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A Test of Pollution Haven Hypothesis (PHH) in the Environmental Kuznets Curve (EKC) Framework in Selected ASEAN Countries

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ABSTRACT

The underlying study focuses on Pollution Haven Hypothesis (PHH) from the trade perspective for the Association of South East Asian Nations (ASEAN) countries for the period 1989 -2015. The PHH claims that in open trade regime developing countries tend to specialize and export pollution-intensive goods. This study examines this proposition in the context of ASEAN versus United states of America (USA) trade. The results indicate that exports of pollution-intensive- goods from ASEAN countries to USA significantly contribute to the pollution thereby, delaying the turning point income level of the EKC in ASEAN countries. The study, therefore, concludes that world pollution cannot be tackled unless advanced countries do not curtail the consumption of pollution-intensive goods.

Keywords: *CO_2 emission, Pollution-intensive industries, Trade*

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INTRODUCTION

Since from the 1970s, the issues related to international trade and environment degradation have been hotly debated. The impact of international trade on environment and impact of environment on international trade has been the focus. The trade agreements in the 1990s like North American Free Trade Agreement (NAFTA), the United Nations Conference on Environment and Development (UNCED), Uruguay Round of the General Agreement on Tariffs and Trade GATT and World Trade organization (WTO) included environment considerations in their main documents. The Environmental

Review of Trade Agreements (1999) of USA also included environmental considerations in its trade negations.

The opponents of trade liberalization raised the issue that under the free trade regime, weak environment regulations and under-pricing of environment resources in developing countries have led the concentration of pollution-intensive goods in these countries. Resultantly, the consumers of developed world have enjoyed pollution-intensive goods at lower prices. This phenomenon of the concentration of pollution-intensive industries in developing countries is known as Pollution Haven Hypothesis (PHH). The PHH was first postulated by (Copeland & Taylor, 1994). They developed this hypothesis in the early 1990s when under NAFTA, the firms operating in rich and highly regulated countries like USA and Canada came in direct competition with the firms operating in poor countries like Mexico that had lax environment standards.

The PHH predicted that under the liberalized trade regime, firms would move from rich countries that had strict environmental regulations to those poor countries that had comparatively weak environment regulations and under-priced environmental resources. Resultantly, the developing countries would specialize and export pollution-intensive industries and developed countries would specialize and export clean industries. The PHH supported the stance of those who postulated that advanced countries are on the downward slope of the Environmental Kuznets Curve (EKC) because they have shifted their pollution-intensive production process to developing countries.

The empirical literature about the PHH has mixed outcome. The studies like (Jaffe, Peterson, Portney, & Stavins, 1995; Tobey, 1990), rejected the claim of the PHH that stringency of environmental regulation of a country had influence on the trade of pollution-intensive goods. On the other hand, Mani and Wheeler (1998) and Cole (2004) found that pollution intensive industries grow rapidly in developing countries in the periods when environmental regulations in OECD countries were stringent. Frankel and Rose (2005) and Cole and Elliott (2005) also found empirical support for PHH from a city-level study of SO_2 concentrations in developing countries. Nevertheless, Dinda (2004) rejected the PHH stance. He claimed that polluting industries also have raised the income levels in host countries. The higher income leads a country to better environment standards. Therefore, sooner or later there would be no country where polluting industries can be relocated and all countries would be on same playing level with same environment cost.

1.1 The PHH and the EKC

The relationship between pollution and economic growth known as Environmental Kuznets Curve (EKC). This relationship arose from the path-breaking studies of Grossman and Krueger (1991); (Panayotou, 1995; Shafik & Bandyopadhyay, 1992). The EKC states a nonlinear inverted U- shaped relationship between pollution and income. The EKC claims that economic growth is the cause as well as a remedy to the environmental problems of the world. Economic growth deteriorates the environment at the early stages of economic development; however, at the later stages of economic development economic growth generates the conditions that are conducive to the environmental problems. Figure 1 explains this nonlinear relationship between economic growth and pollution.

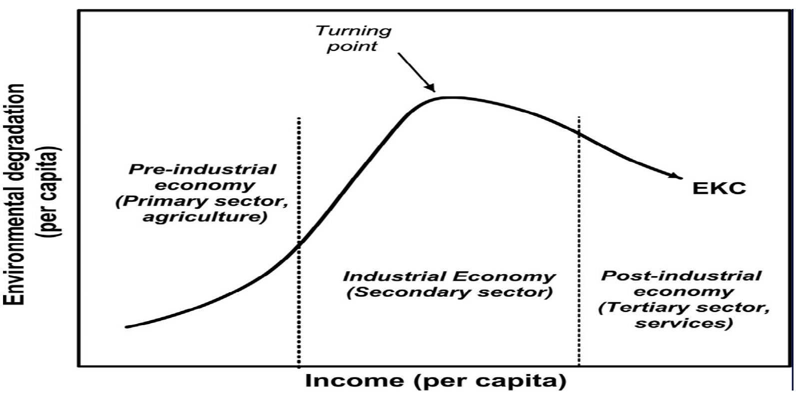

Figure 1.1: The EKC relationships between income and environment

Since 1990s, the EKC attracted the attention of the serious commentator of development economics. It also affected the policy and priorities of governments, World Bank, International Monetary Fund (IMF) and other development financial institutions (DFIs). As it is evinced their pro-growth policies. However, a large body of the literature also criticized the assumptions and theoretical basis of the EKC.

