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Analysis of pollution haven hypothesis (PHH) and environmental Kuznets curve (EKC) in selected Association of South-East Asian Nations (ASEAN) countries

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ABSTRACT

The Pollution Haven Hypothesis (PHH) claims that following the international trade, developing countries tend to specialize and export pollution-intensive goods to advanced countries. The current study examines the PHH claim in the context of exports of the six major ASEAN countries to Japan in the Environmental Kuznets Curve (EKC) framework for the period 1989-2017. The Fully Modified Ordinary Least Square (FMOLOS) panel co-integration approach has been employed to estimate the coefficients of the EKC model. The results reveal that the EKC does exist while the exports of pollution-intensive goods from the ASEAN to Japan increase the CO2 emission. The study concludes that world pollution cannot be curtailed unless advanced countries reduce the consumption of pollution-intensive goods. Therefore, an integrated well-devised global program is imperative to tackle the alarming issue of global warming, and advanced countries should lead this program.

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1. Introduction

For the last several decades, the advocates of free trade and environmentalists have been engaged in hot debate over the environmental impact of international trade. The increase in industrial pollution all over the world became a vital subject in the history of ecological economics. The economists, scholars, policymakers, industrialists and govt associated bodies showed great concerned about the effect of global trade on environment (Ederington and Minier, 2003; Grossman and Krueger, 1993). This debate started in the 1970s and became intense at the start of the 1990s when Copeland and Taylor (1994) presented their famous hypothesis, i.e., Pollution Haven Hypothesis (PHH). This research study was presented in the background of trade between developed and developing nations. This was first study that related a country's pollution size with the volume of its international trade. The PHH postulates that in free trade regime, the developing nations become a pollution haven for developed nations. The pollution-intensive industries tend to shift their production process from advanced nations that have strict environmental regulations to those developing nations that have lax environmental regulations. Resultantly, the developing nations incline to specialize and export pollution-intensive commodities as they have comparative advantage in its production. The PHH is also one of the criticisms on the EKC. The EKC postulates a nonlinear inverted U-shaped income-environment link. Income growth deteriorates the environment of a country at initial phases of economic development nevertheless, at the advanced stages, economic growth generates the conditions that are conducive for a better environment (Grossman and Krueger, 1991; Panayotou, 1995; Shafik and Bandyopadhyay, 1992). Figure 1 explains this nonlinear association between pollution and income growth.

