Trade Openness, Economic Growth, and Environmental Degradation in Asian Developing Countries

Thao Duong
Kalamazoo College

Patrik T. Hultberg
Kalamazoo College

This paper examines the effects of trade openness and economic growth on CO_2 emission using a theoretical trade model. The theoretical results indicate that an increase in trade openness intensifies environmental degradation, while an increase in imports may result in advancement of technology that has positive effect on environmental quality, implying a possible existence of the Environmental Kuznets Curve (EKC). This paper explores these findings using panel data framework based on annual data from Asian developing countries (1986-2013). The empirical results show that trade openness and economic growth intensify CO_2 emission. However, the results do not validate the EKC.

INTRODUCTION

Over the last few decades, globalization has opened the door to the increase in the scale, volume and efficiency of international trade. Today countries trade with one another more frequently and more intensively than at any time in the past. Trade liberalization has been a powerful means for nations, specifically developing countries, to foster economic growth and development (Manni and Afzal, 2012). International trade is an opportunity to stimulate economic growth by earning foreign exchange through exports and gaining capital goods and materials necessary for rapid growth through imports. As a group, developing countries have increasingly strengthened their positions in world trade, accounting for 42 percent in world merchandise trade (World Trade Organization, 2016). In fact, many developing countries have concentrated on manufacturing sectors as a source of comparative advantage to compete against developed countries. Developing countries account for approximately 50 percent in world manufacturing export (UNCTAD, 2014). Along with the increasing share of exports, substantial increases in imports provide developing countries resources needed for further economic development. This progress of integration has been especially successful for a number of nations in Asia.

Economic development that depends largely on natural resources and that discounts the importance of sustainability degrades the environment. Excessive use of finite resources and neglect of sustainable development may lead to severe environmental degradation. Under trade openness developed countries with stringent environmental regulations may shift production towards cleaner industries and relocate polluting manufacturing to developing countries with cheaper labor and lax environmental regulations. Developing countries take advantage of their cheap labor and natural resources to compete in the world economy, thereby fostering economic growth and development at the expense of environmental quality.

Theoretical studies have addressed the effects of trade openness and economic growth on environmental performance. Similarly, a growing number of empirical studies have examined the determinants of CO_2 emission across countries. However, the relationship between trade openness, economic growth and environment remains inconclusive. The predicted inverted U-shaped relationship between economic growth and environmental pollution, the Environmental Kuznets Curve (EKC), has been investigated but results show a lack of consensus. As suggested by Keho (2015), different countries show various patterns between carbon dioxide emission and its determinants, including economic growth and trade liberalization. Acknowledging the importance of stages of development, structure of the economy, climate conditions and environmental regulations, this paper focuses on the group of six developing countries in Asia, China, India, Indonesia, Malaysia, Thailand, and Vietnam.

Openness to the global economy is the central reform policy of several developing countries, including the six countries examined in this paper. After trade liberalization reforms, these nations have emerged as manufacturing-intensive nations and experienced rapid economic growth and development. However, these nations opened up to trade without the enforcement of stringent environmental regulations. The absence of environmental management has consequently resulted in severe environmental degradation and alarmingly high level of pollutions. In the study "State of Global Air, 2017: A Special Report on Global Exposure to Air Pollution and its Disease Burden (2017)," the Health Effects Institute reveals that China and India have the world's deadliest air pollution due to rapid industrialization. Similarly, Indonesia, Malaysia, Thailand, and Vietnam dominate the air pollution ranking in the world with high Pollution Indexes above WHO guidelines. Since these six countries are predicted to continue strengthening their leading positions in world trade, experts are warning of deadly and costly increase in environmental deterioration and public health in the near future (Kojima and Michida, 2011).

This concern raises questions on the relationship between trade openness, economic growth and environmental damage in China, India, Indonesia, Malaysia, Thailand, and Vietnam. In particular, is trade openness a key factor driving CO_2 emission in these countries? To what extent do trade openness and economic growth affect environmental quality? How can the government obtain sustainable growth and development by reducing CO_2 emission without harming the prosperous economic growth? This paper attempts to answer these questions by developing theoretical and empirical models.

