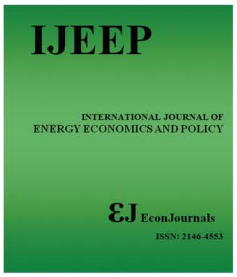

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The Impact of Foreign Direct Investment on CO_2 Emissions in ASEAN Countries

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ABSTRACT

The aim associated with the present study is to examine the sector-specific foreign direct investment and CO_2 emissions. This study employs panel Granger causality tests to investigate the association between sector-specific foreign direct investment and CO_2 emissions. Using a sample of 5 ASEAN countries for the period of 1980-2018, we find causality running from foreign direct investment in polluting intensive industries ("the dirty sector") to CO_2 emissions per capita. This result is robust to controlling for other factors associated with CO_2 emissions and using the ratio of CO_2 emissions to GDP. For other sectors, we find no robust evidence that FDI causes CO_2 emissions. These findings are suitable for the regulation making authorities while developing the regulation related to the FDI and carbon emissions. This study provides the guidelines to the upcoming studies who wants to investigate this area in the future and suggested that upcoming studies should add other that FDI factor to investigate the carbon emissions.

Keywords: Carbon Emissions, Foreign Direct Investment, Granger Causality tests, ASEAN Countries
JEL Classifications: E22, F21

1. INTRODUCTION

The global-warming and change in climate have appeared a severe issue confronting the world society in current years. The effect of human on the weather structure is obvious and the current anthropogenic emission of greenhouse gases particularly CO_2 emissions is very high in the record. The changes of Climate have had a worldwide effect on human being and usual systems. Consequently, all over the world, a significant extent of concentration has been given to grasping CO_2 emissions and establishing an economy with low CO_2 emission. Economic growth and energy consumption are two more essential variables associated with environmental degradation. However, they have to suit conclusive elements in environment pollution and most of the researches restrict their researches simply to environment-pollutant, specifically CO_2 emissions, which associate with economic-growth and energy-consumption. CO_2 emissions may not explain by only energy consumption and economic growth (Ozturk and Acaravci, 2013; Zhang, 2011). Thus, we require to examine different variables that are connected to CO_2 emissions.

However, the most important variable has become FDI, in this regard, certain information's have been addressed particularly in the ASEAN's perspective. Certainly, the foreign direct investment flow of increasing in developing economies arouses a vital query concerning whichever it has any environment effect (Zeng and Eastin, 2012). In such a way, the effect of FDI on CO_2 emissions research is required. However, FDI is actively attracting by ASEAN, past researches without an investigation of the complication relationship of FDI and CO_2 emissions along with the causal relation, which brings to worse discrimination in the hypothesis of pollution haven. The comfortable environment standard in developing economies, with predictable examination may recommend that FDI may encourage carbon emissions at a large level (Pao and Tsai, 2011). To fascinate FDI, developing economies have a propensity to disregard environment issues

across comfortable or non-enforced directions; in economic theory, this phenomenon has selected the hypothesis of pollution haven. Although, when technologies of low carbon are provided to decrease the CO_2 emissions through FDI in overall, or when foreign direct investment flows to concentrate on the service-industry then the impact of foreign direct investment can be reversed. It is thought that outside enterprise employ improved administration exercises and highly developed technologies that are encouraging to a dirt-free environment in host-economies (Zarsky, 1999), this is recognized as the halo effect hypo-thesis. In the same way, Zeng and Eastin (2012) estimate that overall foreign direct investment in-flows in less developing economies encourage improved environmental consciousness.

In this paper, we examine the association among foreign direct investment and CO_2 emissions in ASEAN countries, during the period 1980-2018. Particularly, we develop a panel-granger-Causality test of the association among foreign direct investment and CO_2 emissions. Two important issues addressed by this approach. 1st, by addressing causative relationship it helps us to get more consistent estimates on the association among foreign direct investment and CO_2 emissions. 2nd, a panel model allows us to raise the observations in integer considerably and to describe findings that are specific with the region, because we are working with macro data. Moreover, using foreign direct investment data disaggregated by sectors, our study extends on earlier work. Therefore, we are competent to identify in pollution-intensive sectors increases in FDI are linked through very high CO_2 emissions in ASEAN countries.

The findings of our research show that in pollution-intensive sectors the foreign direct investment in-flows can be associated to rises in CO_2 emissions, but in other sectors, the same link does not hold for FDI. Consequently, policymakers in the country could benefit from examining this distinguished environment effect of foreign direct investment.

The organization of the study is as following way. In part 2nd, we present a review of the literature on the association between FDI and pollution. Part 3rd presents the methodology. In part 4th we discuss the findings with robustness-tests, and part 5th concluding remarks.

