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Environmental Quality, Economic Development, and Political Institutions in East Asia: A Survey of Issues

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This article provides a comprehensive review of literature on the economic growth-pollutant emissions relationship. Using the framework of the Environmental Kuznets Curve hypothesis, the context of selected East Asian countries is given focus. It has been suggested that trade liberalization and even sociopolitical institutions may have an impact in determining the correlation between economic prosperity and environmental degradation.

Keywords: East Asia, environmental Kuznets curve, growth, emissions.

INTRODUCTION

Sulfur dioxide and carbon dioxide emissions play crucial roles in environmental problems. According to Stern (2006), sulfur emissions affect local air pollution, acid rain, and climate change. On the other hand, carbon emissions primarily affect global warming (Marland, Boden, & Andres, 2008). Thus, there has been a growing concern about minimizing the concentrations of these air pollutant emissions. This need for environmental sustainability is supported by the implementation of the Kyoto Protocol and the Millennium Development Goals (refer to Appendix A).

The Kyoto Protocol and the Millennium Development Goals are indications of the growing demand for the institutionalization of global initiatives on environmental preservation. The Kyoto Protocol is a global agreement initiated under the United Nations Framework Convention on Climate Change, with the primary objective of reducing greenhouse gas emissions such as carbon dioxide, methane, nitrous oxide, sulfur hexafluoride, hydro fluorocarbons, and so forth. The protocol was first considered in 1997 in Kyoto, Japan and was implemented in 2005. The first commitment period for the protocol runs for 2008-2012 (United Nations Framework Convention on Climate Change [UNFCCC], 2008).

On the other hand, the United Nations Millennium Development Goals (MDG) is an agreement established in 2000. Of the eight goals of the MDG, the seventh goal corresponds to the call for sustainable development and environment conservation. A notable target of the said goal is to integrate the principles of sustainable development into country programs, and reverse the loss of environmental resources (MDG Monitor, 2007).

The rapid industrialization of East Asian countries has brought about environmental problems to the region (Peters & Murray, 2004). Such finding is obvious because as development accelerates, so too does the use of energy and resources (Asian Development Bank, 2008). Moreover, with an increase in the demand for resource inputs, substantial increases in pollution and greenhouse gas emissions are inevitable. In fact, with the fast pace of Asian industrialization, energy use in East Asia is expected to double over the next two decades. Therefore, it is expected that, by 2020, the East Asian region will surpass Organisation for Economic Co-operation and Development (OECD) countries as the largest source of emissions worldwide (Asian Development Bank, 2008). Furthermore, Guynup (2003) emphasized that East Asian pollutant emissions are already driving significant changes in the Earth's atmosphere. Thus, with the potential adverse impacts of East Asian pollution on global environmental quality, there is an imminent need for East Asian countries to act on the Kyoto Protocol and the Millennium Development Goal on Sustainable Development. There is, indeed, a growing urgency of attaining sustainable development in East Asia.

As implied earlier, the rapid economic growth of East Asian countries has brought about an increasing scale of pollutant emissions (Iwami, 2004). There is a growing question of whether or not development can coexist with environmental quality. Consequently, the objective of this article is to provide a survey of issues related to the growth-emissions relationship in selected East Asian countries. To do this, an overview of the Environmental Kuznets Curve (EKC) hypothesis is also exhibited. The EKC hypothesis postulates an inverted U-shaped relationship between environmental quality indicators and per capita income (Dinda, 2004). During initial stages of economic development, environmental degradation appears inevitable. However, further income increases will produce incentives for environmental conservation (Bhattarai & Hammig, 2004).

Besides national income growth, social and political factors could also influence the extent of pollutant emissions (Stern, 2003). Thus, another objective of this study is to explore the potential role of political institutions in achieving sustainable development. According to the World Commission on Environment and Development (1987), "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: (1) the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; and (2) the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs" (p. 43). In pursuit of such, this paper investigates whether socioeconomic factors like income, foreign direct investment, illiteracy rate, population growth, political freedom, and energy efficiency affect air pollution in East Asia.

In summary, this descriptive study provides slight focus on eight East Asian countries (Japan, South Korea, Singapore, China, Philippines, Thailand, Malaysia, and Indonesia). The results of this study are specific to the East Asian region. Conclusions cannot be generalized to other country groups, for example, OECD. Furthermore, due to data unavailability, this paper analyzes pollutant emissions only for the years 1980 to 2000. Only two measures of environmental quality, CO_2 and SO_2 emissions, are examined. Other measures of environmental degradation, for example, nitrous oxide emissions, heavy metal concentration, municipal wastes, deforestation, biochemical oxygen demand, and threatened species, are not analyzed. Lastly, the Gross Domestic Product of the East Asian countries is used to measure economic development. Other measures such as the Human Development Index and the Physical-Quality-of-Life Index are not utilized in this paper.

REVIEW OF RELATED LITERATURE

The Environmental Kuznets Curve (EKC) hypothesis states that, in the earliest stages of economic growth, pollution increases, but beyond some level of income, development leads to environmental improvement (Stern, 2004). The term "Environmental Kuznets Curve" was derived from Simon Kuznets' (1955) prediction that the relationship between income per capita and income inequality can be represented by a bell-shaped curve. In the 1990s and onwards, it was noted that the level of environmental degradation and per capita income follow the same concave relationship (Dinda, 2004). Thus, the Environmental Kuznets Curve was eventually formulated (Figure 1).

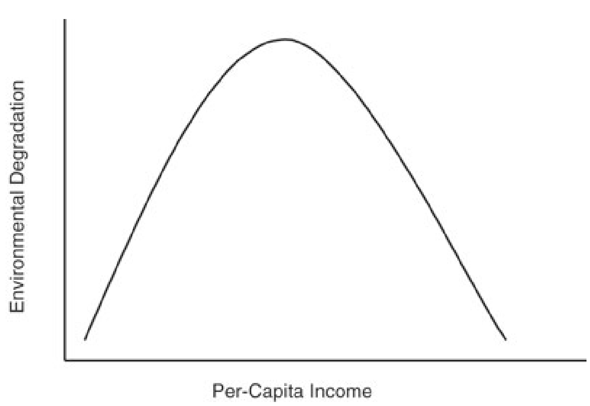

Figure 1. *The Environmental Kuznets Curve (Hayward, 2005).*

According to Ciegis, Streimikene, and Matiusaityte (2006), possible explanations for the EKC are seen in the following: (1) the progress of economic growth from agrarian economy to polluting industrial economy to clean, knowledge-based and service economy; and (2) the tendency of people with higher income having greater preference for better environmental quality. In addition, the EKC mechanism can be further explained by the scale, composition, and technological effects of income (Appendix B). The scale effect states that more output also implies more wastes as byproduct. However, such negative impact of economic growth is outweighed by the composition effect. The composition effect implies that environmental degradation starts to fall with structural change from energy-intensive industry to service- and knowledge-based technology-intensive industry (Dinda, 2004). Lastly, the technological effect indicates that, at the latter stages of economic development, countries learn to adopt cleaner technologies and management practices (Stern et al., 1996).