The next section presents and analyzes the theoretical model and its results. The following section discusses the empirical model and its results. Based on the findings of both theoretical and empirical models, the section offers some policy implications. The final section offers some concluding remarks.

THEORETICAL MODEL

To explore the relationship between trade openness and environmental degradation, the paper presents a simple model in which the optimal environmental policy can be established. To clearly discuss the impact of trade, optimal environmental policy is derived for a closed economy as well as for both exporting and importing nations.

Environmental Degradation in a Closed Economy

This illustrative case assumes a perfectly competitive market with the existence of negative production externality. In the absence of government intervention, the price automatically adjusts to balance market demand and supply. However, the government intervenes by setting an optimal emission tax, *e*, with the view of maximizing the nation's welfare or total surplus which includes consumer surplus (CS), producer surplus (PS), government revenue (R), and environmental degradation (ED):

$$TS = CS + PS + R - ED \tag{1}$$

In a perfectly competitive closed market, there exists an equilibrium price (p^*) and an equilibrium quantity (q^*); that is, the quantity that consumers are willing to buy (q^c) equals the quantity of good that producers are willing to sell (q^p), $q^*=q^c=q^p$.

Let the supply curve be $p = cq$ and the demand curve be $p = a\text{-}bq$. Consumer surplus and producer surplus are expressed in the following forms:

$$CS = \frac{[a-(a-bq^*)]\times q^*}{2} = \frac{bq^{*2}}{2} \tag{2}$$

$$PS = \frac{cq^*\times q^*}{2} = \frac{cq^{*2}}{2} \tag{3}$$

Assuming the government takes environmental damage into account by collecting government revenue (R) according to the optimal emission tax (e) and the number of production outputs (q^*), R has the following expression: $R = eq^*$

Environmental degradation accounting for the waste produced by firms is assumed to be an exponential function, so that: $ED = \gamma q^{*2}$. That is, total environmental damage increases exponentially with the level of output. Thus, marginal environmental degradation (MED) is a linear and increasing function, $MED = 2\gamma q^*$. According to the expression of the marginal environmental degradation, it is clear that for each additional unit of outputs, environmental damage increases by $2\gamma q^*$.

The firm aims to maximize profit at output levels by setting marginal revenue (MR) equal to marginal cost (MC), which implies that the optimal quantity takes the form:

$$q = \frac{a-e}{b+c}. \tag{4}$$

Given that $q = \frac{a-e}{b+c}$, the partial derivative of q with respect to e is given by:

$$\frac{\partial q}{\partial e} = \frac{-1}{(b+c)}. \tag{5}$$

Given the expressions of all the components of nation's welfare, the total differentiation with respect to e can be performed:

$$TS = \frac{bq^{*2}}{2} + \frac{cq^{*2}}{2} + eq^* - \gamma q^{*2}$$

$$\frac{\partial TS}{\partial e} = (\frac{2bq^*}{2})\left(\frac{\partial q}{\partial e}\right) + \left(\frac{2cq^*}{2}\right)\left(\frac{\partial q}{\partial e}\right) + e\left(\frac{\partial q}{\partial e}\right) + q - 2\gamma q^*\left(\frac{\partial q}{\partial e}\right) = 0$$

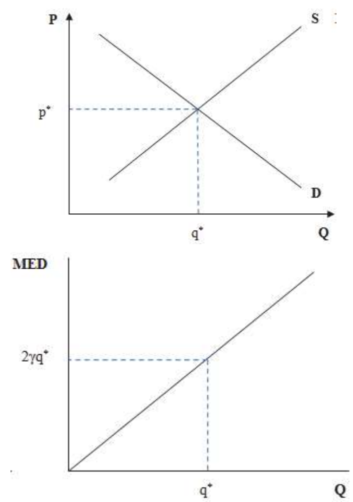
$$\frac{\partial TS}{\partial e} = bq^*\left(\frac{-1}{b+c}\right) + cq^*\left(\frac{-1}{b+c}\right) + e\left(\frac{-1}{b+c}\right) + q - 2\gamma q\left(\frac{-1}{b+c}\right) = 0$$

$$e\left(\frac{-1}{b+c}\right) - 2\gamma q\left(\frac{-1}{b+c}\right) = 0 \tag{6}$$