Figure 1 The EKC relationships between income and pollution

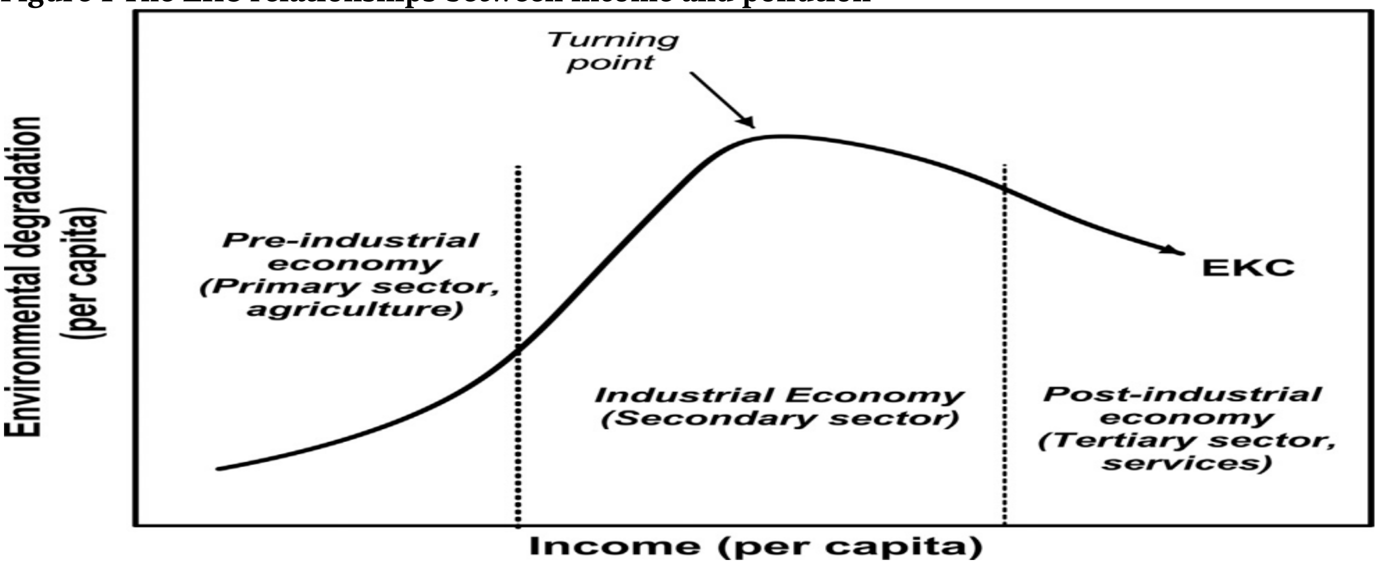

Table 1 Trade as % of GDP of the ASEAN Region

	2011	2012	2013	2014	2015	2016	2017
Brunei	87	87	83	81	81	81	81
Cambodia	125	137	142	145	148	149	149
Indonesia	50	50	49	48	42	44	43
Malaysia	155	148	143	138	134	136	138
Myanmar	33	33	41	43	45	46	48
Philippines	68	65	60	61	61	62	63
Singapore	377	367	362	360	326	325	328
Thailand	114	112	106	105	98	99	99
Vietnam	163	157	165	170	179	182	183

Source: World Bank Focus Economics (2016)

However, according to the proponents of PHH, EKC theory does not incorporate the impact of changes in trade pattern on the environment of a country. They claim that increased international trade has mad developing countries a pollution haven for the pollution-intensive industries. These industries migrated from advanced nations to developing nations to get benefit of lax environmental regulations. This migration has decreased pollution in developed nations as they start to import pollution-intensive product from the developing world. In developed countries downward bend of the EKC and the upward steeper EKC in developing countries may reflect the relocation of the polluting industries (Cole, 2004; Nahman and Antrobus, 2005; Stern, 2004). The EKC therefore, does not infer a net reduction in pollution in advanced nations, rather it implies a relocation of the pollution from the rich nations to developing nations. The ASEAN countries have been following trade and investment liberalization policies for the last three decades. The increased international trade has played a vital role to propel these countries towards the status of middle and high-income countries. Table-1 demonstrates that ASEAN countries have the highest trade to GDP ratio as compared to the other region of the world (World Bank, 2018).

However, liberalized trade and economic growth are also followed by several environmental problems in these nations. The World Bank (2017) report observes a momentous increase in CO2 emissions from the ASEAN countries like Malaysia, Singapore, Thailand, Vietnam and Indonesia. The ASEAN Environmental Report (2018) also indicates that in 90's and 20's the industrial and urban establishment have damaging impact on the environment in ASEAN countries. Similarly, the ASEAN countries also have deteriorated air quality in their cities as evinced by World Air Quality Index 2018. Further, The Environmental Performance Index (EPI, 2018), that is a comprehensive measure of environmental conditions of a country shows that the ASEAN countries especially Indonesia, Thailand, Vietnam, Laos, and Burma have alarming indicators of the environmental quality. Hence, the ASEAN countries as leading trade partner of the advanced countries and having severe environmental problems is a case to be investigated for the PHH trade patterns. The increasing trends of trade and pollution indicate that the ASEAN countries may have the PHH trade pattern.

The scant empirical studies such as Atici (2012), Elliott and Shimamoto (2008) and Takeda and Matsuura (2006) investigates the trade-environment link in the ASEAN countries. Among these studies Atici (2012) is the latest study that investigated the trade and environment link for 1970-2000 period. This study, however, looked at total trade impact on the environment and did not examine the impact of pollution-based export industries on the environment. Also, the studies did not analyse the trade link between advanced countries and the ASEAN in the EKC framework. Moreover, previous studies did not test the PHH claim that developing countries have the skewed EKC because they specialize and export pollution intensive goods to advanced countries. If this test had employed, results would have highlighted how much exports of pollution-intensive exports contributed to the ecological loss of economic development in the ASEAN countries.

