. Multinational companies will tend to relocate their factory/heavy industry in order to avoid the cost of reducing pollution that is typically applied in developed countries that have high environmental standards.

3. RESEARCH METHODS

3.1. Research Model

3.1.1. Environmental equation

Environmental equation is used to describe the influence of trade openness and other variables on the level of CO_2 emissions. The model used to consider the endogeneity factors between trade and income, as adapted from the model used by Frankel and Rose (2005) and Managi (2008), is as follows:

$$\ln E_{it} = c_1 + \alpha_1 \ln income_{it} + \alpha_2 tradeopenness_{it} + \alpha_3 kyoto_{it} + \alpha_4 (open*kyoto)_{it} + \alpha_5 \left(\frac{R\&D}{GDP}\right)_{it} + \alpha_6 regqual_{it} + \alpha_7 haven_{it} + \alpha_8 \left(\frac{FDI}{GDP}\right)_{it} + \varepsilon_{1it} \quad (1)$$

Whereas, E_{it} is the level of CO_2 emissions, $income_{it}$ is income per capita, $tradeopenness_{it}$ is the ratio of exports and imports to GDP which illustrates trade openness of, $Kyoto_{it}$ is a dummy variable where D = 1 for the period after the ratification of Kyoto Protocol and D = 0 for the period prior to the ratification of Kyoto Protocol. Next, open. Kyoto is interaction variable between tradeopenness and Kyoto Protocol, $\left(\frac{R\&D}{GDP}\right)_{it}$ is the ratio of R&D expenditures to GDP, $regqual_{it}$ is an index of the quality of regulation, $haven_{it}$ is an interaction variable between income and tradeopenness, and $\left(\frac{FDI}{GDP}\right)_{it}$ is the ratio of FDI - GDP.

3.1.2. Income equation

Based on the theory of endogenous growth, the income of a country can be determined by several factors such as trade openness, labor capital ratio, number of population, and human resources. The equation used is:

$$\ln income_{it} = c_2 + \beta_1 \ln tradeopenness_{it} + \beta_2 \ln\left(\frac{K}{L}\right)_{it} + \beta_3 \ln P_{it} + \beta_4 \ln Sch_{it} + \varepsilon_{2it} \quad (2)$$

Whereas, $income_{it}$ is per capita income, $tradeopenness_{it}$ is the ratio of exports and imports to GDP which reflects the openness of trade, $\left(\frac{K}{L}\right)_{it}$ is the capital labor ratio. Moreover, P_{it} is the population and Sch_{it} is school attendance year.

3.1.3. Trade openness equation

Endogeneity problems between trade openness and per capita income are often featured in some of the empirical literatures (Frankel and Rose, 2005). To overcome this endogeneity issue, instrumental variable (IV) technique is applied. The gravity model of trade is an IV that is good enough to represent trade openness because it is exogenous and is closely correlated with openness variable. The gravity model is utilized in making a model of trade openness as follows:

$$\ln tradeopenness_{ijt} = c_3 + \gamma_1 \ln distance_{ij} + \gamma_2 \ln P_{it} P_{jt} + \gamma_3 \ln area_i area_j + \varepsilon_{3it} \quad (3)$$

Whereas, $tradeopenness_{ijt}$ is the flow of bilateral trade from country i to country j at time t, $distance_{ij}$ is the distance between country i and country j, P_i and P_j are the populations of country i and j, and a $area_i area_j$ are the area of state i and state j.

The equation with gravity model above is first processed early stage regression. Next, the exponential fitted value of bilateral trade among G20 countries is calculated. The result is later added with the number of partners in bilateral trade using the following formula:

$$tradeopenness_{it} = \Sigma \exp [\text{fitted } \ln tradeopenness_{ijt}] \quad (4)$$

The result is then inserted into the environmental equation 1.