One of the main criticisms on Environmental Kuznets Curve (EKC) is that it does not consider the impact of changes in trade pattern on the environment of a country. As PHH claims that the pollution-intensive industries of rich countries have migrated to developing countries to take advantage of under-priced environmental resources. This migration has decreased the pollution in developed countries as they start to import pollution-intensive goods from developing countries. The down word sloping of the EKC of developed countries may reflect this relocation of the polluting industries. Because of this relocation, the pollution in developed countries has decreased while the total pollution of the world has not come down. The EKC may not imply a net reduction in pollution, but simply a transfer of the pollution from rich countries to poor countries.

The PHH implies that EKC exists only for individual countries not for the whole world. Therefore, it will be useful to analyze the specialization patterns of the industries in developing countries and to investigate the impact of export of pollution-intensive industries on the pollution and on the slope of the EKC. Several studies like Atici (2012); (Azhar & Elliott, 2007; Beladi & Oladi, 2011; Cole & Elliott, 2003; Elliott & Shimamoto, 2008; Haisheng, Jia, Yongzhang, & Shugong, 2005) investigated these links theoretically and empirically and have mixed findings.

1.2 Trade and the Environment

The increase in trade is considered to help a country to achieve the targets of high economic growth. However, this increased trade can also harm the environment quality in that country. Although liberalized trade and investment policies lead to more economic activities and more wealth generation nevertheless, it also has several environmental effects. The interplay between trade and pollution has been securitized by many research studies. As Muradian and Martinez-Alier (2001) noted that neither ecological economics nor environment economics fully encompassed the structural conditions that determine the trade flows between the countries and regions. Cole and Elliott (2003) also found little evidence that trade pattern of a country can affect the EKC. Similarly, Atici (2009) also found that trade openness did not reduce the emission levels in Eastern and Central European countries.

The literature on environment and trade keep on growing like (Anderson, Blackhurst, & Secretariat, 1992; Cole, 2000; Esty, 1994, 2001). One school of thought claims that trade liberalization would reduce pollution as it generates a competitive environment. As a result the country becomes more efficient in the utilization of environment resources. Grossman and Krueger (1991) were the first who provided a systematic analysis of trade and environment relation. They broke down the impact of trade into scale, technique and composition effect. Due to increas in trade and economic activities, scale effect generates pollution at the early stages of economic development. While, continuous increase in economic growth because of free trade, leads to technological changes and efficient resource usage at the later stages of economic development. Finally, it is the composition effect that leads a country to specialize in an industry where the country has a comparative advantage. The composition effect is the most relevant for PHH to affect the EKC transition. How composition effect affects the pollution in a country depends on its source of comparative advantages and most importantly whether it has comparative advantages in pollution-intensive goods or not.

He and Wang (2012) claimed that liberalization of international trade generally leads to increase the economic activities and to more wealth generation and this accumulated wealth creates awareness about the environmental problems. International trade also transfers advanced and most energy efficient technologies from developed to developing countries. Therefore, developing countries with these modern clean technologies can clean their production process with the help of international trade.

1.3 The Environment Problems in Association of South East Asian (ASEAN) Countries

Presently, the ASEAN countries have several environment problems. According to the ASEAN Environmental Report (2015), increased industrialization and urbanization in the 1990s and 2000s generated severe environmental problems like air pollution, water pollution and accumulation of urban wastes in ASEAN countries. Although ASEAN countries have been relatively active in perusing of environmental policies as compared to other regions as they started programs for the conversation of nature and marine life with the collaboration of The United Nations Environment Programme (UNEP). Moreover, the regional and bilateral cooperation also has grown like Asia–Pacific Partnership on Clean Development and Climate (APP) and 10+3 (ASEAN + China, Japan, and Korea) for environment protection (Atici, 2012). Nevertheless, The Global Climate Risk Index (2015) indicates that ASEAN countries are the most vulnerable to the environment changes. Most of the ASEAN countries are island countries and are exposed to the risk of rising oceans. Moreover, ASEAN countries also have deteriorated air quality in their cities. According to World Air Quality Index 2015, all the countries of this region are at the low rank of the air quality index. The deteriorated air quality has very dangerous health repercussions for the people of these countries. Furthermore, Environmental Performance Index 2016 that is the more comprehensive measure of environment conditions of a country reveals the fact that countries especially Indonesia, Thailand, Vietnam, Laos, and Burma have very alarming indicators of the environment. According to Fig. 1.2 CO2 emission has risen over the last three decades in ASEAN region.