2. Literature Review

Since the 1990s, the PHH has become the centre of the debate on the environmental impact of international trade. This debate became increasingly vital as the global production chain reshaped the patterns of international trade (Taylor, 2004). The empirical studies about the trade aspect of the PHH have mixed outcome and several interpretations. Stern (1998) claimed that downward slope of the (EKC) in advanced countries indicates a transfer of the pollution-intensive productions from advanced nations to emerging economies. Antweiler et al. (2001) also supported the PHH theory. They showed that trade liberalization had significantly increased the Sulphur Dioxide (SO2) emissions in the cities of developing countries. They further highlighted that advanced countries had diverted their specialization from heavy to lightweight industries and then to services. Meanwhile, the developing countries increased their specialization in heavy industries. Fontagné et al. (2001) and Keller and Levinson (2002) also endorsed that solving the problem of endogeneity between trade and regulations would increase the empirical support for the PHH.

Similarly, Davis and Caldeira (2010) claimed that 30 per cent of consumption-based CO2 emissions in developed countries was due to imported goods. Peters et al. (2011) also concluded that CO2 emissions in advanced countries had stabilized for the period 1990-2008 while it had doubled in developing countries in the same period. They claimed that net CO2 emission transfer from less developed to developed nations had increased via traded goods. In 1990 it was 0.4 Gt and in 2008 it was 1.6 Gt. Likewise, Lin et al. (2014) reported that "in China manufacturing of exports caused the emissions of 17% of black carbon, 27% of nitrogen oxides, 22% of carbon monoxide and 36% of anthropogenic sulphur dioxide". From the analysis of 187 countries for the period 1970 -2012, Kanemoto et al. (2014) also confirmed the shift of pollution burden from advanced nations to developing countries. They therefore, recommended that consumption of pollution-intensive goods should be curbed in advanced countries to curb global pollution. Sawhney and Rastogi (2015) analysed US-India trade for the period 1991-2010 and concluded that India had become pollution haven for the iron, steel and chemical industries of the USA. McCollough et al. (2016) also reported that the tyre industry (one of the most polluted industry) of the USA had shifted its manufacturing to India. This shifting resulted in a decrease in emissions in USA and increased emissions in India. Tang (2015) revealed that imports of toxic chemicals of the USA from developing economies had increased during the period 1989-2006. In indicates the specialization patterns of developing countries. These empirical findings and facts provide a robust support to the PHH.

Oita et al. (2016) examined the global nitrogen footprint for 188 countries. The results revealed that 25 per cent of global nitrogen footprint was due to internationally traded commodities that were exported from emerging nations to the developed nations. They therefore, concluded that nitrogen pollution in developing countries had been primarily driven by the demand of the consumers of wealthy countries. O'Sullivan (2017) also reported that globalization of goods and services had shifted the harmful effects of some production activities from consuming societies to producing societies. He cited the example of the toys that are sold in the USA, and Western Europe and are manufactured in China. Equally, Zhang et al. (2017) claimed that high mass consumption in the USA and Western Europe were related to 108600 premature deaths in China. Libo and Chang (2017) also found a significant impact of international trade on all pollution indicators in China. They, therefore, recommended that industrial enterprises from China should strictly adhere to environmental standards and to clean development.

On the contrary, the opponents of the PHH claim that following the trade liberalization, a country becomes more competitive and efficient in resource use and to implant environment-friendly technologies. Mani and Wheeler (1998) stated that PHH had been as transient as low wage-havens. Wheeler (2001) claimed that suspended particulate matter (SPM) and organic water pollution (BOD) had been on the decline in Mexico, Brazil, and China since from the beginning of trade liberalization era. Kahn (2003) found that pollution content in manufacturing imports of the USA from developing countries for the period 1958-1994 had decreased. Melo (2004) also revealed that pollution-intensive industries had higher trade barriers as compared to other industries. He examined the trade of five most pollution-intensive industries between 22 developed and 30 less developed countries for the period1981-1998. Similarly, Lovely (2008) claimed that FDI and production fragmentation had positively contributed to curtail pollution in China. Atici (2009) found that trade liberalization did not increase the emission levels in the Eastern and Central European countries. Kearsley and Riddel (2010) also claimed the lack of empirical support in favour of the PHH.