3.2. Data Source

This study utilizes panel data deriving from macroeconomic data of nineteen G20 countries. The time periods that are examined in this study are between the years 1996 and 2008, with the consideration that the median in that time span is a moment when most of the G20 countries ratified Kyoto Protocol in 2002. The Kyoto Protocol variable is a dummy variable that is used to see the effect of ratification of the international agreement in the environmental field on the level of emission in G20. Data on trade openness, expenditures on research and development (R&D), ratio of FDI - GDP, as well as population data are taken from the World Development Index (2014). The CO_2 emissions level data are taken from BP Statistics Review 2014. Meanwhile, data on per capita income, capital-labor ratio, and school attendance year data are taken from the Penn World Table. Other additional data regarding the regulator/government quality index and the distance data among capitals of countries are taken from the Worldwide Governance Indicators (2014) and CEPII (Center for International Prospective Studies).

4. RESULTS AND DISCUSSION

4.1. Estimation Results

The influence of trade openness and Kyoto Protocol as well as other control variables on the level of CO_2 emissions can be determined by conducting econometric estimation. This study uses data from as many as 168 observations from 1996 to 2008 and ordinary least squares method with gravity model instrument variable that describes the flow of bilateral trade among G20 countries. As stated in the study conducted by Frankel and Rose (2005), the gravity model of bilateral trade among countries can serve as an instrument for trade openness variable, given that the gravity model is very exogenous and is closely related to the level of trade openness.

The estimation results are presented in Table 1.

Table 1: Estimation results of trade openness on CO_2 emission level

Variable	Coefficient	Standard error	t-statistics	P
C	−3.393***	1.093	−3.10	0.002
ln income	0.475***	0.148	3.21	0.001
tradeopenness	0.02**	0.009	2.12	0.034
$\left(\frac{R\&D}{GDP}\right)$	−0.022	0.086	−0.26	0.798
regqual	−0.001	0.042	−0.03	0.973
$\left(\frac{FDI}{GDP}\right)$	−0.023***	0.009	−2.67	0.008
kyoto	0.211	0.129	1.63	0.104
open*kyoto	−0.009**	0.004	−2.17	0.030
haven	$-1.28e^{-8}$	$5.23e^{-8}$	−0.24	0.807
R^2	0.673			
Sigma_u	0.599			
Sigma_e	0.155			
ρ	0.937			
$P>\chi^2$	0.000			

***significant at α=1%, ** significant at α=5%

5. DISCUSSION

The results of model estimation using IV technique tell that 67.3% of the variation of the independent variables that exist in the research model can explain changes in the level of CO_2 emissions per capita. This can be seen from the R2 value of 0.673. Value of $P > \chi^2$ of 0.000 indicates that the overall research model is good enough. $\rho = 0.937$ denotes that 93.7% of variance in this model occur because of differences in the data panel.

Based on the regression results using IV technique, variables of income and trade openness have a positive and significant influence. Effect of increased revenues to the level of CO_2 emissions per capita is significant although the magnitude is not too high. Income increase by 1% may increase CO_2 emissions per capita by 0.5%. The results of this study are consistent with those of Managi (2009) who found that an increase in income of a country could raise CO_2 emissions per capita. This indicates the dominance from the scale effect on G20 countries. The higher the income of a country, the more the country tends to allocate its income for development in the production sectors, indirectly driving the consumption of fuel which is generally fossil-based. Major industrialized countries such as the United States contribute high CO_2 emissions per capita as is the case with the other growing economies such as China and India. Other developing countries have also potential in growing CO_2 emissions.

Trade openness also has a significant effect in CO_2 emissions upsurge. An increase in trade openness by 1% can increase CO_2 emissions per capita by 2-0.9% of the level of trade openness. This is evident from trade openness variable coefficient which is worth 2% and open*Kyoto variable coefficient which reaches -0.9%. Based on these results we can see that after the implementation of Kyoto Protocol, the openness of trade tends to reduce the level of CO_2 emissions although its magnitude is less than 1%. However, it can be said that multilateral environmental agreements could potentially be a driving force for the world community to pay more attention to the environmental aspect in trading activity. Currently the basic principles of the relationship between trade and the environment have begun to set forth in bilateral, regional, and multilateral agreements. In those agreements, there are different sides of the environmental provisions in trade that set production standards, production methods, emission norms, health and sanitary and phytosanitary aspects. Clauses on the environment have also been included in international trade agreements. Environmental issues that have already been accommodated in the WTO agreements include: Agreement Establishing the World Trade Organization Agreement on Agriculture, Agreement on the Application of Sanitary and Phytosanitary Measure, and Agreement on Technical Barrier to Trade. Conversely, trade openness has an influence on the environment through a process of accelerated economic growth, in which the process of trade has contributed to the increasing investment and technology diffusion.