2. FDI AND THE ENVIRONMENT: A LITERATURE-REVIEW

The substantial researches are investigating foreign direct investment flows into less developed countries. This concern is based on several levels, to the significant rises of foreign direct investment in-flows to ASEAN-5 over the previous decade. Moreover, in developing economies foreign direct investment has concerned concentration as an economic-growth potential engine. The advantages of foreign direct investment as of its long-term nature on growth stem, the establishment of employment and stock of capital and the technology transfer and skills that bring to higher production (Borensztein et al., 1998). These prospective gains of foreign direct investment over another form of capital in-flows and the concern of multinational corporations to re-locate have made attracting foreign-direct-investment a vital aspect of the economic agenda in several developing economies.

The vital concern is whether negligent environment standards are an element of the growing aspiration of multinational corporations to relocate in a foreign country. The rivalry between LDC's might probably have instigated a 'battle to the lower' in connection to environment parameter, wherever pollution-intensive multinational corporations re-locate to LDC's with less severe environment conditions (Xing and Kolstad, 2002). This is called as the pollution-haven hypo-thesis (Mani and Wheeler, 1998). The several kinds of researches result never favour for the pollution-haven hypo-thesis and empiric confirmation has been varied (Mani and Wheeler, 1998; Wagner and Timmins, 2009).

The pollution haven hypo-thesis with lack of consistent evidence may indicate that environment provisions are unlikely to have an impact on the location of the plant since the multinational corporation's reserves as of lower environment directive can be smaller. Furthermore, pollution intensive industries re-locating to less developed countries may probably have purifier methods of production than comparable domestic-industries. In this regard, in the long run, the foreign direct investment to less developed countries may lead to cleaner technologies. Similarly, probably, domestic-firms will ultimately obtain the purifier technologies of foreign firms. This vision is identified as the pollution-halo hypo-thesis and sustains the concept that the existence of foreign-owned firms might give major environment advantages to less developed countries (Antweiler et al., 2001; Birdsall and Wheeler, 2001; Talukdar and Meisner, 2001; Zarsky, 1999). Generally, the observed support on the relationship among foreign direct investment and pollutant has been doubtful and tangible policy recommendations are complex to formulate.

A probable justification of the uncertainty in the empiric findings throughout researches reclines in the distinctions in the extent (or query) and the empiric method (counting lack of comparable data, distinctions in econometric-approaches, and proxies). The empiric method to examine the association among foreign-direct investment and environment may be view as of two prospects. The method concerns to the researches that endeavour to evaluate if enterprises decide to establish in regions with low environment conditions through employing data at the industry level, environment rigidity measures and pollution intentions via industries (utilization of pollution reduction expenditures moreover at residence and overseas). The greater part of this estimation is collected from case-studies or firm-level investigation. It is difficult to determine and to account for environment rigidity by the source of concern with this approach (Albornoz et al., 2009; Wagner and Timmins, 2009).

The 2nd method in the review of literature has focused on the effect of foreign direct investment on the environment. Specifically, formerly firms are situated in other regions it is probable that the levels of pollution will rises. In this regard, it is claimed that levels of pollution can also be used as a proxy of environment rigidity. The study of the observed association between foreign-

direct-investment and pollution is a complicated chore. Foreign direct investment as an effect of pollution may be higher linked to several forms of industries while accessible country-level data of foreign direct investment for developing economies serves to be at the extent of aggregate. Further, pollution data for these types of regions by industry seldom exists.

The other constraint of both methods is that the majority of the presented studies do-not determine the causal relation among foreign direct investment, pollutant and environmental policy. The causal relation is essential as it is probable that multi-national corporations re-locate to economies which until now have higher attentions of pollutants. In contrast, less developed countries may relocate by multi-national companies and this will bring to rise in attentions of pollution. Furthermore, these twin conditions are never jointly constrained. In the investigation, the general technique mostly indicates pollutant (or environmental regulation) is a function of foreign direct investment or vice versa. The effect of foreign direct investment on pollutants can go both intense when the method empirically must capture into regard this bidirectionality. This type of problem has addressed by few studies through conducting a causal investigation or co-integration (Acharyya, 2009; Hoffmann et al., 2005; Lee, 2009; Merican et al. 2007). In these researches, foreign direct investment can be connected to pollution (or environment degradation).

The chosen nations of ASEAN's, i.e., Singapore, Malaysia, Philippines, Thailand, and Indonesia, have economically well developed in contrast to ASEAN's other nations. In 1967 these 5 nations were the 1st founding members of ASEAN's, and they still more dominant ASEAN members in the twenty-first century. Between the ASEAN's nations, Singapore graded the very high (34,758 US.D), persisted through Malaysia (US.D 6318), Indonesia (US.D 1570), Thailand (US.D 3163) and the Philippines (US.D 1403), in the condition of per capita income in 2011. The ASEAN countries average yearly economic growth-rate from 2000 to 2013 continued more than 5%, which intense increase the OECD average 1.6% and is similar to the growth accomplished via India 7.2% and Africa 4.8%. A motivating query between policy-makers, the steady raises in ASEAN five growth.