Also, He and Wang (2012) claimed that trade liberalization generally leads to an upsurge in economic activities and wealth generation that eventually lead a country to attain a quality environment. Moreover, international trade transfers advanced and energy-efficient technologies to developing nations. Tan et al. (2013) examined the Australia and China bilateral trade for the period 2002-2010 to verify the PHH stance. Their results specified that trade is beneficial for the environment of both nations. This finding is contrary to the PHH claim that increased trade deteriorates the global environment. They also discovered that CO2 emission from Australia and China in nontrade time period was high than the trade period between two nations. Likewise, Keho (2016) found that trade has increased energy efficiency in Six African countries that is the indicator of the improvement of the environment. Further, Mahmood and Alkhateeb (2017) found international trade helpful in reducing pollution for the Kingdom of Saudi Arabia (KSA). They analysed the influence of international trade on CO2 emissions for time span of 1970 to 2016. Hence, the conclusive empirical results on the PHH trade patron are still pending. Especially in the context of trade between advanced and developing nations, the census has not been built yet about the authenticity of the PHH.

3. Methodology

3.1 Model

Following the Grossman and Krueger (1995) and Shafik (1994), the current study employs following basic model. This model is extensively used to examine the EKC relation between income and environment for a panel data set.

$$CO_{2it} = \beta_\circ + \beta_1 X_{it} + \beta_2 X_{it}^2 + \mu_{it} \qquad (1)$$

Here, CO_{2it}, stands for pollution, X_{it} for income and μ_{it} is the residual term that is assumed to be white noised. Whereas countries are shown as i = 1.2.3……… n and years as t = 1.2.3.4…. t. The EKC relation between income and environment is determined when $\beta_1 > 0$ and $\beta_2 < 0$. Past studies specify that pollution is determined by several variables other than income, therefore, two critical determining factors of pollution: (EC) energy consumption and Foreign Direct Investment (FDI) are incorporated in equation (2) as a control variable.

$$CO_{2it} = \beta_\circ + \beta_1 X_{it} + \beta_2 X_{it}^2 + \beta_3 EC_{it} + \beta_4 FDI_{it} + \mu_{it} \qquad (2)$$

As current study aims at determining the impact of the PHH trade pattern on the slope of the EKC, therefore, the exports of pollution-intensive goods from ASEAN countries to Japan (XDJA) are included in the EKC equation (3).

$$CO_{2it} = \beta_\circ + \beta_1 X_{it} + \beta_2 X_{it}^2 + \beta_3 EC_{it} + \beta_4 FDI_{it} + \beta_5 XDJA_{it} + \mu_{it} \qquad (3)$$

If β_5 in equation (3) is found positively significant, it can be interpreted that XDJA are contributing to the pollution of ASEAN countries. The point on the EKC where pollution starts to decline with further growth in income can be attained by following formula

$$\text{Turning point income level} = \frac{\beta_1}{2\beta_2} \qquad (4)$$

The comparison of this point calculated from equation (2) where XDJA are supposed to affect the income environment relation implicitly and from the equation (3) where XDJA have been included explicitly, would reveal how much production, specialization and exports of the pollution-intensive goods contribute in delaying the turning point on the EKC. In other words, it would indicate how much XDJA have contributed to increasing environment cost of economic growth in the ASEAN countries. Some scepticism may be developed about the implicit impact of XDJA on the turning point of the EKC. The difference in income level where the EKC turns from the equation (2) and the equation (3) may be due to other factors then XDJA. To overcome these uncertainties, the current study includes XDJA in the EKC specification as interaction term with income. In this way turning point income level has become context-specific (Rehman et al., 2012; Webber and Allen, 2004). This specification essentially delivers a method to investigate diverse turning points of the EKC corresponding to different level of XDJA. The equation (5) shows the extended model of the EKC by adding XDJA with income as an interaction term.

