The Impact of Foreign Direct Investment towards Carbon Dioxide Level: Pollution Havens Model for ASEAN5 countries

ABSTRACT

This paper aims to investigate the impact of foreign direct investment (FDI) on carbon dioxide (CO2) emissions through pollution-haven hypothesis model for original ASEAN5 (Malaysia, Singapore, Thailand, Indonesia, and Philippines) countries by using Autoregressive Distributed Lag (ARDL) approach also known as Bound test. Annual time series data is employed for the period spanning from 1970-2008 comprising 39 years of observation. The ARDL technique has the advantage of not requiring a specific identification of the order of the underlying data besides this technique is suitable for small or finite sample size. The results of ECM-ARDL for short run analysis are indicated that in the Philippines case, most of the coefficients in the short run are significant except for gross national income per capita (GNI). In the short run, GNI has showed positively relationship with the CO2 while the manufacturing value added (MV) has negative relationship with the CO2. Other countries in this study; Thailand and Indonesia show a mix evidence of relationship between their independent variables and the dependent variable. Moreover, the results of the long run elasticities show that for GNI, MV, and FDI have significantly and positively influenced the level of CO2 in Indonesia and Thailand. As compared to Philippines, only FDI inflow is positively influence the level of CO2 in this country. ASEAN5 countries should carefully monitor the level of CO2 in the nation as they received more FDI inflow in the countries.

Field of Research: *FDI, CO2 emissions, pollution-haven, ASEAN5*

1.0 Introduction

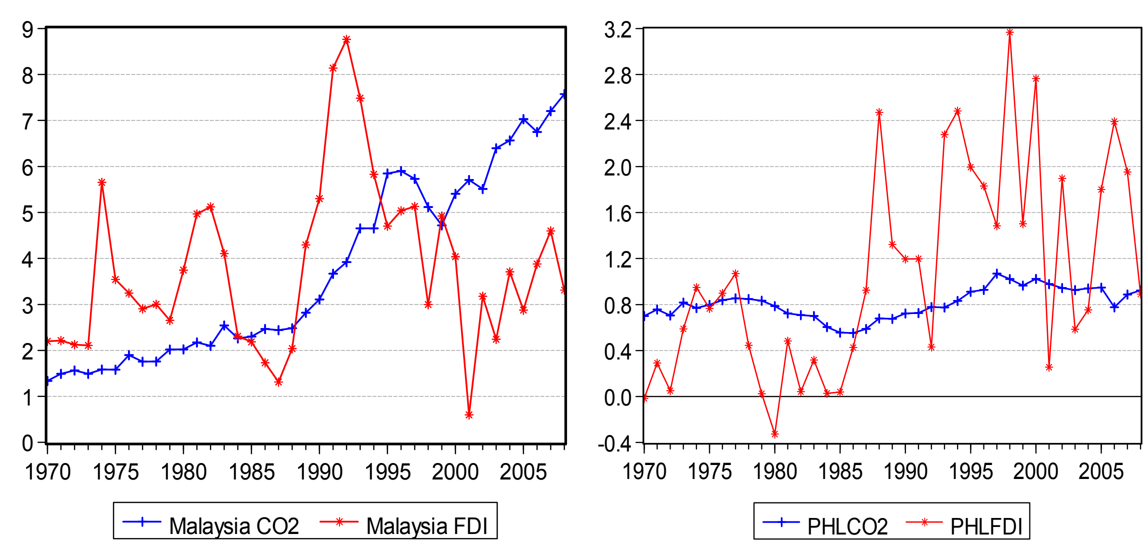
The inflow of FDI has increased rapidly in almost every region of the world especially in developing countries. As the world economy has growing, the global environment has been rapidly deteriorating. Therefore, it is crucial that the macro level effects of investment and trade on the environment are fully understood. Historically, ASEAN5 countries (Malaysia, Indonesia, Singapore, Philippine and Thailand) or previously known as "The East Asian Miracle" has often been cited as a referred model for the rest of the developing world which has attracted very huge amount of FDI during that decade compared to other regions in the world. These countries have even outperformed other regions in the world including the industrial countries in certain aspects (Jomo 2001). Besides FDI, carbon dioxide, a green house gas, which is attributed to rising temperatures worldwide, has also risen significantly from 1970 up to the present year in all ASEAN5 countries. The rising of CO2 level in these countries with the expansion of the growth gave the challenge for ASEAN countries to achieve sustainable growth. Based on the setting of international standards, such as the Millennium Development Goal and the Kyoto Protocol, to reduce the carbon dioxide emissions and the prevailing rhetoric of a pollution-haven hypothesis in economic literature, there is a need to determine whether high-polluting multinationals from the developed nations have been motivated to set-up operations in the developing ASEAN5 countries, as these nations tend to adopt less stringent environmental regulations than nations where the FDIs originated. This finding will answer the question of whether appears to be an FDI driven growth is sustainable with pollution emissions as a criterion to measure sustainability. The general objective of this paper is to examine individually the environmental impact of FDI towards ASEAN5 countries. This study perhaps will able to draw up some policy implication based on the findings for each ASEAN5 countries and contribute to the literature on Pollution Havens hypothesis