Thus, $e = 2\gamma q^*$

In a closed economy, as expected, the optimal emission tax (e) at the equilibrium output level is equal to the marginal environmental degradation (MED). Therefore, if the government aims to maximize the nation's welfare, the optimal emission tax would be exactly equal to the marginal environmental degradation at the equilibrium output, q^* (see Figure 1).

FIGURE 1
EQUILIBRIUM AND MARGINAL ENVIRONMENTAL DEGRADATION
IN A CLOSED-ECONOMY



Environmental Degradation in an Open Economy (The Case of an Exporting Country)

This section extends the previous case by assuming an open economy; in particular, an exporting nation. An exporting nation will face the world price, which is higher than the price in the domestic market (in autarky). Due to a more favorable world price, domestic firms will prefer to export until the (potential) shortage brings the domestic price up to the world price. Access to world markets, as well as the higher price, leads to greater production domestically. The increase in production in turn leads to greater environmental damage. The question is what the impact of trade openness is on the optimal environmental policy.

In an open economy, equilibrium will not lead quantity consumed (q^c) to be equal to quantity produced (q^p) since the quantity produced by the exporting nation is consumed by both domestic and foreign buyers. Thus, consumer surplus and producer surplus are expressed in the following forms:

$$CS = \frac{b{q^c}^2}{2} \tag{7}$$

$$PS = \frac{c{q^p}^2}{2} \tag{8}$$

With the view of maximizing the nation's welfare, the government chooses an environmental tax that maximizes total surplus, including government revenue, $R = eq^P$, and environmental damage, $ED = \gamma {q^p}^2$.

Our supply and demand curves are as before, however, the impact on supply from an environmental tax differs significantly from the impact on demand; in fact, access to the world market ensures that consumers will not be affected by the environmental (production) tax. These results are shown in the following equations: $q^P = \frac{p_w - e}{c}$ and $q^C = \frac{a - p_w}{b}$, where p_w is the world price. Given these equilibrium quantities, the partial derivative of q^P and q^C with respect to e is given by:

$$\frac{\partial q^p}{\partial e} = \frac{-1}{c} \tag{9}$$

$$\frac{\partial q^c}{\partial e} = 0. \tag{10}$$

Total differentiation of the exporting nation's total surplus, then yields

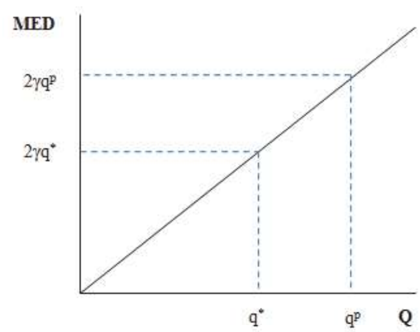
$$\frac{\partial TS}{\partial e} = bq^c\left(\frac{\partial q^c}{\partial e}\right) + cq^p\left(\frac{\partial q^p}{\partial e}\right) + q^p + e\left(\frac{\partial q^p}{\partial e}\right) - 2\gamma q^p\left(\frac{\partial q^p}{\partial e}\right) = 0, \tag{11}$$

which simplifies to $e = 2\gamma q^p$.

The optimal emission tax collected by the government equals the marginal environmental degradation which increases by $2\gamma q^p$ for each additional output produced by exporting countries. At first glance, the emission tax of an open economy is similar to that of a closed economy. However, once the nation is open to exporting, the quantity produced in the open economy is significantly higher than the quantity produced in a closed economy. Consequently, the total environmental damage produced in an open economy is greater than in a closed economy. Indeed, the more the exporting country produces, the higher marginal and total environmental damage become.