Other variables that have a significant effect on CO_2 emissions per capita is the ratio of FDI - GDP of a country. The estimation results of the model indicate that an increase in the ratio of FDI - GDP by 1% can reduce the level of CO_2 emissions per capita by 2.3%. The role of $\left(\frac{FDI}{GDP}\right)$ on the level of CO_2 emissions per capita cannot easily be determined. The effect may be positive or negative. In this study, the influx of FDI flows allows for the process of diffusion of technology from developed to developing countries, so that developing countries can adapt new technologies that are more efficient and environmentally friendly. This actually makes an increase in the flow of FDI funds, contributing to the reduction of CO_2 emissions per capita in the G20. Then again, FDI inflows may also be associated with environmental degradation.

Based on the hypothesis of "pollution haven," pollution-intensive production will shift from developed to developing countries. Developing countries in general will slacken environmental standards in order to attract foreign investment, whereas multinational companies will benefit from lax environmental standards. Multinational companies will tend to relocate its factory/heavy industry in order to avoid the cost of pollution reduction, which is usually applied in developed countries that have high environmental standards. Yet, in this research, "pollution haven" hypothesis represented by haven variable shows no significant effect. Moreover, the amount is very small, which means that the relocation of heavy industry from developed countries to developing countries within G20 does not have a significant impact. This is consistent with the results of Copeland and Gulati (2006) who argued that the differences in the environmental policy did not eventually determine the direction of international trade as described in the "pollution haven" hypothesis.

The estimation results of the model in this study show some insignificant variables in addition to the "pollution haven" hypothesis, i.e., a ratio variable of R&D - GDP, regulatory quality and Kyoto Protocol dummy variables, which are used as indicator of influence of multilateral regulation on the environment. The ratio of R&D - GDP reflects a country's level of spending in research and development. Developed countries generally allocate greater funds for R&D so as to create a production technology that is more environmentally friendly. The $\left(\frac{R\&D}{GDP}\right)$ variable specifies the effect of trading techniques to environmental quality. In contrast to the scale effect which is increasing along with the development of the production sector, the effects of these techniques can actually reduce the level of CO_2 emissions per capita. It can be seen from the negative $\left(\frac{R\&D}{GDP}\right)$ coefficient although insignificant. This implies that within the scope of G20 countries, the scale effect is more dominant than the technique effect.

As with variable of R&D ratio to GDP, regulatory quality variable is also not significant enough to affect the level of CO_2 emissions. Regulatory quality is a measure of the ability of the government to formulate and implement policies to facilitate the development, primarily in the private sector. The size of the regulatory quality variable in the form of a scale that ranges from −2.5 for countries with the weakest regulatory quality to 2.5 for those with the strongest regulatory quality. Based on the descriptive statistics data, the average value for the regulatory quality parameters in G20 countries ranges in 0.6. This validates that the regulatory

quality in G20 countries is still not strong enough, especially in developing countries. The regression results in the research model also implies a similar case in which the parameter of regulatory quality does not have a significant effect on the level of CO_2 emissions of per capita.

Kyoto Protocol is one of the variables to measure the impact of environmental regulations at international level. The coefficient of this variable is expected to be negative in accordance to the expectation that the international community's commitment to addressing environmental problems can contribute to the reduction of CO_2 emissions. Nevertheless, in this study, the value of the coefficient for the Kyoto Protocol variable is in fact positive and not significant. The estimation results reveal that after the implementation of Kyoto Protocol, CO_2 emission level per capita in reality arises by 21.2%. This is in line with the results of research from Nielsen (2014), which entails that by using the IV technique on the fixed effect model, the CO_2 emission level climbs by 18% after the ratification period. Kyoto Protocol is an effort to minimize the effects of climate change, but the effectiveness of the implementation of this regulation is not easy. Emissions of CO_2 are projected to continue to skyrocket in the coming years. Mitigation of global climate change is a complex problem in as the CO_2 gas will remain in the atmosphere even long enough after the gas is emitted into the air (Schmalensee et al., 1998), so it is quite difficult to estimate how long the effects of CO_2 gas' existence can be eliminated.