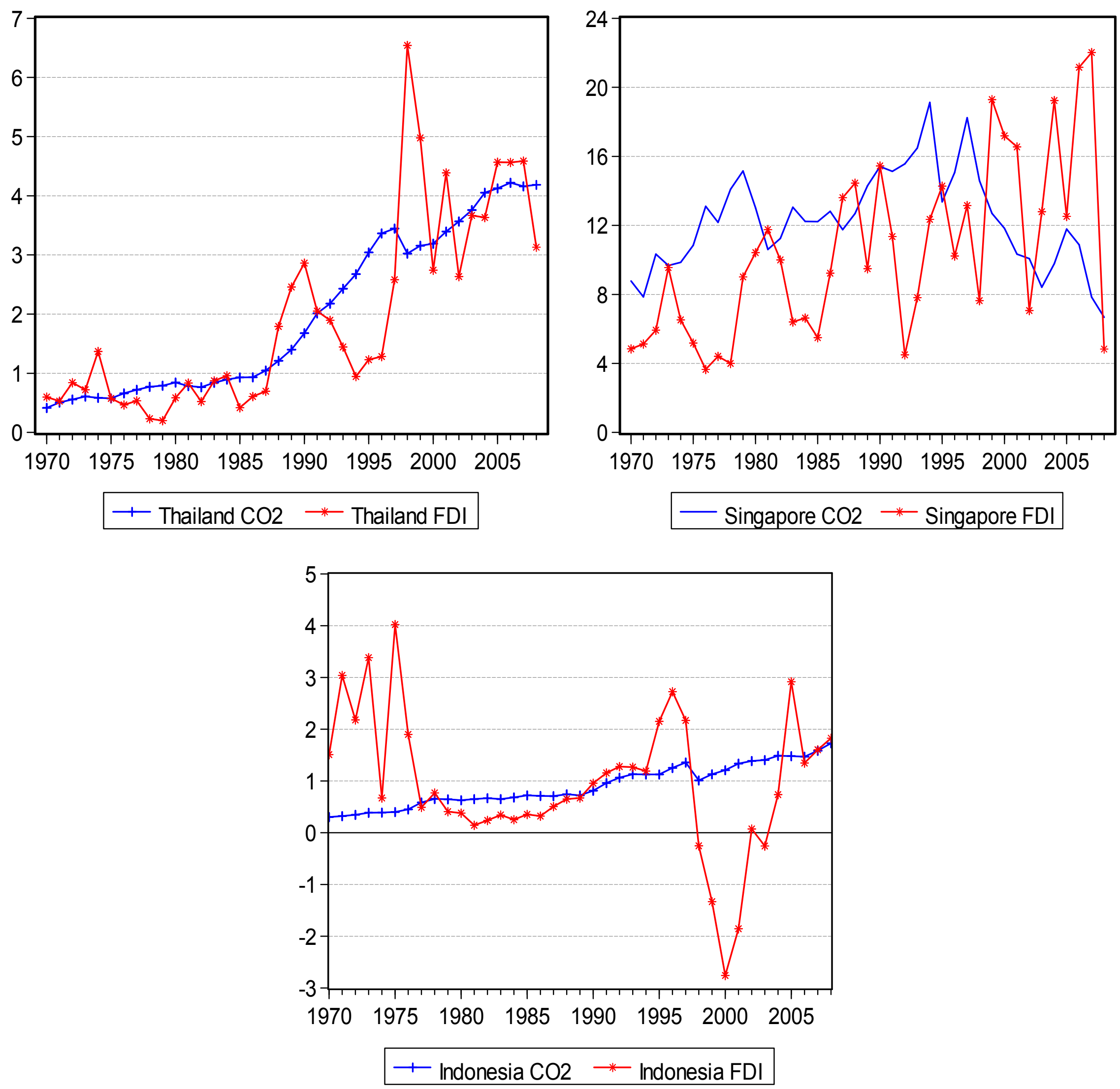
(PPH) model on this group of economies. Besides, the findings of this study, which relates environment with the investment variable, could contribute to on-going plans in which the ASEAN5 governments develop comprehensive environmental policies, recommend specific actions, and outline the investment strategies legislation, and institutional arrangement required to implement them (World Bank, 2003). Furthermore, such a study resonates well with the Asian Development Bank's environmental policy that echoes economic growth with environmental sustainability (Asian Development Bank, 2005). This study also contributes to the available literature on the use of ARDL approach which seems more appropriate compared to standard VEC method given that times series data always contain a unit root.