Figure 2 illustrates the marginal environmental damage of a closed economy with equilibrium quantity produced (p^*) and an opened economy with quantity produced (q^p). The results of the theoretical model show that exporting-intensive countries create environmental damage greater than closed-economy counterparts. Thus, in the case of an exporting country in an open economy, it is critical for the government to choose its optimal emission tax corresponding to marginal environmental damage in order to maximize the total surplus of the country, as well as the world's welfare.

FIGURE 2
MARGINAL ENVIRONMENTAL DEGRADATION IN AN OPEN EXPORTING ECONOMY



Environmental Degradation in an Open Economy (The Case of an Importing Country)

In the case of an importing nation, the relevant market failure is a negative consumption externality. In this illustrative case, the world price is below the domestic (autarky) price, so that the nation imports goods from abroad. The quantity consumed is thus greater than domestic production and, importantly, greater than the quantity consumed prior to trade. Consequently, environmental degradation due to high levels of consumption becomes an alarming issue. The question is thus, what is the optimal environmental policy in this case.

All previous assumptions remain, except that in this case quantity consumed depends on the environmental tax, while quantity produced domestically does not (because the drop in consumption leads to fewer imports, rather than less domestic production). The relevant partial derivatives are thus

$$\frac{\partial q^c}{\partial e} = \frac{-1}{b}, \tag{12}$$

$$\frac{\partial q^p}{\partial e} = 0. \tag{13}$$

In addition, the environmental damage function now depends on quantity consumed, $ED = \gamma {q^c}^2$. Total differentiation of the exporting nation's total surplus, then yields

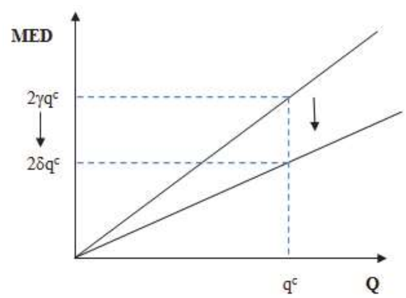
$$\frac{\partial TS}{\partial e} = bq^c\left(\frac{\partial q^c}{\partial e}\right) + cq^p\left(\frac{\partial q^p}{\partial e}\right) + q^p + e\left(\frac{\partial q^p}{\partial e}\right) - 2\gamma q^p\left(\frac{\partial q^p}{\partial e}\right) = 0, \quad (14)$$

which simplifies to $e = 2\gamma q^c$.

Once the country opens to trade and becomes an importing country, the consumption quantity substantially increases, leading to an increase in the consumption externality; that is, as the quantity consumed increases, environmental degradation increases exponentially. As always, in order to maximize the nation's welfare, the government sets the optimal emission tax equal to marginal environmental degradation with an outcome similar to Figure 2.

While imports increases consumption and thus leads to greater environmental damage, it is possible that imports embody better technology. If this is the case, then such imports may improve environmental quality by slowing down the rate of environmental degradation. To explore this possibility, suppose that imports "bend" the environmental damage curve so that $ED = \delta {q^c}^2$, where $\delta < \gamma$. As shown in Figure 3, the improvement of technology results in a downward shift of marginal environmental degradation. That is, the more the country imports, the better technologies it adopts from the world market. Consequently, the amount of environmental degradation from consuming one more unit of good and service declines. At the output level, q^c, marginal environmental damage decreases to $2\delta q^c$ thanks to the advanced technologies gained through trade openness.

FIGURE 3
TECHNOLOGY EMBEDDED IMPORTS LEADS TO LOWER LEVELS OF ENVIRONMENTAL DAMAGE



In an open importing economy, the greater environmental damage from the increase in consumption may be offset, partially or fully, by the technological improvements. Combining these two effects, we may speculate that the environmental quality first aggravates due to the rapid rise in consumption; however, over the time, advanced technologies gained from trade openness positively contributes to the recovery of the environment. This theoretical model thus demonstrates the possibility of an Environmental Kuznets Curve (EKC) hypothesis.