Several econometric studies on income growth and environmental quality have shown that some pollutants such as nitrous oxides and sulfur dioxide follow an inverse U-shaped functional relationship with economic growth (Bhattarai & Hammig, 2004). The first EKC study by Grossman and Krueger (1991) investigated the potential impact of the North American Free Trade Agreement (NAFTA). They pointed out an inverted-U relationship between pollutant emissions, for example, sulfur dioxide and smoke, and income per capita (Dinda, 2004). However, evidence of a Kuznetian relationship has not yet been consistently observed for other pollutants such as carbon dioxide and nitrates (Stern, 2003). For example, Shafik and Bandyopadhyay (1992), using OECD data, found that income has the most consistently significant effect on all indicators of environmental quality. However, though the EKC hypothesis holds for sulfur dioxide emissions, it was observed that municipal waste and carbon dioxide emissions per capita monotonically increase with rising income. Furthermore, findings on the significance of the pollutant emission-income relationship are rather conflicting. In some studies, it was shown that income is not a very significant variable in determining environmental quality. For example, Borregaard, Blanco, and Wautiez (1998) found that in Chile, non-income related and exogenous factors were more significant in affecting the extent of air pollution.

On the other hand, explanations on the possible effects of trade liberalization on environmental quality are offered by the Displacement Hypothesis and Pollution Haven Hypothesis (Appendix C). The Displacement Hypothesis states that trade openness will lead to more rapid growth of pollution-intensive industries in developing countries as the developed countries enforce stricter environmental regulations. Meanwhile, the Pollution Haven Hypothesis implies that lower trade barriers could damage the environment if heavy polluting businesses transfer to countries with poor regulatory institutions (Dinda, 2004).

Several empirical studies have already been done to examine the validity of the Pollution Haven Hypothesis. One of those is the study done by Gallagher (2006), it was noted that environmental degradation in Mexico could not be attributed to the presence of foreign direct investments. Rather, the author suggested that declining environmental quality in Mexico is due to its lax environmental regulations. Meanwhile, in assessing the impact of trade on the environment, Medalla and Lazaro (2006) looked at the share of the developing and developed countries in pollution-intensive industries by examining the pollution index of their imports and exports. The results revealed that exports and imports of environmentally hazardous commodities are concentrated in developed countries. They also noted that developing countries export less pollution-intensive goods.

However, the possible existence of havens was also found by past researches. An example is Akbostanci, Ipec Tunc, & Turt-Asik's (2007) study on the impact of dirty industries on Turkey's exports. Using fixed effects estimation techniques, it was noted that pollution has a positive and significant relationship with Turkey's exports. Meanwhile, in a paper written by McCarney and Adamowicz (2006), an interaction term to test the pollution haven hypothesis between the rich and poor countries was included in the model. Using data on emissions of CO_2 in 143 countries (1970-2000) and biochemical oxygen demand (1980-1995), the hypothesis of the paper is that the variable will have a negative sign for rich countries, indicating that relatively developed countries utilize trade to transfer pollution-intensive productions. The results show that there is indeed a possibility of the existence of pollution havens because of intensive trade.

Another explanation related to the pollutant emissions and growth nexus is the Advantage of the Latecomer Hypothesis. It states that latecomers attain lower levels of environmental damage than their industrial predecessors at the same income level (Iwami, 2005). It is assumed that the latecomers will learn from the cleaner and more efficient pollution abatement technologies employed by their predecessors. A study that tests the latecomer advantage and EKC hypotheses was done by Pang (2007). Pang assessed the impact of latecomer status in explaining economic and environmental deterioration issues in transitional countries in New Independent States and in Central and Eastern Europe. Applying the EKC hypothesis, it was found that not all latecomers could benefit from the latecomer advantage. It was implied that only those countries labeled as "medium latecomers" tended to benefit from being such in reducing both carbon dioxide and sulfur dioxide emissions (Pang, 2007).

Meanwhile, Iwami (2005) defined, for East Asian countries, the latecomer by a constant index of IS (industry share in GDP) in 1990 divided by IS in 1973. A large index indicates rapid industrialization between 1973 and 1990, denoting latecomer status. In his study, Iwami (2005) used the following three binary variables classifications. The medium latecomer dummy is equal to one only for countries with $1 <$ IS index < 1.5. The countries considered as medium latecomers are South Korea, Singapore, and the Philippines. On the other hand, the latecomers dummy was assigned unity for Malaysia, Thailand, and Indonesia because their index is greater than 1.5. Lastly, predecessor countries (base or benchmark group), that is, Japan, Taiwan, and China, represent the constant of the equation (IS index <1). Using Ordinary Least Squares estimation, Iwami (2005) noted that while the latecomers' dummy variable's coefficient exhibited a significant negative sign, the results for the medium latecomers' dummy variable failed to prove the latecomer advantage hypothesis.