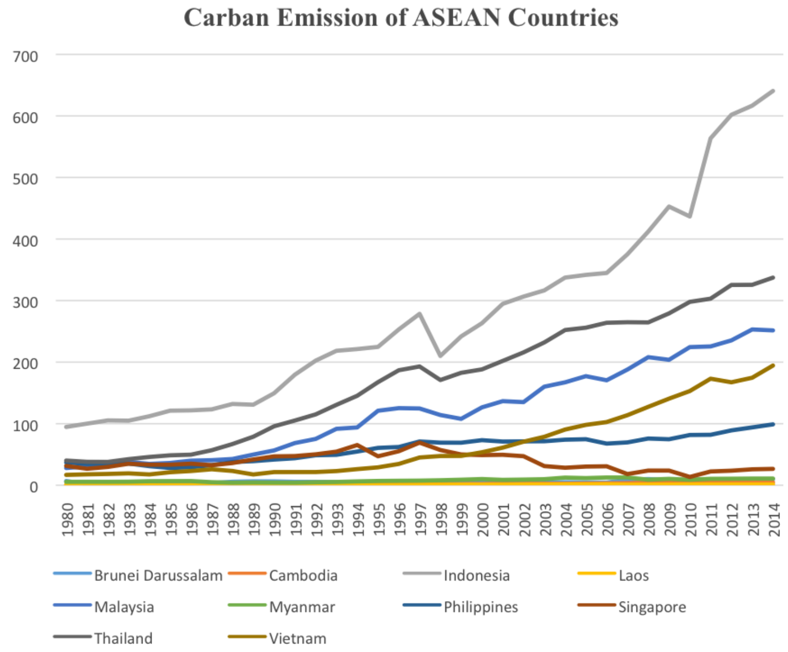

Figure 1.2 CO_2 emissions in ASEAN, 1980–2014, Mt (Source: World Bank, 2015)

The countries like Singapore, Malaysia, Indonesia, Thailand and Vietnam, have a significant increasing trend of carbon emission.

The ASEAN countries have been following the policies of trade liberalization since from the 1980s. The trade has been an important tool for ASEAN countries to achieve the targets of high economic growth and advanced countries have been the main trade partner. Table 1.1 shows the share of the trade in total GDP of ASEAN countries. Singapore and Malaysia have the highest trade to GDP ratio that indicate that they are the most open economies in term of trade and investment regulations of the region. ASEAN countries have the highest trade to GDP ratio as compared to the other regions of the world (World Bank, 2015). Therefore, it can be claimed that ASEAN countries have been perusing an export-led growth strategy.

Table 1.1

Trade as % of GDP of the ASEAN Region

	2011	2012	2013	2014	2015	2016
Brunei	87	87	83	81	83	83
Cambodia	125	137	142	145	145	146
Indonesia	50	50	49	48	42	45
Malaysia	155	148	143	138	134	136
Myanmar	33	33	41	43	44	43
Philippines	68	65	60	61	61	62
Singapore	377	367	362	360	326	330
Thailand	114	112	106	105	98	98
Vietnam	163	157	165	170	179	185

Source: World Bank (2016 Focus Economics (2016)

ASEAN countries as big trade partner of advanced countries like Japan and the USA and with several environmental issues seem to be a perfect case of the PHH that needs to be investigated. These increasing trends of pollution and polluting industries indicate that ASEAN countries may have a PHH trade pattern.

As the countries of South East Asia have been following the policies of trade and investment liberalization from the last three and four decades and have witnessed a remarkable level of economic growth, they are now facing the severe problem of environment degradation. The question arises whether the trade patterns of these countries have any impact on the environment condition of these countries. Whether pollution haven hypothesis (PHH) is relevant for these countries or in other words to what extent PHH is responsible for the skewed shape of the EKC in these countries. And to what extent the PHH is responsible for the flat shape of the EKC in advanced countries.

The studies are scarce that have examined the link between trade and environment in the context of ASEAN countries like (Atici, 2012; Elliott & Shimamoto, 2008; Takeda & Matsuura, 2006). Among these studies (Atici, 2012) was the latest study that investigated the trade and environment link for the period 1970-2000. Since 2000, lot of institutional and structural changes have taken place, therefore there is need to have a fresh look on the pollution, economic growth and trade of pollution- intensive goods in the context of ASEAN countries. Simialrly, the studies are also very rare that have investigated the effect of trade composition (clean goods,pollution-intensive goods) on the environment in ASEAN countries. Furthermore, studies are also scarce that have analyzed the trade link between advanced countries and ASEAN in the context of the EKC to test the PHH claim that developed countries shifted the burden of pollution to developing countries like ASEAN. The developing countries like ASEAN have the skewed EKC because they have become pollution haven as result of oppen trade with advanced countries.