In an open economy, given our assumptions, an importing country thus encounters both negative and positive consumption externalities. In the case of negative consumption externality, the government would choose to set an optimal emission tax with the aim of filling this external cost and maximizing the nation's welfare. Other policies such as emission permit or pollution rights can also help internalize the environmental externality. Moreover, the government would encourage technology improvement and innovation through government subsidies so as to lower the amount of environmental damage and ameliorate environmental quality.

EMPIRICAL MODEL

Methodology

This study employs the Fixed Effects Panel Regression Model to analyze the impact of independent variables (GDP and trade) on dependent variables (CO_2). The study estimates three regression equations as follows:

$$\log CO_{2it} = \beta_0 + \beta_2 \log O_{it} + \alpha_i + \varepsilon_{it} \quad (15)$$

$$\log CO_{2it} = \beta_3 + \beta_4 \log O_{it} + \beta_5 \log G_{it} + \alpha_i + \varepsilon_{it} \quad (16)$$

$$\log CO_{2it} = \beta_6 + \beta_7 \log O_{it} + \beta_8 \log G_{it} + \beta_9 \log G_{it}^2 + \alpha_i + \varepsilon_{it} \quad (17)$$

Where α_i is the unknown intercept for each entity (i= 1…n); β_0, β3, and β_6 are the regression coefficients, and ε_{it} is the error term. $\log CO_{2it}$ is log of environmental damage proxy by CO_2 emission. $\log G_{it}$ is log of economic growth proxy by GDP per capita. $\log O_{it}$ is log of trade openness for country *i* in time *t* which is defined as the percentage of import plus export to GDP (in percent):

$$\text{Trade Openness} = \frac{Import_{it} + Export_{it}}{GDP_{it}}. \quad (18)$$

The inclusion of the square of GDP captures the possible existence of the EKC. According to the EKC, the coefficient of $\log G_{it}^2$ would be negative if the inverted-U-shape relationship between environmental damage and economic growth exhibits.

The study tests the relationship between trade openness, economic growth, and environmental degradation. With the first regression model, we expect a negative effect of trade openness on environmental quality. The study introduces GDP per capita in the second regression model to examine the contribution of economic growth to environmental damage in these six countries. The relationship between economic growth and environmental damage is expected to be positive. Also, the study aims to test the existence of EKC in countries and in the time period under study due to the lack of agreement in the empirical results from sizeable literature.

Empirical Results

Since the values of the included variables may fluctuate throughout the period of 1986-2013, we perform stationary testing. The purpose of stationary testing is to verify whether the effect of volatility is transient or permanent. If it is transient, the values of the variables would subsequently return to its long-run equilibrium, implying the stationary of the data set. Alternatively, if the effect is permanent and absorbed into the system, the values of the variables would not return to its long-run mean which means the data set is non-stationary. This type of data might need a particular panel regression model which includes error correction mechanism to deal with the non-stationarity of the variables. The non-stationarity of a panel strongly influences its behavior and properties and may lead to spurious regressions. It is therefore important to check data stationarity using unit root test.

The study determines unit root properties of the data by applying the unit root tests of Harris-Tzavalis (1999), Breitung (2000), Im, Pesaran and Shin (2003), and Augmented Dickey and Fuller (ADF)-Fisher (1979). The null hypothesis of these tests is that all panels contain unit roots. Inversely, panels are stationary would be the alternative hypothesis. The results of these unit root tests are presented in Table.1.

TABLE 1
UNIT ROOT TESTS

Test	Level			First Difference		
	log(CO_2)	log(GDP)	log(Trade)	log(CO_2)	log(GDP)	log(Trade)
Harris-Tzavalis	0.9733 (0.9593)	0.8796 (0.3506)	0.8697 (0.2713)	0.1177*** (0.0000)	-0.4830*** (0.0000)	-0.0516*** (0.0000)
Breitung	6.4459 (1.0000)	7.9850 (1.0000)	2.0572 (0.9802)	-5.6934*** (0.0000)	-5.6936*** (0.0000)	-5.1389*** (0.0000)
Im, Pesaran and Shin	0.7126 (0.7619)	1.6373 (0.9492)	-1.5388* (0.0619)	-4.7993*** (0.0000)	-9.0331*** (0.0000)	-6.9630*** (0.0000)
ADF-Fisher	13.1237 (0.3601)	8.3243 (0.7593)	19.4312* (0.0786)	55.8988*** (0.0000)	115.521*** (0.0000)	88.706*** (0.0000)

*significant at 10%, **significant at 5%, ***significant at 1%
Note: p-values in parenthesis.