Finally, besides traditional economic explanations, some studies on the EKC also considered using demographic and political factors as explanatory variables (Stern, 2003). In a study done on the United States, factors such as education and propensity for collective action are significant and negatively correlated with pollution, while pollution tends to be higher with increased population density (Khanna, 2001). The importance of the role and quality of institutions is further supported by Bhattarai and Hammig (2004). In their paper on the existence of an EKC involving tropical forests in developing countries, it was noted that the effect of education is negative and statistically significant. It can be attributed to the fact that improvement in human capital such as education can ultimately reduce pressures of deforestation in the tropics. In an institutional sense, improvement in education also means stronger environmental awareness, better enforcement and observance of policies, more public participation in the political process, and more knowledge of fossil fuel alternatives. Deacon and Norman (2004), meanwhile, emphasized the importance of strict policy implementation. To do that, they used proximate explanatory factors such as a "political freedom" index. Using the same index measure employed by Bhattarai and Hammig (2004), an index of 2 suggests least freedom, and an index of 14 implies that a country has the highest degree of political freedom. The "political freedom" index is created by adding each country's political rights and civil liberties indices. With these, they found that the variable representing political and civil rights was negatively correlated with deforestation. Lastly, Boyce and Torras (1998) concluded that lowering inequality within a country is necessary because it also affects other variables that have significant effects on the quality of the environment. Thus, they noted that efforts towards achieving more equitable power distribution can positively affect environmental quality.

To sum it all up, it is worth noting that only a few studies have been conducted to examine empirically the existence of an Environmental Kuznets Curve in East Asia. In their investigation on the relationship between economic development and urban air pollution in Asia, Peters and Murray (2004) found that the EKC exhibited an L-shape. Using graphical analysis, they suggested that the L-shaped curve could still be indicative of the traditional EKC's inverted-U shape. Such could be true if the "pre-pollution" stage is considered irrelevant. Meanwhile, a better empirical verification of the East Asian EKC is offered by Iwami (2004). Employing Ordinary Least Squares (OLS) estimation, he examined the effects of income, energy efficiency, and industrial structure on pollutant emissions. For both sulfur dioxide and carbon dioxide emissions, it was observed that the linear (positive) and squared income (negative), and energy efficiency (negative) have significant effects.

METHODOLOGY

The relationship between pollutant emissions and income is described using the East Asian countries indicated in Iwami's (2005) study. The eight East Asian countries included in this study are as follows: China, Indonesia, Japan, Malaysia, Philippines, Singapore, Thailand, and South Korea. Due to data constraints, this study will only cover the historical period from 1980 to 2000 (before the economic bubble and financial crises).

Cross-country statistics on pollutant emissions for 1980 to 2000 were obtained. For national carbon dioxide emissions (metric tons of CO_2 per capita), data sets were collected from the Carbon Dioxide Information Analysis Center's (CDIAC) *Trends Database on Global, Regional, and National Fossil Fuel CO_2 Emissions*. CO_2 emissions statistics were estimated using data from the combustion of fossil fuels, gas flaring, and the production of cement. In data estimation, it is assumed that CO_2 emission is proportional to fossil fuel consumption. Additional data were obtained from the Center for Global Environmental Research's (2007) East Asian Air Pollutant Emissions Grid Database. The data sources show only a small difference with each other (Iwami, 2004) because their measurement units for emissions are consistently similar. On the other hand, sulfur dioxide emissions (kilograms SO_2 per capita) were obtained using the data sets compiled by Professor David Stern (2006). His database on sulfur emissions in East Asia was primarily compiled using statistics from Carmichael et al. (2002) and Streets, Tsai, Akimoto, & Oka (2000). Sulfur dioxide emissions were determined using data from energy consumption and source, multi-industry reports, sulfur monitoring stations, and end-of-pipe abatement technology. The methodology for pollution data estimation is summarized by the flowchart (Figure 2) provided by the Center for Global and Regional Environmental Research (2002). For further discussion on pollutant emission data estimation, see Appendix D.

Lastly, purchasing power parity-adjusted Gross Domestic Product (GDP) per capita, in constant 2005 international $, is used as national income measure. These data are obtained from the World Bank Development Indicators website. As the theory of the EKC suggests, it is expected that the GDP per capita variable is positive, and the coefficient of the squared GDP per capita term is negative (Stern, 2004).

RESULTS AND DISCUSSION

This section provides qualitative observations related on the growth-emissions relationship in selected East Asian economies. Due to data constraints, using the historical time period from 1980 to 2000, the full sample includes the following East Asian countries: China, Indonesia, Japan, Malaysia, Philippines, Singapore, South Korea, and Thailand.

Average annual GDP per capita for the sample ranges from $1,342, which is for China, up to $24,397, which is for Japan. The complete ranking

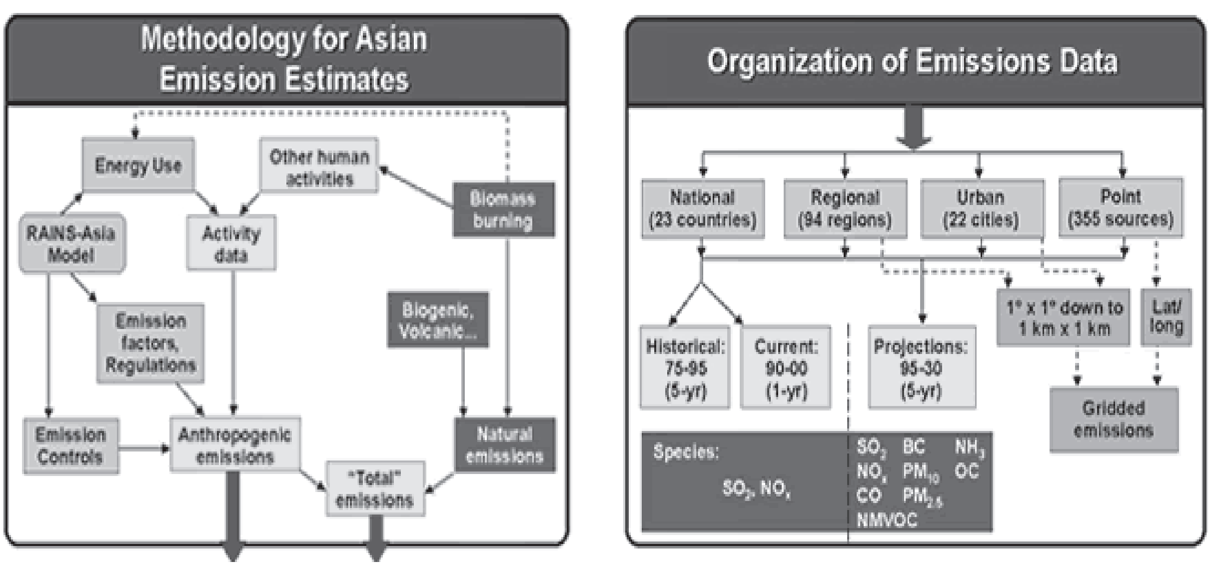

Figure 2. *Methodology for pollutant emission estimation.*

is shown in Table 1 (the country ranked 8th has the lowest average GDP per capita from 1980 to 2000, while the country ranked 1st has the highest average GDP per capita).