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

The equation (5) can be used to find the true impact of XDJA on the turning point of the EKC. Aubourg et al. (2008) claims that through this model the turning point income level can be calculated inclusive of the exports indicators. The income level at the turning point of the EKC can be derived as follow.

$$\text{Turning point income level} = \frac{\beta_1 + \beta_3 XDJA_{it}}{2\ \beta_2} \quad (6)$$

Now the turning point per capita income level from in the equation (6) has become dependent on XDJA. By assuming different values of XDJA, the turning income level of the EKC can be calculated corresponding to different XDJA levels. Moreover, Wald test of zero restriction on the parameters is employed to detect the interaction term effect in this model. CO2 emission is mostly used as proxy of the environment in the prior literature on the EKC and the PHH. Studies like Hassaballa (2013) and Kivyiro and Arminen (2014) provides a logical explanation of taking CO2 emission as a measure of pollution. According to them, CO2 is closely related to the local pollutants like NOx (Nitrogen Oxide) and SO2(Sulphur Dioxide). It is also a significant determinant of global warming and climate changes. Similarly, as per the practice of EKC and the PHH studies, GDP per capita has been taken for the proxy of the income. While the exports of pollution-intensive goods from the ASEAN to Japan (XDJA) has been employed to observe the presence of the PHH. 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.

3.2 Data

Dependent upon the availability of the data, the analysis is confined to only six main ASEAN countries, i.e. Thailand, Malaysia, Vietnam, Singapore, Philippine and Indonesia for the period 1989 - 2017. As per previous exercise of the PHH and the EKC studies, CO2 emission is taken in 'metric ton.' The data about CO2 emissions is attained from the report of International Energy Statistics (IES, 2018). Whereas, the per capita income of all countries has been gathered from the World Economic Outlook 2018. The data for FDI and energy consumption (EC) has been attained from World Development Indicator 2018. The EC is measured in kg of oil equivalent per capita. While, the data for export of pollution-intensive from ASEAN countries to Japan has been taken from International Trade Statistics (2018).

4. Results and Discussions

The empirical analysis includes descriptive statistics, panel unit root tests, panel co-integration tests and Fully Modified OLS (FMOLS). The analysis starts with descriptive statistics given in Table-2. The standard deviations relative to the mean indicate substantial variation in the variables. Moreover, the values of skewness and kurtosis indicate that variables are normally distributed and are not skewed to left or right.

Table 2 Descriptive Statistics

Variables	CO2	X	EC	FDI	XDJA
Mean	147	7125	1697	7.58E+09	1729145
Median	104	2356	845	3.84E+09	1235932
Std. Dev.	125	11852	1679	1.18E+10	1607783

Skewness	1.59	2.57	1.42	3.246102	1.41
Kurtosis	5.93	9.26	3.90	14.54442	4.65
Observations	156.	156	156	156	156

The analysis of time series data requires the investigation the unit root properties of the variables. In table-3 the results of panel unit root tests: Levin et al. (2002)(LLC) and Im and Pesaran (2003)(IPS) are surmised. According to the results all the variables are non-stationary at level i.e., I (0). However, they become stationary at first difference i.e., I (1). Hence, it is concluded that all the variables are integrated of order (1).

Table 3 Panel Unit Root Tests Statistics

	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] *
X	7.13	-5.54	8.07	-4.1
	[1.00]	[0.00] *	[1.00]	[0.02] *
X2	6.69	-1.97	6.67	-1.27
	[1.0	[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] *
XDJA	5.55	-2.81	5.19	-3.59
	[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 Ho: 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 5% significance level

The outcome of panel cointegration tests i.e., Pedroni(1999) and Fisher (1932) for the equations (2), equations (3) and equations (5) is given in Table-4, Table- 5, and Table-6 respectively. Five out of seven Pedroni tests statistics reject the null hypothesis of no cointegration in all cases. The alternate hypothesis is therefore, accepted. Which implies a long run cointegrating link in three equations. Moreover, Fisher tests statistics also do not accept the null hypothesis of none, at most one and at most two co-integration vectors for all equations. Then, an alternate hypothesis of at least one, more than one and more than two co-integration vectors are accepted. Hence, there is robust proof that variables in equation (2), equations (3), and equation (5) have long-run equilibrium co-integrating relationship.