According to the results, log (CO_2) is non-stationary since the null hypothesis cannot be rejected with large p-value in all four tests ($p > 0.1$). Similarly, log (GDP) is a non-stationary variable. Log (trade) is a non-stationary according to Harris-Tzavalis and Breitung tests. Yet, the results of ADF-Fisher and Im, Pesaran and Shin indicate that log (trade) is a stationary variable. However, the conclusion that log (trade) has unit roots is relatively weak (significance at 0.1 level). Therefore, based on the strong result of Harris-Tzavalis and Breitung tests, the study concludes that log (trade) is a non-stationary variable.

Based on these results, the unit root tests were performed again on the first difference of log (CO_2), log (GDP), and log (Trade) with the view of determining their orders of integration. Since the null hypothesis is rejected by all tests, three variables, log (CO_2), log (GDP), and log (Trade), are stationary in their first difference. Based on the results of all four tests, we conclude that the variables are integrated of order 1, I(1). That is, these variables still return to their long-term equilibrium, and the application of error correction mechanism is not necessary.

We conduct a Hausman-test (1978) for each regression models to decide between fixed effects or random effects. The null hypothesis of the test states that random effects is the preferred model, the alternative hypothesis suggests fixed effects as the preferred model. The results of Hausman-Test suggest strong evidence for the fixed-effect estimation in all three panel regression models. This study thus employs fixed effects estimation to examine the effect of trade openness and economic growth on environmental degradation and the validity of the EKC hypothesis.

The relationship among environmental damage, economic growth, and trade openness are clearly examined through three panel regression models. The empirical results for the relation among three key variables are summarized in Table 2.

The result of the first panel regression model suggests that there exists a positive correlation between CO_2 emission and trade openness in Asian developing countries. That is, an increase in trade openness would result in an increase in CO_2 emission perhaps due to the presence and high concentration of manufacturing industries in these countries. This positive relationship of CO_2 and trade openness is significant (at 0.01 level). The finding in this panel regression model is consistent with the finding of the theoretical model that as a country becomes more open to trade, its environmental damage consequently exacerbates. Evidently, these six manufacturing-intensive countries have witnessed the rise in environmental degradation along with the increase in trade openness in the last 27 years. Thus, according to the results of the first fixed-effect panel regression model, it is reasonable to conclude that trade openness has a negative effect on the environmental quality in these manufacturing-intensive developing countries in Asia under the study period.

TABLE 2
ESTIMATION RESULTS OF PANEL REGRESSION MODEL

Variable	**Coefficient and t-value**		
	(15) $logCO_2$	**(16) $logCO_2$**	**(17) $logCO_2$**
logO	1.0686*** (13.78)	0.1619* (1.93)	0.1876** (2.15)
logG		0.7798*** (13.87)	0.5897*** (3.09)
$logG^2$			0.0036 (1.04)
Constant	8.1935*** (25.05)	-7.6105*** (-6.55)	-5.2926** (-2.11)
R^2	0.5413	0.7916	0.7930
F-statistic	189.95	303.92	203.08
Observations	168	168	168
Hausman-Test	13.39***	27.79***	30.45***

*significant at 10%, **significant at 5%, ***significant at 1%
Note: t-values in parenthesis.

The variable, log (GDP) is included in the second fixed-effect panel regression model to examine the effect of both trade openness and economic growth on environmental damage. The empirical results reveal that GDP has a negative effect on CO_2 emission while trade openness continues to negatively affect CO_2 emission. Put another way, as GDP increases during the period of 1986-2013, CO_2 emission simultaneously increases. This relationship between GDP and CO_2 emission is highly significant (at 0.01 level). More importantly, this model confirms the positive relationship between trade openness and CO_2 emission (significance at 0.05 level). All in all, the empirical results indicate that environmental degradation and trade openness, and economic growth are positively correlated.