2.0 Literature review and background of the study

A wide range of studies is available, in the literature, on the impacts of FDI on economic growth but studies on the impact of FDI towards environment are still limited. Most of the past findings on the issue are based on the structure and policy of the countries besides focusing on the categories of the nation. Rock (1996), Eskeland and Harrison (1997), Talukdar and Meisner (2001), Kolstad and Xing (2002), Bimonte (2002), Cole (2004), He (2006), Baek and Koo (2008) and Acharyya (2009) are among the first set of empirical studies that have attempted to address this issues. Rock (1996), for example found that countries with outward-oriented trade policies have a higher pollution intensities of GDP than those following inward-oriented policies. Rock estimates the relationship between the trade policy and the environment with OLS based on cross-country regression equations using the sample of rich and poor countries in the mid1980s. Eskeland and Harrison (1997) which focus on the policy found out that there is no significant correlation between environmental regulations in industrialized countries and the foreign investment in developing countries. The result appeared in Eskeland and Harrison study also resembled the finding of Kolstad and Xing (2002) whereby they found out those developing countries tend to utilize lax environmental regulations as a strategy to attract dirty industries from developed countries. A more recent study based on Vector Error Correction (VEC) model by Baek and Koo (2008) found out that FDI inflows play a pivotal role in determining the short and long run movement of economic growth through capital accumulation and technical spillovers between India and China. However, a FDI inflow in both countries was found to have a detrimental effect on environmental quality in both short run and long run. In addition, Acharyya (2009) founds a positive long run impact of FDI inflows in CO_2 in India from 1980-2003.

Diagram 1: FDI inflow as in % GDP and CO_2 (metric tons per capita) in ASEAN5





FDI and Pollution

Malaysia

Based on diagram 1, Malaysia is experiencing upward trend pollution as measured by carbon dioxide metric tons per capita emissions for the period surveyed. In 2001, carbon dioxide emissions increased to 6 metric tons per capita, representing an increase of four and a half times compared to 1970's level. This increased apparently parallels an increasing trend of FDI inflows from 1970 until 1993. The later year show that the level of FDI inflow falls badly especially in year 2001 but year pass by, it goes back to increasing trend and this pattern also similar the level of CO_2 after year 2001.

Philippines

In 2001, the carbon dioxide level of Philippines increased to 1.0 metric tons per capita, which is almost 1.5 times more than the last 3 decades, though this increase the least among the ASEAN5 nation. Nevertheless, the Philippines's carbon dioxide trend seems to parallel an overall increased in FDI trend as suggest by the figure. Among the 5 ASEAN nations, Philippines is said to have the lowest amount of CO_2 and moderate increase in FDI inflow overtime where it first recorded a negative value of FDI inflow in year 1980.

Thailand

Thailand recorded 0.43 metric tons per capita in 1970 but gradually increased to 4.18 metric tons per capita in 2008, which is an increase of almost ten times over 1970's level. Similar to Malaysia, Thailand demonstrates an increasing trend in carbon dioxide per metric tons emissions which also seems to parallel an increase in FDI as shown in the diagram.

Singapore

Singapore is said to be one of the most competitive ASEAN country and the only developed country in ASEAN group economies. First, the level of FDI inflow in the country is the largest compared to other ASEAN member countries but it does not have a steady trend over times, where the flow of its FDI is always up and down. The level of carbon dioxide per metric tons emission also reflects the parallel movement of the FDI inflow in the country. The FDI inflow is in the expansion trend during 1970 up to 1997 but later turn into contraction period from 1998 up to 2008 as the result of the Asian Financial Crisis 1997-1998 that hit the region.

Indonesia

By year 1978, Indonesia recorded its highest level of FDI inflow which it at 3.04%, followed by the second largest of FDI inflow in year 1996 which is at 2.72%. It achieved the lowest amount of FDI (-2.75) in year 2000. After the huge falls of FDI, the country managed to receive more FDI in the later year it shows that the country's economy has recovered from the deep fall. Nevertheless, the level of carbon dioxide per metric tons emissions seems to increased at increasing rate over time for Indonesia.