Figure 3 represents the average GDP per capita of each East Asian country from 1980 to 2000. Meanwhile, the growth trends of GDP per capita in East Asia are presented in Figure 4. From the said graph, significant gains in GDP per capita are noticeable. From 1980 to 2000, average GDP per capita increased by almost 114%. Except for a decline in 1997 to 1999 due to the Asian financial crisis, East Asia has experienced sustained annual increases in average income since 1980.

On the other hand, the average annual carbon dioxide emissions per capita for the sample range from 0.77 metric ton, which is for the Philippines, up to 13.54 metric tons, which is for Singapore. The complete rankings are shown in Table 2 (the country ranked 8th has the lowest average carbon dioxide emissions per capita from 1980 to 2000, while the country ranked 1st has the highest average carbon dioxide emissions per capita).

Table 1

Ranking of Sample Countries according to Average Annual GDP per Capita, 1980-2000

Rank	Country	Average Annual GDP per capita (adjusted US$, 2000 base year)
1	Japan	24397
2	Singapore	24012
3	South Korea	10831
4	Malaysia	7305
5	Thailand	4119
6	Philippines	2442
7	Indonesia	2133
8	China	1342

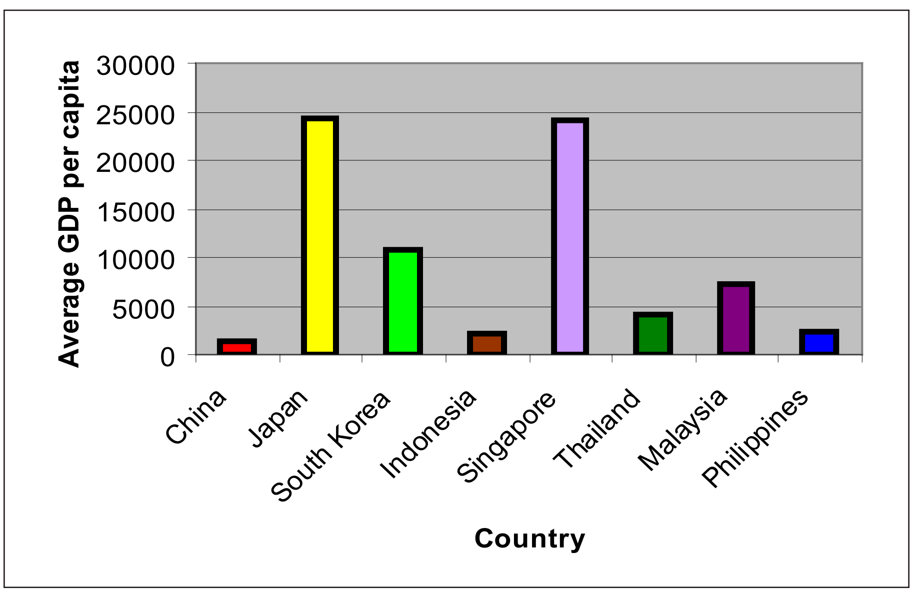

Figure 3. *Average annual GDP per capita of each country, 1980-2000.*

Table 2

Ranking of Sample Countries According to Average CO_2 Emissions per capita, 1980-2000

Rank	Country	Average annual CO_2 emissions per capita
1	Singapore	13.54
2	Japan	8.39
3	South Korea	5.98
4	Malaysia	3.62
5	China	2.13
6	Thailand	1.97
7	Indonesia	1.13
8	Philippines	0.77

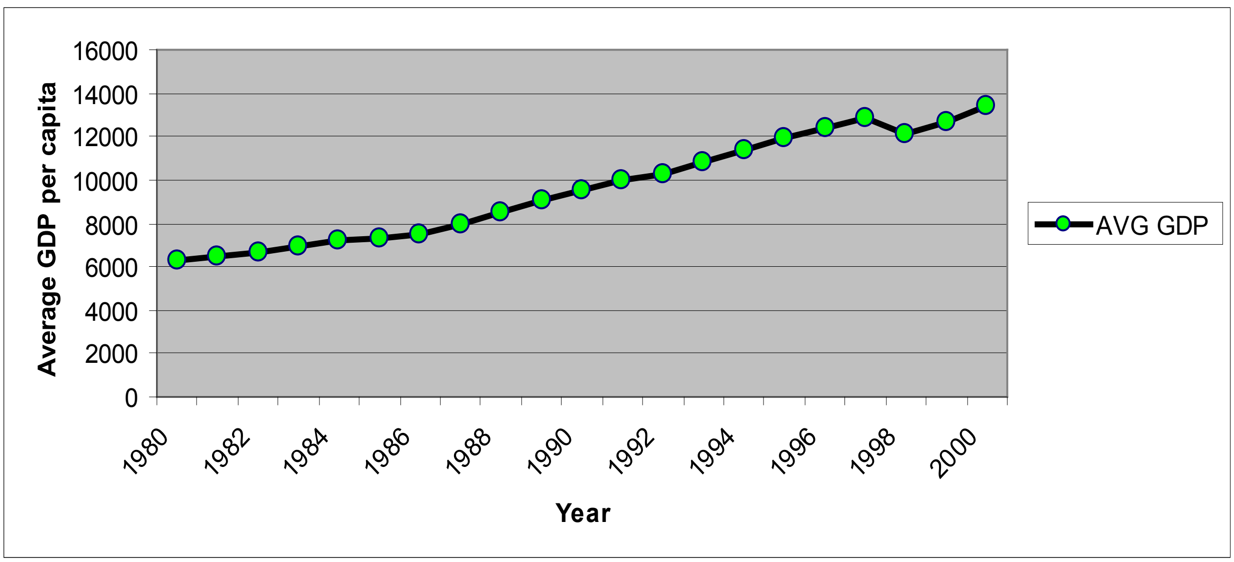

Figure 4. *Overall average annual GDP per capita of East Asian countries, 1980-2000.*

Figure 5 shows the average CO_2 emissions per capita for each country from 1980 to 2000. From the graph, we could see that CO_2 emissions in East Asia can be significantly different among countries. For example, the country with the highest CO_2 emissions, Singapore, has a value which is 17.4 times higher than the country with the lowest CO_2 emissions, which is the Philippines. Meanwhile, Figure 6 presents the average per capita CO_2 emissions in East Asia across time. From 1980 to 2000, average per capita CO_2 emissions increased by about 59%. Again, as the mentioned GDP decline implies, the 1997 Asian financial crisis seems to have an effect on pollution. The existence of the financial crisis might have prompted governments to lessen efforts on projects related to environmental regulation. Indeed, a peak in CO_2 emissions is observed during the financial crisis (Figure 6).