The growth expertise of ASEAN believes that energy-demand will be greater with a 4% average yearly rate as contrasted to the 1.8% world average. Certainly, there is substantiation that exploits of high fossil fuels will be getting a difference for policy-makers particularly in circumstances of running the problem of environment changes. As an impact of primary energy consumption, CO_2 emissions are possible to increase by 5.1% yearly. The share of worldwide CO_2 emissions in ASEAN, which was 4% in 2013; however it will almost double via 2040, according to the current static.

The impact of Foreign direct investment on CO_2 emissions has obtained substantial concentration in developing-regions (He, 2006; Kearsley and Riddel, 2010), however aside from a small number of researches, small is presently recognized about ASEAN's (Atici, 2012; Elliott and Shimamoto, 2008). ASEAN's regions capture foreign direct investment led-growth policies to impel their economic growth, through appealing a large extent of foreign- direct investment inflows to rises investment. Appreciably, the liberalization actions of every person nation have been long-lasting and as an intact, in attracting FDI ASEAN's has become one of the important countries between developing regions. In specified, the ASEAN-five complete huge endeavour to captivate great amounts of foreign-direct-investment in the history with Singapore important the association.

By looking at the causative associations among foreign-direct-investment and the CO_2 emissions is our study contributes to the above literature. We use a panel method which extends the observations in numbers significantly and enables us to describe conclusions that are country especial. Moreover, by using disaggregated foreign direct investment data by regions, our investigation extends on prior work. We investigate whether foreign direct investment in a specific region is linked with specific CO_2 emissions in ASEAN's. Also, we integrate time series techniques of econometric that give the most consistent outcome on the association among foreign direct investment and pollutant as our econometric technique different from prior estimations. After that, we explain the theoretical-framework and the data apply in our investigation and the econometric-technique.

3. METHODOLOGY

3.1. Theoretical Framework

The theoretical-framework slackly follows List and Co (2000). Since during production pollution-emissions are produced, we can believe that pollution emissions are in-puts to the process of production without loss of generalization. Therefore, by the following equation the earnings of a plant in region j are provided:

$$\pi_j = PQ - P_G G - P_Z Z \quad (1)$$

There G denotes the inputs vector and different attributes which contain, export and import taxes, labour, distance to the markets, capital. P_Z is the unit price of CO_2 emissions and Z is the amount of CO_2 emissions utilized in production. Context $\eta_G = \frac{G^*}{Q^*}, \eta_Z = \frac{Z^*}{Q^*}$ here the asterisk super-script shows the choice of profit-maximizing, the firm profits can be stated as follow:

$$\pi_J^* = \left(p - \eta_G P_G - \eta_Z P_Z\right) Q^* \quad (2)$$

Profits as a function of the input intensities and its prices indicate by Equation. 2. The emissions private marginal cost is zero (that is $p_Z = 0$), in the deficiency of any environmental regulation. P_Z will raise with high rigid environment regulation. Therefore, the profits of the firm depend on the pollution-intensity of production; can affect by the degree that environment regulation (as reflected in p_Z). Firms profits with higher η_Z will be more delicate to changes in p_Z. Thus, we focus on whether foreign direct investment in industries with higher pollution-intensities has a different impact on pollutant in our study.

Therefore, where p_Z is the lowest, another things equivalent a firm will re-locate to the region. Though, in different situations,

a recent site indicates also fresh prices set P_G related to differing labour cost, imports and exports tariffs, and energy transportation. The input intensities probably change, formerly a plant faces will also different prices.

This denotes that foreign direct investment will emerge from a country with steady to missing (or feeble) environment regulation whether the subsequent situation is fulfilled:

$$\pi^*_{J,S} = \left(p - \eta_{G,S}P_{G,S} - \eta_{Z,S}P_{Z,S}\right)Q^* < \left(p - \eta_{G,W}P_{G,W}\right)Q^*_W = \pi^*_{J,W} \quad (3)$$

here the sub-script s shows the country effects of environmental regulation and w is the country with-out environment regulation. We can suppose that $p_Z = 0$ in the country with feeble environment regulation for simplifying Equation. 3. The country with low environment limitations will get foreign direct investment from industries with high pollution intensity, under the situation presented in Equation. 3. Although, observe that different inputs and properties in G can influence the plant location decision as mentioned prior.

The firm site resolution will rely on the parameters of actual-values in equation.3 which must be evaluating these values. We examine foreign direct investment inflows to ASEAN economies and ranked by differing sectors in sort to evaluate their impact on CO_2 emissions, while it is complex to accumulate data at firm level persistent all over the country to evaluate the profit function for all plant. That is leading to higher emissions in these countries; we should presume to examine those pollution-intensive industries should re-locate to regions with negligent environment regulation if the above condition holds.

3.2. Data

The growth in per capita CO_2 emissions is our pollution measure. CO_2 is a pollution usually employ in the studies due to its contributions to global warming, and in international agreements, it is commonly concerned as a key variable of interest (Acharyya, 2009; Hoffmann et al., 2005; Merican et al., 2007; Talukdar and Meisner, 2001). Additionally, CO_2 emissions are the single measure associated with the environment that is accessible constantly over the year for ASEAN nations.