Overall trend

Hence, the increasing carbon dioxide trend seems to parallel the increasing FDI trend in all the ASEAN5 countries. This is even more significant since the reduction of carbon dioxide emissions metric tons per capita is an indicator adopted by the United Nations for its Millennium Development Goals (MDGs) to ensure environmental sustainability.

3.0 Theoretical Framework and Model Specifications

The empirical model adopted by Taldudkar and Meisener (2001) is used in this paper.

$$COE_t = \beta_0 + \beta_1 GNIPC_t + \beta_2 MV_t + \beta_3 FDI_t + \varepsilon_t \text{ ------- (1)}$$

COE_t = CO_2 Metric ton per capita
$GNIPC_t$ = Gross National Income per capita
MV_t = Manufacturing, value added as % of GDP
FDI_t = Gross Foreign Direct Investment Inflow as % GDP

Based on Modernization/Neo-classical/Neo-liberal theories, we expect:
$B_1, \beta_2 > 0, \beta_3 < 0$,
Based on the Pollution-Haven Hypothesis, the following is expected:

$B_{1,}$ $\beta_{2,} > 0$, $\beta_3 > 0$,

The CO2 data used in this model include emissions from aggregate fossil fuel consumption and cement manufacture. This dataset excludes emissions from activates such as the burning fuel wood and dung in the informal sector of a developing country which makes the data more pertinent to test its relationship with the FDI level.

The value added measure of manufacturing in term of percentage GDP reflects structural change in the ASEAN5 economy. In this way, conclusions on the impact of structural change on CO2 emission level per capita income can be drawn. Manufacturing added is expected to have a positive sign because it has strong connections with the CO2 level of the country.

The sign of gross national income per capita, GNIPC is also expected to be a positive based on the previous studies using linear model (Fried and Getzner, 2003 and Cole, 2004). The rise in GNIPC will also lead to a rise in the CO2 level of the nation.

FDI will be used to directly test for pollution-haven hypothesis. Taludkar and Meisner, (2001) and Letchuman and Kodoma, (2000) found out that the lack of environmental standards and enforcement in developing countries intensify pollution further by attracting investment in pollution intensive industries from developed countries and lead to a comparative advantage for those nations with lower environmental standards. However, the detractors of the pollution-haven hypothesis counter-argue that FDI will result in an improved environment since it will allow the host FDI nations to have access to cleaner technology. In this model, higher FDI is expected to lead higher pollution. For neo-classical and neo liberal, the sign is negative but for PHH it is positive.Finally, we transform the model into Bound testing approach.

Model for Pollution

Let the long run relationship between the four variables in log linear form is given as follows:

$$LnCOE_t = \underbrace{\alpha + \beta_1 LnGNIPC_{t-1} + \beta_2 LnMV_{t-1} + \beta_3 LnFDI_{t-1} + \varepsilon}_{\text{(Long Run Estimates)}} \text{-----------------(3)}$$

Equation 4 below basically joint the short run dynamics into the adjustment process.

$$\underbrace{\Delta LnCOE_t = \alpha + \sum_{i=1}^{v}\sigma_i \Delta LnCOE_{t-i} + \sum_{i=0}^{s}\beta_i \Delta LnGNIPC_{t-i} + \sum_{i=0}^{r}\epsilon_i \Delta LnMV_{t-i} + \sum_{i=0}^{q}\in_i \Delta LnFDI_{t-i} + d\varepsilon_{t-1} + u_t}_{\text{(Short Run Estimates)}} \text{ -- (4)}$$

Finally, we transform the model into Bound testing approach in equation (5) below:

$$\Delta LnCOE_t = \alpha + \sum_{i=1}^{v}\sigma_i \Delta LnCOE_{t-i} + \sum_{i=0}^{s}\beta_i \Delta LnGNIPC_{-i} + \sum_{i=0}^{r}\epsilon_i \Delta LnMV_{t-i} + \sum_{i=0}^{q}\in_i \Delta LnFDI_{t-i} + \beta_0 LnCOE_{t-1} + \beta_1 LnGNIPC_{t-1} + \beta_2 LnMV_{t-1} + \beta_3 LnFDI_{t-1} + u_t \text{ -----------------(5)}$$

where Δ is the first-difference operator, u_t is a white-noise disturbance term and all variables are expressed in natural logarithms (LN). The above final model also can be viewed as an ARDL of order, (v s r q). The structural lags are determined by using minimum Akaike's information criteria (AIC). From the estimation of ECMs, the long-run elasticities are the coefficient of the one lagged explanatory variable (multiplied by a negative sign) divided by the coefficient of the one lagged dependent variable (Bardsen, 1989). For example based on the final model above, the long-run CO2, GNIPC, MV and FDI elasticities are (β_2 / β_1), (β_3 / β_1), and, (β_4 / β_1) respectively. The short-run effects are captured by the coefficients of the first-differenced variables.