As for average annual per capita sulfur dioxide emissions, the sample values range from 83.12

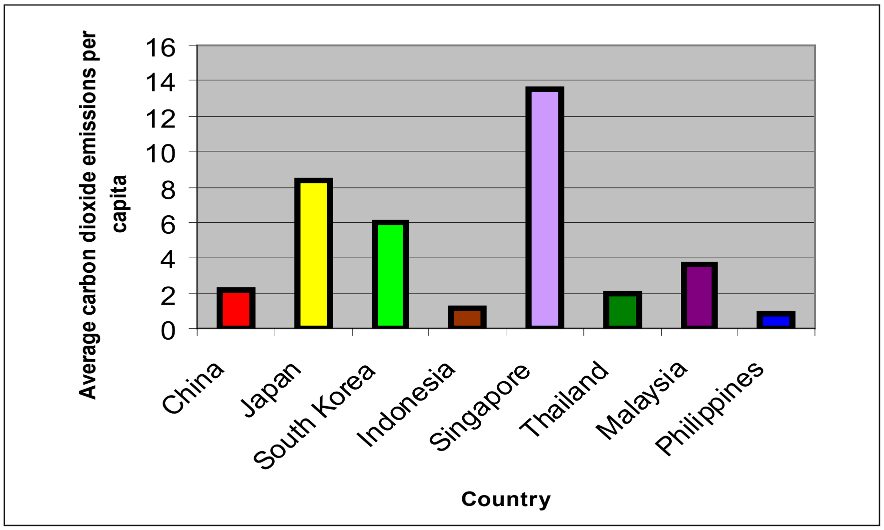

Figure 5. *Average annual CO_2 emissions per capita of each country, 1980-2000.*

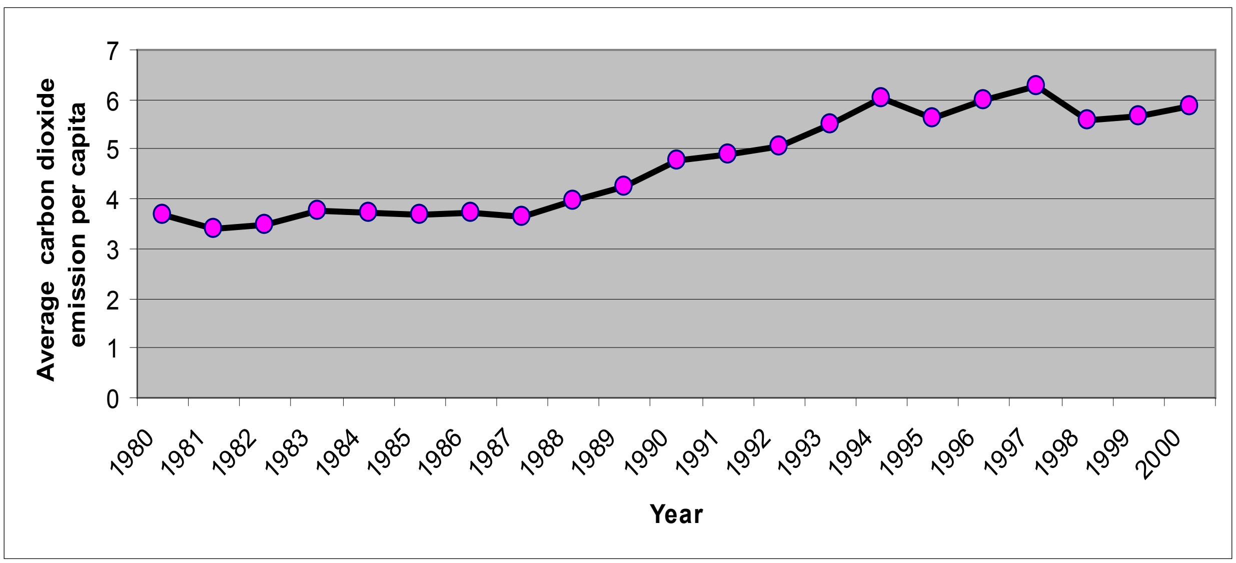

Figure 6. *Overall average annual CO_2 emissions per capita of East Asian countries, 1980-2000.*

metric tons, which is for Singapore, up to 8,980.96 metric tons, which is for China. The complete ranking is shown in Table 3 (the country ranked 8 has the lowest average sulfur dioxide emissions per capita from 1980 to 2000, while the country ranked number 1 has the highest average sulfur dioxide emissions per capita). Figure 7 shows the average SO_2 emissions per capita for each country from 1980 to 2000. From the graph, we could see that SO_2 emissions in East Asia can be significantly different among countries. For example, the country with the highest SO_2 emissions, China, has a value that is approximately 108 times than the country with the lowest SO_2 emissions, which is Singapore. Meanwhile, Figure 8 indicates the average per capita SO_2 emissions in East Asia across time. Figure 8 implies that SO_2 emissions are not monotonically increasing over time. There has been an observable peak in SO_2 emissions in 1997, during the Asian financial crisis. It is also worth noting that from 1980 to 2000, average per capita SO_2 emissions increased by approximately 46%.