CO_2 emissions growth used by (Hoffmann et al., 2005), CO_2 emissions in total (Acharyya, 2009), CO_2 emissions GDP ratio and per-capita CO_2 emissions in level (Talukdar and Meisner, 2001) in previous work. Different measures of pollution such as PT, NOX and SO_2 have used in a few other studies (Waldkirch and Gopinath, 2008; Xing and Kolstad, 2002). We put a focus on the per-capita growth CO_2 emissions since total CO_2 emissions can-be related with the growth of population. We assemble the CO_2 emissions growth per capita as the 1st difference of the logarithm of per-capita CO_2 emissions. We use an alternate indicator of pollutant, for the reason of robust-ness. We employ the CO_2 emissions growth to GDP ratio at constant international dollars in 2005 (here growth is formed as the difference of the logarithm; by using purchasing power parity rates). We collected both CO_2 emissions indicators from the WDI (WDI, 2018).

Concerning foreign-direct-investment, we extend the studies by examining foreign direct investment in-flows dis-aggregated through the sector. The high pollutant concentration in Plant sectors would be, more possible to be situated in countries with feeble environment polices, at- least in hypothesis, the same as stated in Section 3. Thus, we examine the main three differ sectors: secondary, primary, and tertiary to conclude the form of capital in-flows that are very harmful to the environment. We consider that dis-aggregation in sectors for ASEAN is vital contributes since aggregate measures of foreign-direct-investment uses in most of the existing literature. Approximately saying, the secondary sector includes manufacturing activities, the primary sector, mining and agricultural activities and the tertiary sector, services. An explanation of the industries integrated into each group shows in Table 1. Though, several industries inside the sectors have enormous disparities in pollution-intensities. Consequently, we examine an additional indicator that aggregates foreign direct investment just in pollutant intensive industries. Examining foreign direct investment in pollution-intensive industries is also an important input of this research.

The method to classifies an industry as pollutant-intensive differs in the studies. Jaffe et al. (1995) and Levinson (1996) employ capital-expenditures of pollution abatement as a per-centage of latest or whole capital expenditures to estimate pollution intensity indicator, Kahn (2003) employs toxic-inventory and the energy-use, while List and Co (2000) estimate CO_2 emissions through industry and pollutant abatement operating expenditures. In some of the earlier papers, industries were studied as pollution-intensive in Table 1. Although the disparities in the aspect of sectors and methodology, as well as in the number to attain the pollution-intensity, there are immense analogies in the industries tagged as pollution-intensive. In most of the studies, primary, petroleum and chemicals metals are considered as pollutant-intensive. Based on the available data on disaggregated foreign direct investment and information, pollution-intensive we classify as motor vehicles and other transport equipment mining, quarrying and petroleum, electrical and electronic equipment, chemicals and chemical products, non-metallic mineral products, wood and wood products, paper and paper products, and metal and metal products. Therefore, we generate a pollution-intensive/dirty-sector composed of these industries. We also assemble foreign-direct-investment inflows as a share of GDP in differ sectors (dirty, tertiary, primary, secondary). The data on foreign direct investment dis-aggregated through sector arrives from the UNCTAD database (UNCTAD, 2018). We assemble foreign direct investment through the sector as a GDP share employ data from the world development indicator (WDI, 2018), and employ the logarithm of the sect-oral foreign direct investment in-flow as a GDP share.

In the investigation, different control variables examined are per capita real-GDP (US dollars constant 2000) and the manufacturing-value-added GDP share. These indicators are employed as the 1stdifference of the natural log, we are concerned in the growth of these variables and were collected from the WDI (WDI, 2018). The five ASEAN countries selected for the investigation are Indonesia, Malaysia, Thailand, Philippines, and Singapore. The selected period of estimation is from 1980