After regression of Equation (3), the Wald test (*F*-statistic) was computed to differentiate the long-run relationship between the concerned variables. The Wald test can be carry out by imposing restrictions on the estimated long-run coefficients of pollution, economic growth, investment and manufacturing value added.

The null and alternative hypotheses are as follows:
H_0 : $\beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$ (no long-run relationship)
Against the alternative hypothesis
H_1 : $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq 0$ (a long-run relationship exists)

For a small sample size study ranging from 30 to 80 obervations, Narayan (2004) has tabulated two sets of appropriate critical values. One set assumes all variables are I(1) and another assumes that they are all I(0). This provides a bound covering all possible classifications of the variables into I(1) and I(0) or even fractionally integrated. If the F-statistic falls below the bound level, the null hypothesis cannot be rejected. On the other hand, if the F-statistic lies exceed upper bound level, the null hypothesis is rejected, which indicated the existence of cointegration. If however, it falls within the band, the result is inconclusive.

The main aim of this model is to test the pollution-haven hypothesis. Hence, the model will investigate primarily the association between carbon dioxide emissions per capita with FDI. Besides, this final model for pollution also investigate the impact of structural change, the value added manufacturing variable on the environment. Finally, it will examine the impact of growth levels on the greenhouse gas emissions.

4.0 The data

The data used in this research paper (CO2, GNI, MV and FDI) for ASEAN5 countries (Malaysia, Thailand, Singapore, Indonesia, Philippines) are all collected from various sources such as International Monetary Fund Statistical Database, World Bank and UNCTAD database that can be access from the internet. The sample data used is annual data starting from 1970 up to 2008 comprising 39 years. The analysis is run by using Microfit version 4.1.

5.0 Results and analysis

Unit Root Test

The analysis began with testing the unit root of every variable for each country in ASEAN5. Unit root test such as augmented Dickey-Fuller (ADF) and the Phillip Perron (PP) test are done to determine the order of integration of the variables. ADF is less powerful in term of detecting the stationary of the data. Therefore, it is why the analysis is paired up with PP since it is more powerful test for detecting the unit root. Results from Table 1A up to Table 1E for ASEAN5 countries namely Malaysia, Indonesia, Philippines, Singapore and Thailand shown a similar result where its dependent variable which is CO2 is not stationary at level but stationary at first difference for both no trend and with trend. In other words, the CO2 for ASEAN5 is stationary at I(1) only after its first difference. This is one of very important condition that the data must met in order to perform the ARDL techniques. Result for the explanatory variables (GNI, MV and FDI) for ASEAN5 countries exhibit a mix evidence of stationarity for ADF and PP unit root test. This clearly suggest that the data that are found to have a stationary at I(1) at level for both no trend and with trend is proven to be a nonlinear types of data and does not suitable to proceed the analysis with Johansan-Juselius cointegration test. This research should proceed with Autoregressive Distributed Lags (ARDL) module as suggested by Pesaran (2001) and Narayan (2004).

Testing Long Run Relationship

In order to proceed with the ARDL testing, we first tested for the existence of long run relationship between the series of the variables. Table 2 display the results of F-statistic for each ASEAN5 countries by using lag order equal to 2. The critical value is also reported in Table 2 based on the critical value suggested by Narayan (2004) for a small sample size between 30 and 80. The test outcome shown that the null hypothesis of no cointegration for Thailand, Indonesia and Philippine is rejected at 1% significant level given their F-statistic value is larger than the critical value for both restricted intercept with no trend and with trend. This implies that the null hypothesis of no cointegration is rejected and therefore proving that there is a relationship between the variables in the long run. However, there is no evidence of long run relationship for Malaysia and Singapore given that the F-statistics value is lower based on the critical value table. Having found a long run relationship for Thailand, Philippines and Indonesia, we estimated the long run model based on equation 3. The maximum order of lag chooses here are 2 as suggested by Pesaran and Shin (1999) and Narayan (2004). From this, the lag length that minimize Schwarz Bayesian criterion (SBC) is selected.