Table 3

Ranking of Sample Countries According to Average SO_2 Emissions per capita, 1980-2000

Rank	Country	Average SO_2 emissions per capita
1	China	8980.96
2	South Korea	605.22
3	Japan	473.59
4	Thailand	395.93
5	Indonesia	285.28
6	Philippines	240.69
7	Malaysia	109.89
8	Singapore	83.12

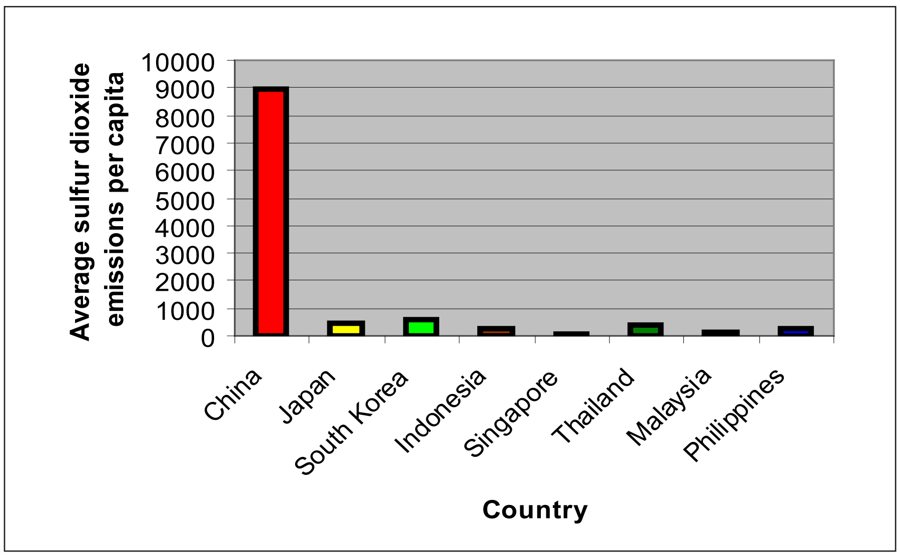

Figure 7. *Average annual SO_2 emissions per capita of each country, 1980 to 2000.*

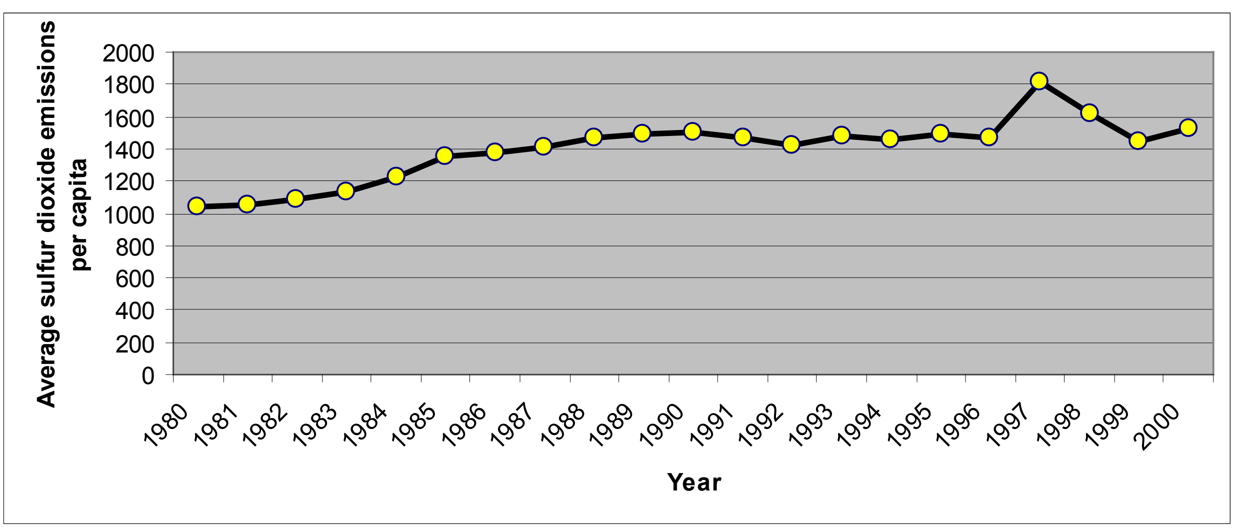

Figure 8. *Overall average SO_2 emissions per capita of East Asian countries, 1980-2000.*

CONCLUSIONS AND POLICY RECOMMENDATIONS

This article is a qualitative inquiry on the state of environmental quality and economic development for a sample of East Asian countries. In this descriptive research, it has also been briefly shown that economic, political, demographic, and temporal variables contribute to environmental degradation.

Indeed, the shape of the income-environment relationship demonstrated by the Environmental Kuznets Curve has critical policy implications (Borghesi, 1999).From the survey of literature of this study, it is logical to state that current environmental degradation might only be temporary. It is possible for a country to outgrow its environmental problems in the long run. Though such might be true, the process described in the EKC might be a long one. It might not be a fast, automatic process. Hence, income growth alone cannot suffice to ensure that environment policy targets will be attainable (Lankoski, 1997). There may be other factors necessary for the attainment of sustainable development. The social and institutional factors that affect the environment also have crucial policy implications (Bartoszczuk, Ma, & Nakamori, 2008). For instance, trade policies have colossal impacts especially if the economy is highly dependent on trade.

Determining suitable policies that must be employed is valuable especially if both short-term and long-term effects are being considered. In terms of the economy's sectoral composition and the manufacturing industry as the product of transition, the neo-institutional perspective believes that the political and environmental management techniques of firms vary from the manipulation of environmental demands to the neglect of environmental issues. The action will depend on the stage of the policy process and the strength of the implementation of the environmental measures and policies (Rivera, 2004; Oliver, 1991).

The governing agency must also possess the capacity to engage in strategic planning, monitoring, and control of private sector activities, at the same time having the ability to mobilize economic resources (Ehrhardt-Martinez, Crenshaw, & Jenkins, 2002). Command-and-control regulations are still effective. However, incentive-based and cooperative mechanisms must also be engaged towards more involvement of firms and businesses in both economic and environment goals of the government.

Indirect policies, such as population control, and intervention on other social factors, such as density of the population and quality of the bureaucratic apparatus, must be complemented with more direct ones that focus on rewards to acclimatize cleaner technologies using environmental corrective taxes and subsidies. Achievement of several social goals is then essential towards environmental sustainability. Policies must also include physical measurement of the resources and other environmental indicators since each has a different relationship with the development of the economy. It will be helpful for policy-makers if the economy is still operating in a sustainable degree (Cole, 1999).