Table 1: Summary-statistics

		Mean.	Std. dev.	Max.	Min.
Difference and log trans-formation (in the investigation series employ)					
Variable-name	**Trans-formation**				
CO_2 per-capita growth	d(ln(per-capita CO_2))	0.014	0.104	0.514	−0.584
CO_2 RGDP share	d(ln(CO_2 per-real GDP))	0.001	0.200	0.528	−0.620
Total FDI (%GDP)	ln(total FDI)	0.288	2.538	1.747	−20.431
Primary FDI (%GDP)	ln(primary FDI)	−1.831	6.124	1.703	−29.641
Secondary FDI (%GDP)	ln(secondary FDI)	−1.136	4.426	1.214	−30.602
Tertiary FDI (%GDP)	ln(tertiary FDI)	−1.122	3.470	1.511	−30.843
Dirty FDI (%GDP)	ln(dirty FDI)	−1.581	3.671	1.706	−29.641
GDP per-capita growth	d(ln(per capita GDP))	0.013	0.055	0.140	−0.153
Manuf. val. add. Growth	d(ln(Manuf. val. add. share))	−0.008	0.085	0.418	−0.581
Raw series					
Variable name	**Transformation**				
CO_2 per capita	none	1.812	2.841	26.751	0.214
CO_2 as GDP	none	0.250	0.148	1.462	0.081
Total FDI (%GDP)	none	2.117	1.634	16.311	4.33E-13
Primary FDI (%GDP)	none	1.042	1.671	15.414	3.31E-13
Secondary FDI (%GDP)	none	0.513	0.533	2.650	1.15E-14
Tertiary FDI (%GDP)	none	1.262	1.758	12.520	8.7E-13
Dirty FDI (%GDP)	none	1.154	1.762	15.444	3.31E-13
GDP per-capita	none	2111.1	1831.6	10627.0	521.4
Manuf val add.	none	17.152	4.543	23.450	4.437

Sum of statistics of accessible observations for 10 nations, from the time-period 1980-2018

to 2018 and Table 1. Provide summary statistics of the variables employ in this estimation.

3.3. Estimation Method

For estimation of the association among sect-oral foreign direct investment in-flows and pollutant emissions we employ a granger Causality test. The test of Granger Causality is related to the Vector-Auto-Regressive (VAR) framework. We contribute to the literature about the empirical method in the subsequent two ways. 1st, our estimation concentrate on ASEAN countries and employ sect-oral foreign direct investment. As we know, there is never any estimation that considers the country overall and employs data on FDI through the sector. Specifically, we test the impact of FDI in-flows, in those industries that are examined the more pollute. 2nd, we extend on prior research through employing a test of Granger Causality in a frame-work that leads in to study country attributes and time particular impacts. To verify the robustness of our findings we: (1) expand our estimation to a multi-variate VAR, where we control for different variables linked to CO_2 emissions and (2) employ CO_2 emissions to GDP-ratio as an emissions alternative measure.

The model employed for the granger-Causality test, which related to Hoffmann et al. (2005) estimation is described in details below. In this analysis, the panel-VAR frame-work employed is specified as follow:

$$Y_{i,t} = \sum_{j=1}^{k} \alpha_j x_{i,t-j} + \sum_{j=1}^{k} \beta_j y_{i,t-j} + \alpha_i + \tau_t + e_{i,t} \quad (4)$$

$$x_{i,t} = \sum_{j=1}^{k} \delta_j x_{i,t-j} + \sum_{j=1}^{k} \gamma_j y_{i,t-j} + \alpha_i + \tau_t + e_{i,t} \quad (5)$$

Here Y shows the per capita CO_2 emissions growth and x is the foreign direct investment in-flows in a particular sector. The sub-script i shows the region (i = 1,2,3,….N) and t shows the period (t = 1,2,3,….T). K shows Y variables login number and x integrated as an independent variable, and a_i and τ_t shows the time fixed-effects and country. It is implicit that independent variables and dependent variable are stationary and in these equations, the error term is un-correlated white noise.

For the evaluation of equations (4, 5), we have an un-balanced panel for the reason of missing values for the sect-oral foreign direct investment variables. In our investigation, the Granger Causality test takes the subsequent steps. 1st, equation 4 using to test causative from foreign direct investment to pollutant, the following hypo-these is set:

$H_O : \sum_{j=1}^{k} \alpha_j = 0$ here foreign direct investment does not affect per-capita CO_2 emissions growth

$H_a : \sum_{j=1}^{k} \alpha_j \neq 0$, here foreign direct investment does affect per-capita CO_2 emissions growth

Employing the normal Wald-test for the limitations of coefficient, an F-statistic is constructed. If H_0 accepted, then we can conclude that there is no confirmation of causality operating from sect-oral foreign direct investment to CO_2 emissions. If H_0 is rejected, then we can conclude that there is confirmation that foreign direct investment in a particular sector granger-Causes growth of CO_2 emissions per-capita.

2nd, to check the causative relation from CO_2 emissions to sect-oral foreign direct investment, we set the following hypotheses by using equation 5:

$H_0 : \sum_{j=1}^{k} \gamma_j = 0$, where CO_2 emissions growth does not affect foreign direct investment in-flows

$H_a : \sum_{j=1}^{k} \gamma_j \neq 0$, where CO_2 emissions growth does affect foreign direct investment in-flows

In this context, rejection of H_0 will bring to conclude that in a specific sector CO_2 emissions will affect foreign direct investment in-flows. Our model is specified, bi-variate VAR form in Equations (4,5), but it can be expended to a multi-variate form through extending the independent variables in number. We restrict our Granger causality discussion operating from foreign-direct-investment to CO_2 emissions since our major focus is on the effect of foreign direct investment on CO_2 emissions. For the VAR multivariate, subsequent Talukdar and Meisner (2001) method, we contain manufacturing growth value-added as a GDP share and the per capita GDP growth. These measures are possible to be vital determinants of pollutant and levels of CO_2.