Short run and long run elasticities

The results of ECM-ARDL for short run analysis are reported in table 3. For Philippines, most of the coefficients in the short run are significant except for GNI. In the short run, GNI has positively relationship with the CO2 while the MV has negatively relationship with the CO2. Other countries in this study; Thailand and Indonesia show a mix evidence of relationship between their independent variables and the dependent variable. For example, the GNI and FDI for Thailand are significant and have a positive sign while the MV shown has a negative sign. For the case of Indonesia, the result shows that GNI, MV and FDI are all significant and have positive impact towards the level of CO2. The short run analysis is kept short here because we are more interested to investigate the result from the long run elasticities analysis.

The error correction term (ECT_{t-1}) for Philippines, Thailand and Indonesia are significant and have the negative sign. The significant of ECT suggest that more than 67%, 9% and 28% of disequilibrium caused by previous years shock will be corrected in the current year and converges back to long run equilibrium for the countries respectively. These coefficients of 0.67, 0.09 and 0.28 reflect the speed of adjustment for these countries and it is shown that adjustment for Philippines will occur more quickly compared to Indonesia and Thailand. To make sure that the models are robust, we applied various diagnostic checking. Based on Panel B, all the models passed all diagnostic checking which renders the long term estimates of these models to be reliable. In summary, the models have no evidence of serial correlation and heteroscedasticity effect in disturbances. Besides, those models also pass the Jarque-Bera normality test which suggest that the errors are normally distributed and all the model's specification are well specified.

Table 4 computed the result of the long run elasticities for CO2 and its determinants, GNI, MV and FDI. The estimated result show that for Indonesia, GNI per capita, manufacturing value added (MV), and FDI significantly and positively influenced the level of CO2 metric ton per capita. The estimated coefficient imply that a 1% increase in GNI per capita, MV and FDI will lead to a rise in CO2 by 0.95%, 0.07% and 0.008% respectively. This evidence conform to the postulation that income per capita is a major determinant of CO2. A positive value for FDI lends a support to the hypothesis of a pollution-haven existing in Indonesia. For Philippines, the estimated result show that GNI per capita and MV are significantly and negatively influence the level of CO2 metric ton per capita. The result imply that as 1% increase in GNI and MV, the CO2 metric ton per capita will decrease to 1.33% and 1.96% respectively. Since the GNI and MV are not significant, therefore both determinants are insignificant in explaining the CO2. Philippine model can still support the existence of pollution havens given that as there is 1% increase in FDI, the CO2 metric ton per capita will rise for 0.08%. Based on result derived from Thailand, it is shows that the pollution-haven hypothesis is also accepted given that value is significant. Similar to Indonesia, both GNI and MV are significant and positively influenced the level of CO2 besides conform to neo-liberal theory. A 1% increased in GNI and MV will lead to an increase of 3.51% and 5.89% in CO2 metric per capita revealing that for this model, MV give higher impact compared to the other two determinant. Here we can concluded that the pollution havens hypothesis are hold for all the three countries study above. FDI was included to specifically testing for the existence of pollution-havens in every nation.

5.0 Policy implication and conclusion

This research paper examines the relationship between pollution and foreign direct investment for ASEAN5 nations spanning from 1970 to 2008 by using the ARDL approach. Based on the summary from the analysis, FDI will always generate the level of CO2 for all stages of economic development. The link between FDI and CO2 is supported with the Pollution-Haven hypothesis. It is found that for Philippines case, MV and GNI will bring a negative correlation with the omission level. Nevertheless, the MV and GNI for Thailand and Indonesia have a positive relationship with the level of CO2. As for policy recommendation, all the three countries should adopt the concept of sustainability in development because of FDI is always strongly associate with the rise of CO2 metric per capita. Therefore, the government should propose a suitable environmental policy to control the emission without sacrifice the growth of the development. Adopting and implementing more environmental friendly policies would be more potent than curbing economic growth or to wait for pollution to decrease after attaining a certain level of economic growth [Grossman and Kruger (1995); Moomaw and Unruh (1997); Taldukar and Meisener (2001)]. Furthermore, in order to decrease pollution, all nations would do well in lessening its manufacturing activities given the prevailing conventional wisdom that manufacturing activities are a major contributor to existing world CO2 levels [Taldukar and Meisner (2001); Cole (2004); Jorgensen (2006)].

Here we can conclude that the pollution havens hypothesis are hold for all the three countries study above. FDI was including to specifically testing for the existence of pollution-havens in every nation.