Table 4 The test statistics of Panel Cointegration test for Equation (2)

Pedroni Residual Cointegration Test		
Automatic lag length selection based on AIC with a max lag of 4		
	Statistic	Prob.
Panel v-Statistic	2.482	0.0065
Panel rho-Statistic	-1.165	0.122
Panel PP-Statistic	-3.149	0.0008
Panel ADF-Statistic	-3.248	0.0006
Group rho-Statistic	0.7142	0.7624
Group PP-Statistic	-1.747	0.0404

Group ADF-Statistic		-2.489	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 5 The test statistics of Panel Cointegration test for Equation (3)

Pedroni Residual Cointegration Test		
Automatic lag length selection based on AIC with a max lag of 4		
	Statistic	Prob.
Panel v-Statistic	1.768	0.0385
Panel rho-Statistic	-0.439	0.3304
Panel PP-Statistic	-2.855	0.0022
Panel ADF-Statistic	-3.012	0.0013
Group rho-Statistic	1.414	0.9213
Group PP-Statistic	-1.545	0.0612
Group ADF-Statistic	-2.503	0.0062

Johansen Fisher Panel Cointegration Test				
Hypothesized	Fisher Stat.*		Fisher Stat.*	
No. of CE(s)	(from trace test)	Prob.	(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 6 The test statistics of Panel Cointegration test for Equation (5)

Pedroni Residual Cointegration Test		
Automatic lag length selection based on AIC with a max lag of 4		
	Statistic	Prob.
Panel v-Statistic	1.036	0.1501
Panel rho-Statistic	-0.447	0.3275
Panel PP-Statistic	-2.805	0.0025
Panel ADF-Statistic	-3.010	0.0013
	Statistic	Prob.
Group rho-Statistic	1.2036	0.88
Group PP-Statistic	-1.799	0.03
Group ADF-Statistic	-2.860	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 confirming the long run cointegration relation, the FMOLS is applied to estimate the cointegrated relation. The results for all three equations are shown in Table-7. From the results, it is evident that the coefficient on income (X) is positively significant, and the coefficient on squared income (X2) is negatively significant. The EKC presence is therefore, justified for the ASEAN countries. The results are in line with (Borhan et al., 2012; Kumar and Khanna, 2009; Lipford and Yandle, 2010; Saboori et al., 2012). The turning point on the EKC where pollution starts to decline with further economic growth is observed at $17921 GDP per capita for the equation 2. All the ASEAN countries are well below to this per capita income level except Singapore, that is an advanced country with per capita income of $ 57714 (2017). These results are in line with Jain and Chaudhuri (2009), who claim that advanced countries are on the falling part whereas developing economies are at the rising part of the EKC.

Table 7 Estimation Results of Pooled FMOLS

Variables	Model No 2	Model No 3	Model No 5
X	0.014337 (0.001)	0.009638 (0.050)	0.019725 (0.00)
X2	-4.00E-07 (0.000) *	-3.30E-07 (0.000) *	-6.76E-07 (0.000) *
DXJA*X			2.24E-09 (0.000)
DXJA		1.71E-05 (0.000)	
FDI	9.91E-09 (0.000)	8.06E-09 (0.000)	7.99E-09 (0.000)
EC	0.019565 (0.122)	0.020881 (0.133)	0.000974 (0.010)
R2	0.836	0.868	0.872
Observations	150	150	150
Turning Point	17921	14603	17454

These results imply that more economic expansion in the ASEAN countries especially in Thailand, Philippine, Vietnam and Indonesia that are below to the turning point of the EKC, will bring more emission of CO2. These countries, therefore, need to pursue effective environmental policies while pursuing economic growth. The results of the equation-3 are almost like the results of the equation-2 regarding size, sign, and a significance level of the coefficients. The exports of pollution-intensive goods from ASEAN to Japan (XDJA) have a positive and significant impact on pollution. It implicates that XDJA also contributes to pollution in the ASEAN countries. Interestingly, when XDJA is controlled to affect the income-environment relation in equation-3, the turning point income at EKC is observed at $14603 per capita . Therefore, it can be concluded that the specialization and export of pollution-intensive goods delaying the turning point of the EKC. The higher Adjusted R2 (coefficient of termination) of the equation-3 indicates that it is superior to equation -2 in terms of speciation and explanatory power.

The results of equation-5 are also almost tantamount to the equation-2 and equation-3 regarding the size, sign, and a significance level of the coefficients. The interaction term has a significant positive effect on pollution. It suggests that given level of income, pollution in the ASEAN countries increases with the increase in XDJA. This also can be interpreted in another way around. The income level where EKC turns in the equation-5 can be calculated by the formula given in the equation-6. In this formula, XDJA is taken as zero, income level where EKC turns is $14590 per capita. However, considering the average value of XDJA, the income level where EKC turns, reaches to $17454 per capita. Hence specialization and exports of pollution-intensive goods (chemical, plastic, paper and pulp, woods) to advanced countries like Japan delays the turning point of the EKC. This suggests that exports of pollution intensive goods increase the environmental cost of economic growth in ASEAN countries.