The test of Granger-causality with fixed-effect employ in this investigation states the merits of accounting for nation time effects and characteristics. A vital feature when examining causative relation, comprising nation and time fixed-effect in VAR-panel evaluation enables us to tackle with omitted-variable-bias. In specific, country fixed-effect curb for the characteristic that does not vary for a specified country, for instance, the propinquity to the ASEAN's or different markets. The effects of time contain for actions during a year that is general to all the countries for instance oil prices variations or economic crisis in the region.

Moreover, the variables employed in the investigation are stationary is a vital state for the validity of our investigation. The panel unit-root test perform by us that expects unit-root of individual procedures suggested via Im et al. (2003) in the subsequent variables: per capita CO_2 growth, CO_2 in GDP ratio growth FDI through sector levels (all in logarithm form), manufacturing value added in GDP growth share and GDP per-capita growth (growth determined as the 1stdifference of the logarithm, for all variables). As stated to the Akaike-Information-Criterion (AIC), the number of lags added in the investigation is elected. The series are non-stationary at the 5% level for all the variables, so we reject the null hypothesis.

4. RESULTS

Table 1 shows the summary-statistics of all variables in this investigation. In summary statistics series are provide in two forms first, difference and log transformation second, without difference and log transformation.

The granger-Causality test results by fixed-effect particular in the methodology section for the bivariate and multivariate vector autoregressive shows in Table 2. The table in the estimation shows the F test, by the probabilities in parenthesis, and the Table 2 shows the sum of the coefficients of the causation lagged prior independent variables in brackets. In Table 2 lags and observations in number are also given.

The column 1 estimates show the Granger Causality test when we employ foreign direct investment in-flows in total and columns 2 to 4 when we employ in secondary, tertiary and primary sectors, in Table 2. The test of Granger-causality estimates, when we employ the aggregated foreign direct investment in-flows to dirty industries indicate in column 5 of Table 2. There is confirmation that sectoral foreign direct investment granger causes CO_2 emissions in two situations at the significance level of 5%, considering the bi-variate VAR outcome. Respectively, when employing foreign-direct-investment in the dirty and tertiary sectors, this

Table 2: Granger causality test

	Total FDI	Prim FDI	SecFDI	Ter FDI	DirtyFDI	DirtyFDI
	(1)	(2)	(3)	(4)	(5)	(6)
Null Hypo-thesis: FDI does not granger cause CO_2 growth						
Bi-variate	2.284	1.508	0.184	3.047	6.118	6.132
	(0.138)	(0.065)	(0.800)	(0.017)	(0.000)	(0.000)
	[0.002]	[0.003]	[0.002]	[−0.001]	[0.005]	[0.007]
	<3, 226>	<3, 212>	<2, 200>	<3, 226>	<2, 161>	<2, 161>
Multi-variate	0.231	0.783	0.716	1.631	6.244	5.616
	(0.684)	(0.320)	(0.375)	(0.167)	(0.002)	(0.001)
	[−0.001]	[0.0013]	[−0.002]	[−0.001]	[0.004]	[0.003]
	<2, 171>	<3, 164>	<2, 153>	<3, 188>	<3, 142>	<3, 142>
Null-hypothesis: FDI granger cause CO_2 growth						
Bi-variate	0.680	0.114	1.078	0.185	0.245	0.263
	(0.344)	(0.687)	(0.121)	(0.633)	(0.674)	−0.661
	[1.487]	[2.325]	[1.506]	[1.156]	[−2.683]	[−2.357]
	<3, 243>	<3, 237>	<2, 213>	<3, 243>	<3, 374>	<2, 374>
Multi-variate	0.717	0.0287	1.588	0.434	0.472	0.472
	(0.374)	(0.852)	(0.157)	(0.470)	(0.448)	−0.448
	[6.120]	[1.728]	[2.363]	[1.371]	[−3.871]	[−3.871]
	<2, 375>	<3, 380>	<2, 366>	<3, 213>	<3, 355>	<3, 355>

The coefficients sum of the causation prior lagged regressor's in brackets, F-values with probabilities in parenthesis. Numbers of observation and lag showed by < >. The test of granger-causality investigated through country time-fixed-effects and 1 measure of foreign direct investment at the time in logs. We employ the CO_2 per-capita growth for estimation in column 1 to 5, whereas we employ the CO_2 growth as a share of real-GDP in column 6

null hypothesis is rejected at level 5 and 1%. When considering causative relationship from CO_2 emissions to sect-oral foreign direct investment for the bi-variate VAR, we identify that the null hypothesis do doest rejected, CO_2 emissions do not granger cause foreign direct investment, at the level of 5%.