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APPENDIX

Unit Root Test: Table 1a

Country	DF/ADF Unit Root Test			
Malaysia	Level		First Difference	
	No Trend	With Trend	No Trend	With Trend
LCO2	-0.535 (0)	-2.406 (0)	-7.433 (0)***	-7.326 (0)***
LGNI	-1.440 (0)	-2.002 (0)	-5.498 (0)***	-5.662 (0)***
LMV	-2.462 (1)	-1.685 (1)	-3.647 (0)***	-4.252 (0)***
LFDI	-3.651 (0)	-3.602 (0)**	-8.494 (0)***	-8.384 (0)***
	PP Unit Root Test			
LCO2	-0.488 (1)	-2.449 (2)	-7.422 (1)***	-7.316 (1)***
LGNI	-1.440 (0)	-2.035 (2)	-5.503 (1)***	-5.662 (0)***
LMV	-2.922 (3)*	-1.578 (3)	-3.527 (2)**	-4.193 (2)**
LFDI	-3.650 (2)*	-3.608 (2)**	-8.540 (1)***	-8.430 (1)***

Unit Root Test: Table 1b

Country	DF/ADF Unit Root Test			
Indonesia	Level		First Difference	
	No Trend	With Trend	No Trend	With Trend
LCO2	-1.428 (0)	-2.680 (0)	-5.552 (0)***	-5.564 (0)***
LGNI	-1.798 (0)	-1.439 (0)	-4.614 (0)***	-4.797 (0)***
LMV	-0.782 (0)	-1.567 (0)	-7.340 (0)***	-7.452 (0)***
LFDI	-2.181 (4)	-2.060 (4)	-2.802 (3)*	-2.904 (3)
	PP Unit Root Test			
LCO2	-1.840 (10)	-2.577 (5)	-5.654 (8)***	-6.090 (10)***
LGNI	1.716 (2)	-1.556 (1)	-4.575 (2)***	-4.688 (4)***
LMV	-0.769 (1)	-1.590 (3)	-7.368 (3)***	-7.679 (5)***
LFDI	-2.997 (2)**	-2.902 (2)	-9.868 (15)***	-17.384 (36)***

Unit Root Test: Table 1C

Country	DF/ADF Unit Root Test			
Philippines	Level		First Difference	
	No Trend	With Trend	No Trend	With Trend
LCO2	-1.382 (0)	-1.615 (0)	-6.412 (0)***	-6.325 (0)***
LGNI	-0.631 (0)	-0.996 (0)	-4.412 (0)***	-4.371 (0)***
LMV	-1.242 (0)	-3.801 (4)**	-6.617 (0)***	-6.519 (0)***
LFDI	-4.191 (0)***	-4.707 (0)***	-10.042 (0)***	-9.913 (0)***
	PP Unit Root Test			
LCO2	-1.524 (3)	-1.798 (3)	-6.404 (3)***	-6.324 (3)***
LGNI	-0.980 (2)	-1.445 (3)	-4.412 (0)***	-4.371 (0)***
LMV	-1.368 (3)	-3.217 (3)*	-6.615 (3)***	-6.512 (3)***
LFDI	-4.247 (4)***	-4.804 (3)***	-10.776 (3)***	-10.626 (3)***

Unit Root Test: Table 1D

Country	DF/ADF Unit Root Test			
Singapore	Level		First Difference	
	No Trend	With Trend	No Trend	With Trend
LCO2	-1.478 (0)	-1.324 (0)	-5.363 (1)***	-6.048 (1)***
LGNI	-4.694 (0)***	-22.332 (0)***	-47.368 (0)***	-47.188 (0)***
LMV	-3.347 (2)**	-3.181 (2)	-5.152 (0)***	-5.302 (0)***
LFDI	-3.455 (0)**	-4.347 (0)***	-6.460 (0)***	-5.480 (4)***
	PP Unit Root Test			
LCO2	-1.549 (1)	-0.852 (5)	-5.981 (3)***	-8.152 (11)***
LGNI	-5.056 (4)***	-12.281 (5)***	-47.684 (4)***	-61.448 (4)***
LMV	[illegible]	[illegible]	[illegible]	[illegible]
LFDI	-3.454 (1)**	-3.495 (10)*	-8.305 (16)***	-8.746 (15)***