METHODOLOGY

2.1 Model

The EKC postulates a nonlinear relationship between income and pollution. To model, this nonlinear relationship between income and pollution Dinda (2004) proposed following model.

$$Y_{it} = \beta_o + \beta_1 X_{it} + \beta_2 X^2{}_{it} + \mu_{it} \quad (1)$$

In equation [1], Y is pollution and X are income. The EKC relation between income and pollution will exist if β_1>0 and β_2< 0.

Pollution is determined by so many factors other than income, therefore, to avoid any model miss- specification two important determinants of pollution energy consumption (EC) and Foreign Direct Investment (FDI) are included as control variables in equation (2).

Yit=β°+β1Xit+β2Xit2+β3ECit+β4FDIit+µit (2)

The PHH claims that the advanced countries are specializing and exporting clean goods while developing countries are specializing and exporting pollution-intensive goods. The pollution in advanced countries has come down because they have shifted the pollution-intensive production process to the developing countries and are importing these pollution-intensive goods from developing countries. Therefore, following the expansion in trade and economic activities, the total pollution of the world has not come down against the claim of EKC hypothesis rather it has just relocated. To test the impact of the PHH trade patterns on the EKC in ASEAN countries, the export of pollution-intensive goods of ASEAN countries to advanced (USA) is included in the estimation of the EKC in equation (3).

Yit=β°+β1Xit+β2Xit2+β3ECit+β4FDIit+β5XDUSAit +µit (3)

Where DXJA= export of pollution-intensive goods from ASEAN to USA. μ_{it} is error term that captures the variation of Y variable that is not explained by explanatory variables while, i = 1.2.3……… n countries and t = 1.2.3.4…. t years. Equation (2) is used to test inverted U-shaped (EKC) relation between income and pollution.

If β_5 in equation [3] is found positive significant then it can be interpreted that export of pollution-intensive goods of ASEAN to USA is responsible for the pollution in ASEAN countries. The turning point of the EKC can be calculated by the following formula.

$$\text{Turning Point Income level} = \frac{\beta_1}{2\beta_2} \quad (4)$$

The comparison of the peak turning point of the EKC of ASEAN countries from Equation (2) where export of pollution-intensive goods are supposed to affect the income environment relation implicitly and from equation (3) where the export of pollution-intensive has been included explicitly, would reveal how the PHH affect the slope of the EKC. This estimation would reveal how much production and export of pollution-intensive goods is responsible for the delay in the peak turning point of the EKC of ASEAN countries.

Some scepticism may develop about the implicit impact of the export of pollution-intensive exports on peak turning point of the EKC. The difference in peak turning point income level of the EKC from equation (2) and from equation (3) may be due to other factors then export of pollution-intensive goods. To overcome these uncertainties this study includes the export of pollution-intensive goods in the model specification of the EKC interactively with income so that turning point will become context specific as suggested by (Rehman, Nasir, & Kanwal, 2012; Webber & Allen, 2004). This specification provides a way to empirically investigate the different turning points of the EKC corresponding to different level of exports of pollution-intensive goods from ASEAN to USA. The resulting model will be as

$$Y_{it} = \beta_\circ + \beta_1 X_{it} + \beta_2 X_{it}^2 + \beta_3 (X * XDUSA)_{it} + \beta_4 FDI_{it} + \beta_5 EC_{it} + \mu_{it} \quad (5)$$

Where, $X * XJDA$ is an interaction term that has the following interpretation. Given the income level, pollution will increase with the increase in exports of pollution-intensive goods while, given the level of exports, pollution will rise due to increase in income. To determine whether interaction term matters in this model or not, Wald test for zero restriction of the parameter for interaction term can be implied

In Equation (5) exports of pollution-intensive goods affect the pollution indirectly by affecting the economic growth and the economic growth affects the environment. This indirect effect is assumed to influence the turning point of the EKC owing to its effect on GDP. This specification is very important in terms of tracing out the true impact of PHH on the turning point of the EKC. According to Aubourg, Good, and Krutilla (2008), this model allows locating the turning point GDP values inclusive of exports indicators. With this specification, the formula for determining the GDP per capita at the turning point is given by Equation (6).

$$\text{Turning Point Income level} = \frac{-(\beta_1 + \beta_3 XDJA)}{2\beta_2} \qquad (6)$$

2.2 Justification of the Variables

The main objective of the study is to determine the role of the trade of pollution-intensive goods in an income-environment relationship. For this purpose, the variables that represent pollution, income and pollution-intensive goods have been included in the study. Two important determinants of pollution also have been included as a control variable to avoid any misspecification of the model.

To measure the pollution, CO_2 emissions as a proxy of pollution has been taken as per practice in the EKC and PHH literature. Pollution is a wide term and the empirical studies on the EKC and the PHH have used air pollutants like CO_2, SO_2 and PM_{10} as a measure of pollution. However, the majority of the studies on the EKC and the PHH used CO_2 as a measure of pollution owing to the availability of the data. The studies like (Hassaballa, 2013; Kivyiro & Arminen, 2014) provided a logical justification for the use of CO_2 emissions as a measure of pollution. They explained that CO_2 is a primary source of global warming and highly correlated with local pollutants like Sulphur Dioxide and Nitrogen Oxide. CO_2 is also a major determinant of Green House Gases (GHG) and is the main contributor to the environmental degradation. Income is measured by the GDP per capita of a country.