We evaluate the test of Granger-causality in a multi-variate VAR that contain the GDP per-capita growth and manufacturing-value-added, for the objective of robustness. In Table 2 the Granger Causality test results, for the multi-variate VAR are also given. We estimate that, when we employ foreign-direct-investment inflows in the dirty sector, the null hypothesis that foreign direct investment does not granger causes CO_2 emissions is rejected only. We failed to reject the hypothesis that foreign direct investment does not granger-cause CO_2 emissions, that employ a foreign direct investment in different sectors (primary, secondary, tertiary, and total), for all the other findings. We estimate that, in all cases, we accept the hypothesis that CO_2 emissions granger causes foreign direct investment for the multi-variate VAR.

We also investigate, whether our findings are robustness to employing the growth ratio of CO_2 emissions to real-GDP. This measure is effective since the changes of economic-activity can influence CO_2 emissions and it directly shows the emission to out-put production intensity. Therefore, in low emissions of per unit CO_2 of real-GDP, cleaner technologies could be reflected. The estimates received for the test of granger Causality employing the growth-ratio of CO_2 emissions to real-GDP and foreign direct investment in dirty sectors in Table 3 of column 6. We just estimate evidence of causation operating from foreign direct investment in dirty-sectors to CO_2 emissions at the level of 1%, when we employ this different measure of pollutant emission for the bivariate and multi-variate VAR. This supports our earlier findings.

It is required to converse the extent of the impact that foreign direct investment in the dirty-sector has on CO_2 emissions. Employing the findings presents in Table 2 for the bi-variate VAR (where the dependent variable is the growth of per capita CO_2 emissions and the independent variable is fora foreign direct investment in the dirty-sector), for the average country, we determine the following impact. The rise in foreign direct investment as a share of GDP in the dirty sector through one-standard-deviation rises per capita CO_2 emissions with 0.96% in the two periods next behind the early rise in foreign direct investment in the dirty sector. The rise in per capita CO_2 emissions of 0.96% for the country average shows a rise of 0.03 in metric tons per capita CO_2 emissions. For 2018, this impact is considering that significant magnitude, the CO_2 emissions range among 1 and 2 per capita metric-tons in the sample for the most of the nations (value in this range have 13 out of 18).

The Table 3 shows the findings for the bi-variate and multi-variate VAR models with aggregate foreign direct investment in dirty industries. Column 1, 2 present the findings for the bi-variate model (in parenthesis coefficients with standard-errors). We observe that in dirty sectors the first and second lag of foreign direct investment is significant statistically at the level of 5 and 1%, respectively, when we use CO_2 emissions as dependent-variable in the bi-variate VAR. Columns 3, 4 shows the findings for the multi-variate VAR. For the multi-variate VAR, we estimate that in the dirty sector foreign-direct-investment remains to have

Table 3: VAR estimation

	Bi-variate (CO_2 per-capita)	Multi-variate (CO_2 per -capita)	Bi-variate (C_{O2} GDP share)
Dependent variable: CO_2 growth			
FDI dirty t−1	0.001 (0.002)**	0.002 (0.001)	0.001 (0.002)*
FDI dirty t−2	0.001 (0.002)***	0.001 (0.002)***	0.001 (0.002)***
FDI dirty t−3	0.001 (0.002)		0.001 (0.002)**
CO_2 growth t−1	−0.165 (0.105)***	−0.086 (0.064)	−0.176 (0.114)***
CO_2 growth t−2	−0.226 (0.086)***	−0.205 (0.069)***	−0.389 (0.077)***
CO_2 growth t−3	−0.012 (0.073)		−0.031 (0.075)
GDP per-capita growth t−1	0.182(0.144)**		
GDP per-capita growth t−2	0.258 (0.107)		
Manuf. val. add. growth t−1	0.033 (0.041)		
Manuf. val. add. growth t−2	0.123 (0.040)***		
Constant.	0.210 (0.012)***	0.003 (0.005)	0.211 (0.015)***
R-square	0.235	0.240	0.285
Dependent-variable: FDI			
FDI dirty t−1	0.321 (0.103)**	0.223 (0.171)	0.314 (0.302)**
FDI dirty t−2	−0.218 (0.146)	0.128 (0.128)	−0.218 (0.142)
FDI dirty t−3	0.366 (0.215)*		0.364 (0.213)*
CO_2 growth t−1	−1.583 (1.117)	−2.868 (2.861)	−2.033 (2.333)
CO_2 growth t−2	−3.017 (2.124)	−2.001 (2.171)	−0.466 (2.466)
CO_2 growth t−3	−0.061 (1.778)		0.242 (1.271)
GDP per-capita growth t−1	11.571 (22.416)**		
GDP per-capita growth t−2	−22.510 (21.380)		
Manuf. val. add. growth t−1	1.446 (1.614)		
Manuf. val. add. growth t−2	1.701 (1.166)		
Constant.	−4.348 (2.683)	1.147 (2.101)*	−4.400 (2.613)
R-square	0.406	0.473	0.408