Unit Test: 1E

Root Table

Country	DF/ADF Unit Root Test

Thailand	Level		First Difference	
	No Trend	With Trend	No Trend	With Trend
LCO2	-0.615 (1)	-1.822 (1)	-3.970 (0)***	-3.907 (0)**
LGNI	-1.024 (1)	-2.000 (1)	-3.299 (0)**	-3.321 (0)*
LMV	-1.547 (1)	-3.371 (0)*	-8.223 (0)***	-8.409 (0)***
LFDI	-1.637 (0)	-3.160 (0)	-6.453 (0)***	-6.351 (0)***
	PP Unit Root Test			
LCO2	-1.156 (2)	-1.449 (3)	-3.970 (0)***	-3.907 (0)**
LGNI	-0.729 (3)	-1.553 (3)	-3.360 (1)**	-3.375 (1)*
LMV	-1.917 (0)	-3.589 (3)**	-8.529 (2)***	-8.866 (3)***
LFDI	-1.622 (1)	-3.238 (1)*	-6.507 (3)***	-6.395 (3)***

Note: (*),(**),(***) indicate significant at 10%,5% and 1% significance level respectively. Number in parentheses is standard errors.

Table 2: F-Statistics for Testing the Existence of Long Run Relationship

ASEAN5 F Statistics		Significant Level	Bound Testing (restricted intercept and no trend)		Bound Testing (restricted intercept and trend)	
Malaysia	3.3418		I (O)	I (1)	I (0)	I (1)
Thailand	15.0902	1%	4.400	5.664	5.085	6.698
Singapore	2.1284	5%	3.152	4.156	3.593	4.865
Philippine	7.2148	10%	2.622	3.506	2.955	4.083
Indonesia	5.8643	Lags=2, k=3 and n=37 (39-2). This bound test statistic based on Narayan (2004)				

Table 3: Estimation of Restricted Error Correction Model (ECM Model)

Panel A: Estimated Model			
	Philippines	Thailand	Indonesia
Dependent variable: D(LCO2)	ARDL(2,2,0,2)	ARDL(1,1,1,0)	ARDL(1,1,0,0)
Constant	4.6784** (1.5402)	-0.51093 (0.84249)	-1.8119 (1.1191)
ECT_{t-1}	-0.6783** (0.5402)	-0.091965* (0.083470)	-0.28825* (0.14460)
$D(LCO2)_{t-1}$	-0.25005* (0.13864)		
D(LGNI)	0.29758 (0.26625)	1.5404*** (0.24980)	1.1524*** (0.32109)
$D(LGNI)_{t-1}$	1.0053** (0.31220)		
D(LMV)	-0.59872* (0.29543)	-0.059751 (0.28190)	0.021103* (0.13634)
$D(LMV)_{t-1}$			
D(LFDI)	0.0016270* (0.0097366)	0.029486* (0.016974)	0.0025839* (0.013537)
$D(LFDI)_{t-1}$	-0.024399*** (0.0085274)		
Note: (*),(**),(***) indicate significant at 1%,5% and 10% significance level respectively. Number in parentheses is standard errors.			

Panel B: Diagnostic Checking			
Serial Correlation[a]	4.4240 (0.674)	0.0034717 (0.953)	3.1174 (0.10)
Functional Form[b]	0.54452 (0.461)	0.22520 (0.635)	0.71528 (0.398)
Normality[c]	9.0148 (0.254)	5.7469 (0.3423)	3.3779 (0.185)
Heteroscedasticity[d]	0.72196 (0.396)	0.70818 (0.400)	0.091787 (0.762)
Note: Dependent variable is D(LGDP). (*),(**),(***) indicate significant at 1%,5% and 10% significant level respectively. [a] Langrange multiplier test of residual; [b] Ramsey's RESET test using the square of the fitted values; [c] Based on a test of skewness and kurtosis of residuals; [d] Based on the regression of squared residuals on squared fitted values.			

Table 4: Estimation of Long Run Elasticities

Country/ ARDL (p,q,r,s)	Thailand ARDL(1,1,1,0)	Philippines ARDL(2,2,0,2)	Indonesia ARDL(1,1,0,0)
Dependent variable: LCO2*			
Constant	-5.5557 (4.5286)	15.3691** (0.61707)	-6.2857*** (1.3909)
LGNI*	3.5173* (2.5914)	-1.3394 (0.55766)	0.95192** (0.44019)
LMV*	5.8987* (6.9707)	-1.9669 (1.0055)	0.073209* (0.48909)
LFDI*	0.32063* (4.5286)	0.088534* (6.1707)	0.0089639* (0.048909)

Note: (*),(**),(***) indicate significant at 10%,5% and 1% significance level respectively. Number in parentheses is standard errors.