The EKC hypothesis is evaluated in the third panel regression model with the inclusion of the square term of GDP. The empirical result suggests strong evidence that the EKC hypothesis is not valid for the panels of these six developing countries in the period under study. The non-negative coefficient of the square term of GDP per capita implies that the curve of CO_2 emission is not polynomial. That is, that log (CO_2) and log (GDP) do not obtain an inversed-U-shaped relation. However, this result may not contradict the EKC hypothesis since developing countries remain below the hypothesized income point.

Analysis

According to the empirical results, an increase in trade openness by 1% leads to an increase in CO_2 emission approximately by 1.06%. With the inclusion of the variable GDP in the regression model, the magnitude of trade openness's effect on environmental damage substantially declines: an increase in trade openness by 1% results in a slight increase in CO_2 emission by 0.16% while the variable, GDP, remains constant. Yet, trade openness continues to have negative effect on environmental quality.

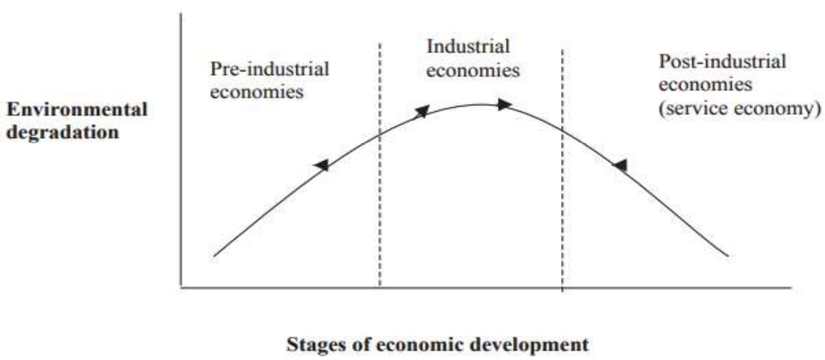
This finding is consistent with our study's expectation and more importantly confirms the results in our theoretical model. China, Indonesia, India, Malaysia, Thailand, and Vietnam heavily concentrate on manufacturing industries. In the last few decades, manufacturing sector has been the comparative advantage of these developing countries in world trade. Despite the benefits obtained from manufacturing-intensive exports, increasing openness to trade has shown severe environmental consequences. Moreover, the high demand and usage of imported equipment, machines and natural resources of these countries also contributed to the degradation of the environment. Thus, the faster their economies grow with trade openness, the faster their environment qualities exacerbate.

The Global Manufacturing Competitiveness Index (2016) predicted that by 2020, all six countries will be considered among the ten most influential manufacturing countries and drive the global economies and world trade. At this speed, environmental degradation will grow exponentially and surpass the already alarming level of pollution unless stringent policies are implemented by the government. The increase of environmental damage with economic growth and trade openness certainly calls for stringent environmental regulations and transformation of the economy to ensure a more sustainable scale of economic activities.

The model with the square term of GDP per capita could not show an inverted U-shaped curve of the EKC hypothesis. That is, it is inconclusive that economic growth initially worsens environmental performance, but later improves environmental damage after reaching a certain critical point of income. One way to interpret this empirical result is that these six developing countries have not yet reached their income threshold, alternatively, have not yet adopted clean technology. At this early stage, countries may be interested in jobs and income more than clean environmental conditions, and thus environmental pressure grows faster than income due to high priority of increasing outputs. These countries may not have the ability to afford environmental abatement and recovery. Once they reach the threshold income, the value of environment may increase sufficiently and the level of pollutions may decline.

In particular, the EKC hypothesis asserts that there are primarily three stages of economic development: pre-industrial economies, industrial economies, and post-industrial economies (Panayotou, 2003). In the economy at low level of development, the intensity of environmental damage corresponds to the demand for resource and the degradable wastes created by subsistence economic activities. However, once industrialization prospers, resource extraction and waste greatly accelerate. As the economy moves toward services, effective and advanced technologies along with the demand for environmental quality lead to a decline of environmental damage (Panayotou, 1993). As shown in Figure 4, a country with industrial-intensive economy may still experience a steady increase of environmental degradation since it has not yet reached the income threshold. This may explain why the six countries under study have not yet seen an improvement in their environmental qualities despite prosperous economic growth brought about by trade openness.