Two control variables FDI and energy consumption (EC) have been included in the EKC model to avoid any possible misspecification of the model. The FDI is considered one of the important determinants of the pollution in the literature of environmental economics. There are two conflicting views about the impact of FDI on the pollution. One is Halo Effect Hypothesis that claims that FDI will spur economic activities that lead to efficiency and technological improvement and to positive environment spill over (Albornoz, Cole, Elliott, & Ercolani, 2009). The other is Pollution Haven Hypothesis (PHH) that postulates that FDI is going to those developing countries that have lax environmental regulations and making the environment of host countries worse. (Cole & Elliott, 2005; Cole, Elliott, & Fredriksson, 2006). The empirical and theoretical results are mixed about the impact of FDI on pollution (Xing & Kolstad, 2002; Zarsky, 1999).

EC is another important determinant of pollution in the literature of environmental economics. There are numerous studies that included energy consumption while testing the link between economic growth and environment like (Ang, 2007; Apergis & Payne, 2009; Halicioglu, 2009; Kivyiro & Arminen, 2014; Richmond & Kaufmann, 2006).

To test the existence of the PHH for ASEAN countries XDJA has been used. The XDJA is the export of pollution-intensive goods from ASEAN to USA. The pollution-intensive goods include those goods that have the most polluted production process. In the context of this study chemical, plastic, paper and pulp and wood industries are taken as most pollution-intensive industries.

2.3 Data

This study uses time serious data of six ASEAN countries for the period 1989 to 2014. Depending upon the availability of data, the analysis is confined to only six major ASEAN countries namely Singapore, Malaysia, Indonesia, Thailand, Vietnam and Philippine.

As per usual practice in the EKC and PHH literature, CO2 emission in the 'metric ton' has been taken as a measure of environmental degradation and GDP per capita as a measure of income. The data for CO2 emission has been taken from the report of International Energy Statistics 2016. While the per capita GDP data has been obtained from the World Economic Outlook 2016 and the data about FDI and energy consumption (measured in kg of oil equivalent per capita) has been collected from World Development Indicator 2015.The data for export of pollution-intensive from ASEAN countries to USA has been taken from International Trade Statistics (2016).

2.4 Estimation Technique

The standard Ordinary Least Square (OLS) regression technique with nonstationary time series may lead to spurious regression and may cause invalid inference of the empirical results. Therefore, it is essential to examine the stationary properties of each variable before estimating the relationship between the variables. For this purpose, the panel unit root test of Levin, Lin, and Chu (2002) has been employed (LLC). The simple form of this test is shown in equation (7).

$$\Delta y_{it} = z_{it}\gamma_{it-1} + py_{it-1} + \sum_{j=1}^{k_i}\varphi_{ij}\Delta y_{i,t-j} + \varepsilon_{it} \qquad (7)$$

captures the deterministic component of heterogeneous time effect and fixed effects and *k* is the lag order. The null hypothesis H_o: p =0 that variable is non-stationary for all *i* against the alternative hypothesis H_1: $p < 0$ that variable is stationary for all *i*. However, problem with this test is that it assumes homogeneous p for all *i* $p_i = p$. According to Breitung (1999), this test may lose its power if this assumption is violated. Im, Pesaran, and Shin (2003) (IPS) suggested the following panel unit root test to overcome this limitation.

$$\Delta y_{it} = z_{it}\gamma_i + p_i y_{it-1} + \sum_{j=1}^{k_i}\varphi_{ij}\Delta y_{i,t-j} + \varepsilon_{it} \qquad (8)$$

This test allows p to differ through all *i*, and H_o: $p_i = 0$ is that every variable in the panel holds a unit root problem for all *i,* and the H_1: $p_i < 0$ for at least one *i* is that at least one of the individual variables in the panel has no unit root problem. If all the variables in the panel are found non-stationary and integrated of same order, then panel co-integration can be applied to find long run equilibrium relationship among the time series variables. We used co-integration tests suggested by Pedroni (1999) and Kao (1999). These cointegration tests need to estimate Eq. (2) for every cross-sectional identity and then to estimate Equation. (9).

$$\hat{\varepsilon}_{it} = \rho_j\hat{\varepsilon}_{it-1} + \sum_{j=1}^{K}\emptyset_{ik}\Delta\hat{\varepsilon}_{it=k} + v_{it} \qquad (9)$$

Here the null hypothesis of no cointegration H_o: $p_i = 0$ is tested against the alternative hypothesis of cointegration H_1: $p_i < 1$. Contrasting to the ***Padroni*** tests, the Kao tests assume that the slope coefficients are homogeneous for all *i* in the panel. After finding the variables are co-integrated in the panel, the next step is to estimate long run cointegration vector. The long run coefficients are estimated using Fully Modified Least Square (FMOLS) estimation method that was developed by (Pedroni, 2001). FMOLS is estimated with the non-parametric approach and it includes the alterations to tackle the serial correlation and the endogeneity problem.