Another reason which allows lack of effective implementation of this agreement is the absence of involvement of CO_2 emitters such as the United States in the implementation of Kyoto Protocol. Such emerging economies as China and India, with CO_2 emission level that is quite high and projected to continue to proliferate, are not directly tied either to the implementation of Kyoto Protocol's commitments. Among 185 countries that have ratified Kyoto Protocol, only 37 countries listed in Annex B which have set a specific CO_2 emissions reduction limit from 2008 to 2012, so that the emission reduction targets which can be achieved through the implementation of Kyoto Protocol only covers less than a third of global emissions. The emissions levels of the United States and China alone represent nearly half of the global emissions level, so that the involvement of these countries is believed to give a significant influence on the implementation of Kyoto Protocol.

5.1. Effects of Trade Openness on Income Level

As previously described, in this study, the endogeneity on trade openness variable (tradeopenness) and income variable (income) is one thing to consider before estimating the environmental equation to analyze the influence of trade openness on the environment. Based on the literature on endogenous growth theory, the income of a country can be determined by such factors as trade openness, labor capital ratio, number of population, and human resources.

After conducting regression to the equation of income, the results are as follows.

Table 2 illustrates the estimation results of income equation, which sees that the trade openness variable has a positive and significant effect on the income of a country. The results are consistent with studies conducted by Noguer and Siscart (2005) which denotes that the more a country is involved in international trade, the greater the impact of trade on income.

Table 2: Income equation estimation results

Variable	Coefficient	Standard error	t-statistics	P
C	1.835***	0.347	5.29	0.000
ln tradeopenness	0.160***	0.045	3.53	0.000
$\ln\left(\frac{K}{L}\right)$	0.598***	0.031	19.12	0.000
ln populasi	−0.103**	0.042	−2.47	0.014
ln Sch	1.030***	0.138	7.46	0.000
R^2	0.940			
ρ	0.942			
$P>\chi^2$	0.000			

***significant at α=1%, **significant at α=5%

In accordance with the endogenous growth models, the role of human capital is also one of the variables that are taken into account in the income equation. The estimation results suggest that variable of human resources stated in the average school attendance year has a positive and significant impact on income. In the meantime, the number of population is used to control the impact of the size of a country on income level. The larger the size of a country in terms of population, the more negative the influence on the level of income.

Variable of capital-labor ratio (K/L) in this model can describe the effect of the comparative advantage of a country against its income. Capital-labor ratio also indicates a country's specialization in the production sectors; whether the country is likely to have specialization in pollution-prone production sectors or in more environmentally friendly production sectors. A country's trade pattern can be determined by the allocation of capital and labor, as suggested in neoclassical trade theory. Countries like Japan which has higher capital-labor ratio (K/L) in theory will be more specialized in the pollution-prone industrial sectors, while countries that have lower capital-labor ratio (K/L), e.g. India, mostly uses up resources in the form of labor so they are more specialized in the production sectors that are more environmentally friendly. The estimation results in this study prove that capital-labor ratio has a positive and significant impact on income. An increase of one unit of capital-labor ratio in a country can increase income up to 59.8%.

6. CONCLUSIONS

Trade openness variables indicates a positive and significant impact on the quality of the environment, which, after the implementation of Kyoto Protocol, increase in trade openness rate by 1% may increase CO_2 emissions per capita by 2-0.9% of the level of trade openness.

After the adoption of the Kyoto Protocol, trade openness tends to reduce CO_2 emission level so that Kyoto Protocol has the potential to become a driving force for more environmentally-sound trade

activities. Nowadays, international trade agreements have included environmental clauses. The Kyoto Protocol variable exhibits a positive effect but is not significant to CO_2 emissions level per capita. This indicates lack of effectiveness of Kyoto Protocol in reducing the level of CO_2 emissions globally. Emissions reduction targets which can be achieved through the implementation of Kyoto Protocol only covers less than a third of global emissions. It is accomplished by implementing CO_2 emission reduction limit specifically by 37 Annex I countries during 2008-2012. The implementation of Kyoto Protocol is deemed to be more effective if it involves main emitters of CO_2, both developed and developing countries.

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