Table 8 Wald Test of Restrictions

Null Hypothesis: C (3) =0 Interaction does not matter in the model			
Alternate Hypothesis: C (3) =0 Interaction does matter in the model			
Test Statistic	Value	Df	Probability
t-statistic	3.68648	139	0.0003**
F-statistic	13.59016	(1, 139)	0.0003**
Chi-square	13.59016	1	0.0002**
Normalized Restriction (= 0)		Value	Std. Err.
C (3)		1.04E-09	2.83E-10
Restrictions are linear in coefficients.			

**rejection of the null hypotheses at 5% significance level

It is also worth mentioning that peak turning point per capita GDP in the equation-5 at average XDJA is almost like the turning point per capita income in the equation -2 where the impact of export of pollution-intensive is supposed to exist implicitly. This indicates that three models adequately explain the effect of XDJA on pollution in the ASEAN countries. Furthermore, the coefficients on explanatory variables as well as on interaction term are consistent regarding the sign, magnitude, and significance level. The equation-5 has the highest Adjusted R2 than equation-2 and equation-3. It implies that equation-5 is more correctly specified. The results of the study confirm both the contributing role of the pollution-intensive exports to pollution and delaying of the EKC turning point. The coefficient on FDI in all three models is significant and positive. Which defines that FDI also contributes to CO2 emission in the ASEAN countries. This empirical output is another support to the PHH stance that FDI fAl-Mulali and Sheau-Ting (2014)lows to the developing countries harm the environment of the host country. The results are similar to Baek and Koo (2009), Kostakis et al. (2017) and Neequaye and Oladi (2015) who claimed that FDI has increased the pollution in developing countries apart from increasing the income and employment. Moreover, the coefficients on energy consumption (EC) in all three models are also positively significant. This implies that EC also has contributed to the increase in the emission of CO2 from the ASEAN region. The results are similar to the findings of Ang (2007) Ramanathan (2002). Finally, to justify the inclusion of interaction term in equation-5 Wald test of coefficient restriction has been employed. The F-statistic, t-statistics, and Chi-square statistics in table-8 reject the null hypothesis. The alternate hypothesis is therefore, accepted that interaction term has significant impact in the equation 5.

5. Conclusions and Recommendations

In recent times, environmental problems such as water and air pollution, environmental changes, and global warming have attracted significant attention of communities, academic scholars, and policymakers. Environmental issues exert severe threats to human life as well as the future of the planet. The attempts are underway to understand the driving factors of environmental changes. The theories like EKC and the PHH try to explain this phenomenon in economic prospectus. However, the existing environmental policies that focus the reduction of greenhouse gases domestically overlook the importance of embodied CO2 emission in internationally traded flows. The current study therefore, investigates this issue in the context of the trade between ASEAN countries and Japan. According to the results, the PHH holds in case of ASEAN versus Japan trade. The results also confirm that economic growth does maintain a nonlinear inverted U-shaped connection with the pollution for the region. The necessary message of the PHH is that world pollution cannot be curtailed unless advanced countries reduce their high mass consumption, particularly of pollution-intensive products.

A logical question in this context arises, to whom present developing countries would pass their pollution-intensive production process in future when they would become rich? The current study, therefore, does not recommend any partial solution for the environmental problems of the world, especially for global warming and environmental changes that are mainly driven by CO2 emissions. An integrated well-devised global program is imperative to tackle these alarming issues, and advanced countries should lead to this program. The developed countries should assist developing countries by providing them with finance and technology in making sound environmental policies because developed countries are the ultimate users of pollution-intensive goods. Moreover, people of developed countries must adopt a sustainable lifestyle to reduce their carbon footprint. Moreover, the pollution-intensive goods are resource-intensive, and emerging nations have comparative advantage in the production of these goods as environment resources are under-priced there. The pricing policies for environmental goods, therefore, need to be examined in developing countries. The real cost of environmental resources must be reflected in the price of goods and services that are produced using these resources.

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