RESULTS AND DISCUSSIONS

This research study aims to investigate the presence of the PHH in ASEAN countries in the context of the EKC frame work. Moreover it also assesses the extent to which the exports of pollution-intensive goods contribute to the slope of the EKC in ASEAN countries. The descriptive statistics and correlation among the variables have been detailed in Table 3.1 and in Table 3.2 prior to the estimation of any relationship among the variables. The descriptive analysis describes the degree of reliability and degree of variation of the variables while correlation analysis highlights how much dependent and independent variables are related to each other.

Table 3.1

Descriptive Statistics

Variables	CO_2	Y	EC	FDI	XDUSA
Mean	147	7125	1697	7.58E+09	1570301
Median	104	2356	845	3.84E+09	1166951
Maximum	641	56010	7370	6.85E+10	8727829
Minimum	13.47	97.2	269	-4.55E+09	123450
Std. Dev.	125	11852	1679	1.18E+10	1746569
Skewness	1.59	2.57	1.42	3.246102	1.912153
Kurtosis	5.93	9.26	3.90	14.54442	6.946982
Jarque-Bera	122	427	58.1	1140.246	196.3258
Observations	156.	156	156	156	156

Table 3.2

Correlation Matrix

Variables	CO2	Y	Y2	EC	FDI	XDUSA
CO2	1.00	-0.29	-0.24	0.00	0.26	1.00
Y	-0.29	1.00	0.85	0.85	0.76	-0.29
Y2	-0.24	0.85	1.00	0.59	0.62	-0.24
EC	0.00	0.85	0.59	1.00	0.85	0.00
FDI	0.26	0.76	0.62	0.85	1.00	0.26
XDUSA	1.00	-0.29	-0.24	0.00	0.26	1.00

It is the precondition of using the panel cointegration tests that the time series variables in the panel must be integrated on same order. The results of the LLC and IPS unit root tests for each time series variable have been summarized in Table 3.3. The results indicate that LLC and IPS statistics do not reject the null hypothesis that all the variables in the panel are non-stationary. However, at first difference, all the variables become stationary, therefore, it can be concluded that all the variables in the panel are integrated of order I (1).

Table 3.3

Results of Panel Unit Root Tests

	LLC		IPS	
Variable	**Level**	**First Difference**	**Level**	**First Difference**
CO2	2.09	-10.36	4.05	-9.26
	[1.00]	[0.00] *	[1.00]	[0.00] *
Y	7.13	-5.54	8.07	-4.1
	[1.00]	[0.00] *	[1.00]	[0.02] **
Y2	6.69	-1.97	6.67	-1.27
	[1.00]	[0.02] *	[1.00]	[0.10] ***
FDI	3.72	-9.59	4.43	-12.19
	[0.99]	[0.00] *	[0.99]	[0.00] *
EC	0.52	-8.47	0.51	-7.84
	[0.70]	[0.00] *	[0.70]	[0.00] *
XDUSA	3.31	-7.28	4.31	-7.34
	[1.00]	[0.002] *	[1.00]	[0.00] *

Note: The lag selection for every variable is based on Akaike Info Criterion (AIC). Newey-West bandwidth selection with Bartlett kernel is used for the LLC test.
The Levin, Lin and Chu (LLC) and Im, Pesaran and Shin W-stat (IPS) tests have $H_{o:}$ The series has a unit root. LLC and IPS tests for all the series include a constant as an intercept.
*rejection of the null hypotheses of a unit root at the 1% significance level
**rejection of the null hypotheses of a unit root at the 5% significance level
***rejection of the null hypotheses of a unit root at the 10% significance level

After examining the unite root problem, the panel cointegration tests have been applied to examine the long-run equilibrium relationship among the variables. The co-integration results of Pedroni (1999) and Fisher (1932) tests are reported in in Table 3.4, Table 3.5 and in Table 3.6. The results indicate that a long run cointegrated equilibrium relationship exists among the variables for equation (2), (3) and (5). The test statistics reject the null hypothesis of no cointegration at 5 percent level of significance for all three equations. Therefore, it can be concluded that all the variables in equation (2), (3) and in (5) correlated and there exists a long run equilibrium relationship among these variables.