FIGURE 4
THE ENVIRONMENTAL KUZNETS CURVE (SOURCE: PANAYOTOU, 2003)



Policy Implication

This study successfully comes to the conclusion that trade openness and economic growth have substantially exacerbated the decline in environmental quality. The excessive output growth along with increasing trade openness have led to higher fossil fuel consumption and alarmingly high levels of CO_2 emission. The six economies under this study are facing long-term serious environmental damage for the sake of economic growth, as their shares in the world trade market expand. Given the theoretical and empirical findings of this work, the study has significant practical and policy implications. With the aim of transforming the long-term trade-off between environmental quality and economic growth, it is necessary for policy makers to enforce national environmental laws and regulations to improve CO_2 emission.

Command-and-control regulation can be an effective solution to pollution reduction because it would require firms to take social costs of pollution into account. With command-and-control regulation, the government can easily monitor compliance of firms and reach the emission reduction goal. Yet, despite its efficiency, the government may discourage the incentive to research new methods to reduce emissions or improve environmental pollution beyond the required standard. Once the goal of emission is met, there is no incentive to further improve the environmental quality.

The development of cap-and-trade policies could successfully restrict the quantity of CO_2 emission by setting a cap on this pollutant in the manufacturing industries. This approach creates economic incentives for firms to develop new sustainable technologies and adopt low-cost emission reduction techniques since the emission permits now have advantageous financial values and can be traded in the market. In the long run, the government of these six countries would be able to reduce the levels of emission more aggressively by lowering the emission cap and forcing firms to change to green technologies and sustainable production. The cap-and-trade approach can also be applied at the international level.

Market-based environmental regulation is cost efficient and encourages economic incentives with regards to pollution reduction. These factors make market-based environmental policies more successful in reaching the emission reduction goal at a lower cost compared to command-and-control regulation. Carbon tax should be set specially for manufacturing industries. With carbon tax, the government would charge firms at a rate corresponding with the amount of emitted carbon. This policy would impact all sectors of the economy including firms and consumers. Firms would pay for carbon tax depending on the amount of carbon emitted during production and consumers would pay the carbon tax in the price of energy usage and products. By applying a carbon tax, the government ensures that the quantity of carbon emission is reduced as much as possible in both consumption and production. The government may use the revenue collected from carbon tax to invest in green and sustainable technologies which would further decrease the levels of emission.

CONCLUSION

This study is an attempt to examine the relationship between trade openness, economic growth and environmental quality in six manufacturing-intensive developing countries in Asia: China, India, Indonesia, Malaysia, Thailand, and Vietnam using data from 1986 to 2013. The results show that there is a positive relationship between trade openness and environmental degradation; an increase in the share of exports and imports in GDP contributes to the increase in levels of emission and pollution. This finding supports the Pollution Haven Effect hypothesis.

Another interesting finding is that economic growth has a negative effect on environmental quality. That is, as the economy of the six countries grows environmental degradation worsens. The study also tests the existence of the EKC hypothesis in these countries for the period under study by introducing the square term of GDP per capita into the model. However, the results show that the inverted U-shaped relationship between economic growth and environmental quality does not exist in these six economies.

This study has limitations. It solely focuses on carbon dioxide emission, yet the inclusion of other pollutants such as nitrous dioxide (N_2O), methane (CH_4) or sulfur dioxide (SO_2) may further explain the extent of environmental damage at the cost of economic growth. Further analysis may be necessary to examine the contributions of various key sectors to environmental degradation in these countries. Additionally, future studies can broaden the model by including more explanatory variables to analyze the determinants of environmental pollution better. The magnitude of the impact of trade openness on environmental quality, particularly in these developing countries, might need further in-depth studies.

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