Aside from the initiatives encompassing the local level, the differentiation between pollutants accumulated in a global scale is also crucial. It supports the need for multilateral agreements to discuss on pollutants with global brunt and arrive at actions to solve environmental degradation globally (Cole, 1999). The increased integration of the global economy also leads to the difficulty in setting aside international consequences of domestic environmental policies and the institutionalization of efforts to advance environmental protection. This kind of situation dictates that negotiated agreements wherein the foreign country uses environmental policy instruments to target pollution plus some mechanisms of transfer is still the first best policy (Copeland & Taylor, 2003).

Emissions trading is an example of such a tool, which is now widely adopted especially in compliance with the Kyoto Protocol. It operates by giving companies and countries quotas on the level of emissions that they can accrue. However, the mechanism also offers flexibility since it also allows the participating actors to emit in excess of their allocation allowances by purchasing them elsewhere. This can be done by carrying out projects with other developed countries or installing them in less-developed countries that will somehow compensate for the excessive emissions. On the other hand, countries that have surplus allowances can sell them to other participants in the agreement. Such equitable burden sharing rules provide enticement for countries to join and ratify (Bosello, Buchner, Carraro, & Raggi, 2001).

Overall, despite the widespread debates on the validity of the Environmental Kuznets Curve hypothesis and its use as a tool for policy-making or whether countries must be after sustainable development, what is guaranteed is that the materialization of environmental quality improvement anchors on government policies, social institutions, and the behavior of markets (Yandle, Vijayaraghavan, & Bhattarai, 2002). Undoubtedly, environmental interventions must still be put into place as adjunct to economic growth. Investment and policy initiatives must still be put into actuality (Cole, 1999). A distinction must also be made between policy responsiveness and policy capacity. It is only in the presence of both responsiveness and capacity that efforts in improving the quality of the environment will be greatest (Ehrhardt-Martinez et al., 2002). While pushing for economic progress, we must not miscalculate man's capability of adaptation to surpass ecological problems. Coherent programs for sustainability must be put into motion.

Finally, this paper recommends other paths of future research. An intensive econometric analysis on the existence of the Environmental Kuznets Curve is recommended. It is suggested that other environmental measures like water quality, biological oxygen demand, nitrous oxide, and heavy metal concentration be examined as well. Another recommendation is the exploration of the role of other socioeconomic variables such as income inequality, information access (e.g., number of people with phone and internet access in a country), and vehicle ownership. Some macroeconomic variables like research expenditures and exchange rate can also be used. The use of other measures of development, for example, the Human Development Index, is also recommended.

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APPENDICES

APPENDIX A

The Kyoto Protocol and the Millennium Development Goal on Sustainable Development

The Kyoto Protocol is a global agreement initiated under the United Nations Framework Convention on Climate Change with the primary objective of reducing greenhouse gases emissions which includes carbon dioxide, methane, nitrous oxide, sulfur hexafluoride, hydrofluorocarbons. and perfluorocarbons. The protocol was first considered on December 11, 1997 in Kyoto Japan and was implemented on February 16, 2005. A sum of 182 countries signed and ratified the protocol, 36 countries are developed that also include the European Union and 137 are developing countries. The first commitment period for the Kyoto protocol runs from the period 2008-2012 (UNFCCC, 2008).

The provisions of the Kyoto protocol are based on "common but differentiated responsibility". By this, it means that different countries will have varied tasks and targets; however, the tasks and targets are all directed towards the reduction of greenhouse gases emissions, which is the goal. The countries under the protocol are classified into Annex I countries composed of developed countries including the EU and the developing countries forming the Annex II. The Annex I countries acknowledged greenhouse gases reduction obligations (which also varies for each country) and submit annual emissions inventory for monitoring, the first report to be passed in 2010 (Environment Canada, 2008). The Annex II countries, on the other hand, have no specific emissions obligations but may participate in the mechanisms of emission trading as stated in the protocol. The said categorization of countries was agreed upon because foremost, the parties believe that the colossal historical share and the present global emissions of greenhouse gases have been accumulated by the developed economies. Developing countries have also a relatively low share on per capita emissions in comparison with the share of the industrialized countries and third, in the course of economic transition and development of the developing countries, their accretion of emissions will grow in response to their rising development and social needs (UNFCCC, 2008). On the average, the countries under Annex I should reduce their greenhouse gases emissions by 5% at the end of the first commitment period. Countries that fail to comply with the stated countries will have to submit 1.3 emission allowances on the subsequent commitment period for every ton of gas emission accrued in excess. To meet their quotas, Annex I countries can engage in several kinds of flexible mechanisms of emissions trading. Countries and individual companies, which are the ultimate buyers of emission credits, can engage in the trading if they anticipate that the emissions they will generate will exceed the quota. This can be done either by Joint Implementation (JI) or Clean Development Mechanism (CDM). The mechanism of Joint Implementation allows industrialized nations to carry out joint projects with other developed economies. Countries can also invest on sustainable development projects that reduce emissions in developing countries to compensate for their unmet reduction obligations through the Clean Development Mechanism (United Nations Development Programme [UNDP], 2008). CDM can range from installation of solar panels in the rural communities located in developing countries to investments in energy-efficient technologies of production. Greenhouse gas projects carried out in the Annex II countries earn carbon credits that can be sold in the world market.

Through the emissions trading mechanisms of the Kyoto Protocol, sustainable development in both developed and developing countries are motivated mainly through technology transfer and investment flows. It enables Annex I countries who find it costly to achieve their commitments to invest in environment projects elsewhere instead of reducing the emissions domestically. Also, both the private sectors and the industrialized countries are encouraged to contribute to the emission reduction efforts subjected not only in its territory, rather encompassing a broader scope. Annex II countries; on the other hand, can attain sustainable development in a cost-effective and environment-preserving approach through the investment flows from the sale of carbon credits, at the same time, derive benefits from the Greenhouse Reduction Projects of the Annex I countries.