Table 3.4

Panel Cointegration test for Equation (2)

Pedroni Residual Cointegration Test

Automatic lag length selection based on HQIC with a max lag of 4

	Statistic	**Prob.**
Panel v-Statistic	2.48153	0.0065
Panel rho-Statistic	-1.16522	0.122
Panel PP-Statistic	-3.14869	0.0008
Panel ADF-Statistic	-3.24798	0.0006
Group rho-Statistic	0.714171	0.7624
Group PP-Statistic	-1.74652	0.0404
Group ADF-Statistic	-2.48054	0.0066

Johansen Fisher Panel Cointegration Test

Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)

Hypothesized No. of CE(s)	**Fisher Stat.* (from trace test)**	**Prob.**	**Fisher Stat.* (from max-eigen test)**	**Prob.**
None	102.5	0.00	66.88	0.000
At most 1	50.18	0.00	31.93	0.0014
At most 2	26.94	0.0079	25.35	0.0133
At most 3	10.7	0.5549	10.75	0.5506
At most 4	11.76	0.4652	11.76	0.4652

* Probabilities are computed using asymptotic Chi-square distribution.

Table 3.5

Panel Cointegration test for Equation (3)

Pedroni Residual Cointegration Test

Automatic lag length selection based on HQIC with a max lag of 4

	Statistic	Prob.
Panel v-Statistic	1.768202	0.0385
Panel rho-Statistic	-0.43876	0.3304
Panel PP-Statistic	-2.85488	0.0022
Panel ADF-Statistic	-3.01195	0.0013
Group rho-Statistic	1.413785	0.9213
Group PP-Statistic	-1.54475	0.0612
Group ADF-Statistic	-2.50281	0.0062
Cross section specific results		

Johansen Fisher Panel Cointegration Test

Hypothesized No. of CE(s)	Fisher Stat.* (from trace test)	Prob.	Fisher Stat.* (from max-eigen test)	Prob.
None	233.5	0.00	156.6	0.00
At most 1	103.1	0.00	43.67	0.00
At most 2	67.7	0.00	44.71	0.00
At most 3	33.35	0.0009	25.05	0.0146
At most 4	17.92	0.1182	15.12	0.2348
At most 5	17.97	0.1167	17.97	0.1167

* Probabilities are computed using asymptotic Chi-square distribution.

Table 3.6

Panel Cointegration test for Equation (6)

Pedroni Residual Cointegration Test

Automatic lag length selection based on HQIC with a max lag of 4

	Statistic	**Prob.**
Panel v-Statistic	1.03593	0.1501
Panel rho-Statistic	-0.44694	0.3275
Panel PP-Statistic	-2.80485	0.0025
Panel ADF-Statistic	-3.01019	0.0013

	Statistic	**Prob.**
Group rho-Statistic	1.203595	0.88
Group PP-Statistic	-1.79868	0.03
Group ADF-Statistic	-2.86033	0.0021

Johansen Fisher Panel Cointegration Test

Hypothesized No. of CE(s)	**Fisher Stat.* (from trace test)**	**Prob.**	**Fisher Stat.* (from max-eigen test)**	**Prob.**
None	205	0.00	123.4	0.00
At most 1	109.2	0.00	70.67	0.00
At most 2	53.49	0.00	30.1	0.0027
At most 3	31.38	0.0017	26.48	0.0092
At most 4	14.88	0.2483	14.44	0.2734
At most 5	15.45	0.2177	15.45	0.2177

* Probabilities are computed using asymptotic Chi-square distribution

After proving the long run cointegrating relation among the variables, the FMOLS has been used to estimate the coefficient of the independent variables. The results are reported in Table 3.7. According to the results, the coefficient on GDP is positive and statistically significant and the coefficient on squared of the GDP is negatively significant. This proves the existence of the EKC relationship between economic growth and pollution in ASEAN countries. The turning point of the EKC where pollution automatically starts to decrease with further increase in economic activities is found at be $17921 per capita in equation (2). The ASEAN countries are well below to this per capita income level except Singapore and Malaysia. Singapore is the only country among ASEAN whose per capita income is well above then the turning the point income of the EKC. Therefore it can be assert that economic growth without any policy measures would be accompanied by pollution. These results are in line with the findings of the Jain and Chaudhuri (2009). They claimed that advanced countries are on the downward slope of the EKC while developing countries are on the upward slope of the EKC.

In equation (2) the exports of dirty goods from ASEAN to USA are assumed to exist implicitly. It implies that exports of dirty goods would affect the income level and would delay the turning point of the EKC than it would have been without the export of the dirty goods. To find the turning point of the EKC that is exclusive of the impact of the export of pollution intensive goods to USA, the equation (3) has been devised. In Equation (3) the export of pollution-intensive goods to USA from ASEAN countries has been taken as control variable.

Table 3.7

Estimation Results of Pooled FMOLS

Variables	Model No 2	Model No 3	Model No 5
Y	0.014337 (2.694)	0.008447 (1.836)	0.012813 (2.617)
Y^2	-4.00E-07 (-5.595)	-3.30E-07 (-4.709)	-2.61E-07 (-3.623)
XDUSA*Y			1.04E-09 (3.686)
XDUSA		2.03E-05 (2.400)	
FDI	9.91E-09 (8.437)	7.76E-09 (5.720)	1.16E-08 (9.795)
EC	0.019565 ((1.815)	0.021666 ((1.789)	0.0259 1.904)
R^2	0.836	0.841	0.850
R^2	0.836	0.841	0.850
Observations	150	150	150
Turning Point	17921	13198	21417^

^The peak turning point of the EKC at average per capita income of the ASEAN countries in sample period

The results from the equation [2] are almost like results of equation [2] in terms of the sign and magnitude of the coefficients.

The coefficient of export of pollution-intensive is positive and significant. It implies that the increase in the export of pollution-intensive goods to advanced countries like USA would lead to increase in pollution in ASEAN countries. The peak turning point is observed earlier at $13198 in equation (3), where export of pollution-intensive goods is controlled to affect the income. Thus, it can be stated that specialization and export of pollution-intensive goods to USA has delayed the turning point of the EKC. It implies that specialization patterns have increased the environment cost of economic growth in ASEAN countries.

The equation (3) has higher R^2 (coefficient of determination) then equation (2). Therefore, equation (3) can be considered best model as then equation (2) in term of the specification.

The exports of dirty goods are assumed to affect the peak turning point of the EKC owing to its impact on income, whereas export of pollution-intensive goods may also affect the pollution directly. This issue may raise the scepticism about the interpretation of the findings of the equation (2) and equation (3). To overcome these shortcomings, equation (5) has been devised by modifying the equation (3), where the exports of pollution-intensive goods have been taken as an interaction term with income.

The results of equation (5) are also like equation (2) and equation (3) in terms of magnitude, sign and significance. The interaction term has significant positive effect on pollution. It implies that at any given level of income pollution in ASEAN countries will increase with an increase in the exports of pollution-intensive goods. The peak turning point income level of the EKC for equation (5) is calculated by the formula given in equation (6). In this formula, if XDUSA is taken as zero then turning point per capita income GDP value turns to be $14590. However, considering the average value of XDJA in above-mentioned formula the turning point per capita income GDP value reaches to $21417. These results indicate that specialization and export of pollution-intensive goods (chemical, plastic, paper and pulp, woods) to advanced countries like USA delaying the turning point of EKC. The results of the study confirm both the contributing role of the pollution-intensive export to pollution and delaying of the EKC turning point thereby enhancing environment cost of economic growth in ASEAN countries.

CONCLUSION AND RECOMMENDATION

4.1 Conclusion

Following conclusions can be drawn from this research study.

1. The EKC does exist for a pool of six ASEAN countries namely Singapore, Malaysia, Indonesia, Thailand, Philippine and Vietnam for the emission of GHG for the period 1989-2014.
2. The peak turning point of the EKC is observed at $17921 per capita. Singapore is the only country that has crossed this threshold. The other five ASEAN countries except Malaysia are well below to this per capita income level. Therefore, it can be stated that economic growth without any policy measure will be accompanied by more emission of GHG in the ASEAN region.
3. When the effect of exports of pollution-intensive goods to USA is controlled in the third model the turning point of the EKC arrives earlier at $13198 per capita. Therefore, it can be concluded that production and export of pollution-intensive goods (chemical, plastic, paper and pulps and wood) have delayed the turning point of the EKC thereby, have increased the environmental cost of economic growth for ASEAN countries.
4. The negative significant coefficient on FDI in all three models indicates that FDI is also contributing to the increase in GHG emissions in ASEAN countries

4.2 Recommendations

Although, the share of industrial production that is mostly pollution-intensive has decreased in total output in advanced countries, yet the consumption of these goods still very high in these countries. It indicates that this demand is being met by the imports from developing countries. It also indicates that advanced countries have displaced their pollution-intensive industries to the developing world. The logical question arises, if developing countries follow the same growth patterns, to whom they would shift these pollution-intensive industries in future when they will become rich. The advanced countries must curtail the mass consumption of pollution-intensive goods. The world EKC would exist only if income elasticity of demand for pollution- intensive must fall with further economic growth in advanced countries.

The differences in environmental policies in advanced and developing countries causing later one to become pollution haven for developed countries. Therefore, this study does not suggest any partial solution rather it recommends an integrated well designed global programme to tackle the environmental problems of the day.

The Developing countries have been eager to attract FDI for employment and economic growth without any proper well defined environmental management system. They can reap more advantages of FDI if it is directed towards high tech, service sector and energy saving technologies. They should maintain a balance between economic growth and environment. Moreover, the developed countries should provide developing countries with assistance in monetary and in technological terms to upgrade their local skills where they have comparative advantage.

Furthermore, the pollution intensive goods are resource intensive and environmental resources are under-priced in developing countries. The true price of these resources must be reflected in pollution- intensive goods through adequate price policies. It is also worth mentioning that the study does not suggest anti-globalisation measures. Rather it recommends such policies that will make developing counties to specialize in local skills where they have comparative advantage with less environmental cost.

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