Another imperative endeavor that affirms and formalizes the role of nations in strengthening the economy and at the same time, improving environmental quality is the United Nations Millennium Development Goals (UN MDG) characterized by eight goal-action plans. The agreement was established in 2000 during the Millennium Summit with 189 world leaders. The goals are believed to be achievable by 2015. Of the eight goals of MDG, the seventh goal (goal 7) corresponds to the call for sustainable development and environment conservation. The four targets are to 1) Integrate the principles of sustainable development into country policies and programs and reverse the loss of environmental resources; 2) Reduce biodiversity loss, achieving, by 2010, a significant reduction in the rate of loss; 3) Halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation; and 4) By 2020, to have achieved a significant improvement in the lives of at least 100 million slum dwellers (MDG Monitor, 2007). Some of the indicators in use towards achieving the goal of environmental sustainability are land areas covered by forests, energy use of countries and carbon emissions, use of solid fuels, proportion of population with access to clean water source, and improved sanitation and proportion of population living in a secured tenure (International Labor Organization [ILO], 2008). The United Nations, in the pursuit of the goal 7 of the MDGs, believes that economic and social well-being is tantamount to environmental sustainability (UNDP, 2008).

Aside from the global efforts to improve the water quality and sanitation, which are primary concerns, the MDG goal 7 also adopted carbon emission reduction measures in connection to the goals and mechanisms of the Kyoto Protocol. In response to the global call of emissions reduction, one of the instruments of the MDG goal 7 are the carbon facilities that aims for the commercialization of emissions reduction projects primarily directed to developing countries (UNDP, 2008). The same mechanisms such as Joint Implementation and Clean Development Mechanism are in place. Schemes directed to the realization of environmental sustainability in developing countries where the poorest of the poor lives are relevant apparatus that gears towards the attainability of the other MDG goals such as poverty eradication and global partnership in development through fully market-enabled environment (UNDP, 2008).

The Kyoto Protocol and the Millennium Development Goals are indications of the growing demand for the institutionalization of global initiatives on environmental preservation. Because the two initiatives are still in their early stages of implementation and observance, little can be said about the effectiveness of the mechanisms that they employ. However, the Kyoto Protocol and goal 7 of the MDGs are indications of the emerging awareness of countries in the world of the different environmental issues. The pressure of abiding to these agreements is also pressing especially on the developed nations having not only responsibilities one's own country and people but also to the rest of the global community. Improvements in policies and programs are being intensified to adjust to the demands of the stated global initiatives (Capdevila, 2007).

APPENDIX B

The Scale, Composition, and Technology Effects in the EKC

There are three mechanisms responsible for the shape of the environmental Kuznets curve. The first is known to be the scale effect, which states that as output and scale of production are expanded, environmental degradation (i.e., amount of pollution emission, natural resources depletion) also becomes faster, ceteris paribus. A negative relationship thus exists between economic growth and environmental quality at all income levels. A 1% increase in production is assumed to be proportionally equivalent to 1% increase in emissions (Stern, 2003). Such is inevitable in the first stages of development but it can be offset by either the technical or the composition effect. The composition (output mix) effect, on one hand, is the mechanism by which increase in income can bring a change in the output produced by an economy and the economic structure. At different levels of economic improvement, this mechanism implies that countries will also have varied environmental concerns. The composition effect will shift production towards environmentally beneficial or damaging goods, depending on the comparative advantages of the countries (McCarney & Adamowics, 2006). The technological effect indicates that, at the latter stages of economic development, countries learn to adopt cleaner technologies and management practices. That is, with high incomes, they already have the ability to reduce environmental damage per unit of input or output (Stern, Common, & Barbier, 1996).

APPENDIX C

The Pollution Haven Hypothesis and the Displacement Hypothesis

Trade liberalization, as economic theories suggest, increases wealth. The displacement hypothesis and pollution haven hypothesis are two related assumptions that are central themes in the composition effects of trade in developed and developing countries (Dinda, 2004). As the theory suggests, the trade-induced composition effect is captured by the trade intensity, which is the ratio of imports and exports to GDP. Therefore, a change in the composition of the economy or the domestic output is a function of the trade intensity (Antweiler, Copeland, & Taylor, 2001).

The displacement hypothesis holds that trade liberalization leads to the displacement of environmental effects from one country to another rather than being lowered or reduced (Dinda, 2004). As an economy develops, its export of polluting commodities will decrease, in effect, displacing the environmentally degrading activities to other countries. Meanwhile, the pollution haven hypothesis is a related and an extension of the aforementioned hypothesis. Its central argument is that due to trade liberalization, pollution-intensive industries tend to transfer to countries with relatively less stringent environmental regulations. The hypothesis is corollary to the theory of comparative advantage: the countries specialize and take advantage of their relatively abundant factor endowment to gain competitiveness in the international economy (Akbostanci, Ipec Tunc, & Turut-Asik, 2004). The difference in specialization that leads to trade is derived from the fact that in developed countries, cleaner environment is demanded while in developing countries, increased employment, investment, and higher income is more valued than environment quality. Because of the comparative advantage of developing countries in the production of pollution-intensive commodities, industries are attracted by lax regulations and lower pollution costs in the said countries coined to be the "havens". On one hand, a simultaneous trade-induced composition effect for developed countries is positive as their domestic output change from pollution-intensive (such as manufacturing) to productions that are environmentally efficient such as services. For the developing countries, the contrast is true.

With this, what happens is the "race to bottom" phenomenon because the large decrease in the quality of the environment of a haven cannot be compensated by the rise in income.

APPENDIX D

Carbon Dioxide and Sulfur Dioxide Data Estimation

According to Marland, Boden, & Andres (2008), national carbon dioxide emissions are estimated from detailed data on emission sources, using source-specific emission factors. CO_2 emission estimates are derived primarily from energy statistics published by the United Nations using the methods of Marland and Rotty (1984). The energy statistics were compiled primarily from annual questionnaires distributed by the United Nations Statistical Office and supplemented by official national statistical publications. As for sulfur dioxide emissions data, estimation procedures were discussed by Streets et al. (2000) and Carmichael et al. (2002). As mentioned in their papers, measurement of gaseous sulfur dioxide is employed using IVL passive sampler technology (Carmichael et al., 2002). Accurate estimates were obtained using an "extrapolation of a detailed 1990 inventory, which was constructed as part of the World Bank's RAINS-Asia project, using IEA energy use data" (Streets et al., 2000, p. 4413). Furthermore, high resolution data estimates were interpolated from the RAINS-Asia computer model. Such estimation is consistent with that of the Center for Global Environmental Research (2007). Accordingly, the major basis for determining sulfur dioxide emissions is the proportional percentage of sulfur content in fuel.