VAR model estimated and Std errors are in parenthesis. '***', '**', '*" denote 1, 5, and 10% significance level

a considerable impact on CO_2 emissions still when we curb for different variables, where in the dirty-sector 2nd lag of foreign-direct-investment is significant statistically at the level of 1%. We estimate that the per capita GDP growth of first lag and the manufacturing-value-added growth of second lag have a positive and statistically significant impact on CO_2 emissions at the level of 5 and 1%, for the control variables, respectively. The columns 5, 6 are shown findings from the bi-variate VAR, when we employ the growth ratio of CO_2emissions as GDP. For the bi-variate VAR with per capita CO_2 emissions, these results are very identical to those presents in columns 1, 2. When employing growth ratio of CO_2 emissions as GDP, in the dirty sector the first lag of foreign direct investment has a positive and significant impact on CO_2 emissions at the level of 10%, while the 2nd and 3rd lag have a significant impact at the level of 1 and 5%, respectively.

Shortly, our results indicate that there is evidence of robust that foreign-direct-investment in the dirty-sector granger cause CO_2 emissions. This implies that, though later managing for nation and characteristics of time-specific, when foreign direct investment in the dirty-sector rises, CO_2 emissions are expected to rises. Though, we find foreign direct investment in other sectors has no robust impact on CO_2 emissions. Our findings contradict with several earlier studies via (Birdsall and Wheeler, 2001; Carrada-Bravo, 1995). Though, the function of dirty industries individually and the probable endogeneity in the foreign direct investment and pollutant association, these researches did not consider.

5. CONCLUDING REMARKS

Foreign direct investment has risen over the previous ten years in LDCs. Consequently, policymakers and academics are concerned about identifying the environmental impacts of these flows. We investigate the association between FDI and CO_2 emissions in ASEAN-5 from 1980 to 2018 and present insights on the environment impact of foreign-direct-investment, in this study.

The results show that foreign-direct-investment in-flows in pollutant-intensive industries can be associated with rises in per-capita CO_2 emissions and GDP per-unit, in the case of some ASEAN nations. Discriminating the environment impact of foreign direct investment through sectors is appropriate for policymakers. It is improbable that ASEAN nations would desire to control the in-flows of foreign-direct-investment in the pollutant intensive-sectors while this outline of investment shows a huge contribute to total foreign direct investment. About 38% of total foreign-direct-investment in-flows have on average spent to pollutant intensive-industries, in our sample.

In our estimation, a vital policy suggestion is that foreign-direct-investment in pollutant intensive industries must be intimately controlled. The negative impacts that this form of foreign-direct-investment has on the environment, it is important for governments to be aware in the state. It may be a probable policy-action that will secure improved environment condition in the region is the construction of a fund for environment enhancement in these nations. The extent of this funding must be reliant on the total of foreign-direct-investment in the pollute sectors, and the environmental-damage findings are linked with the rise in CO_2 emissions, here the private and non-private sectors can contribute.

We are not capable to immediately accept or reject the pollutant halo or pollutant haven hypo-thesis, although our investigation represents that foreign direct investment in pollutant intensive sectors causes higher CO_2 emissions in ASEAN. The shortage of immediately accessible data of firm-level for ASEAN does not enable us to analysis these hypotheses empirically.

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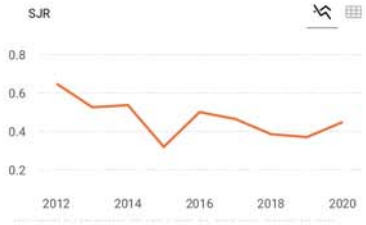

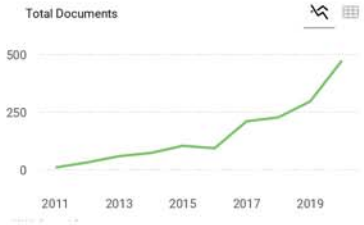

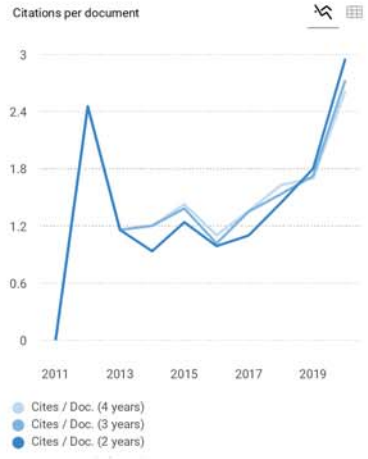

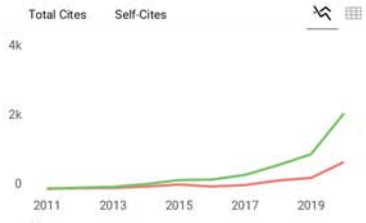

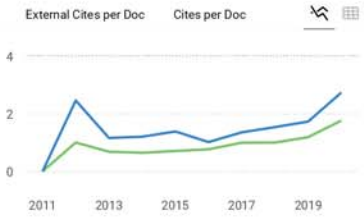

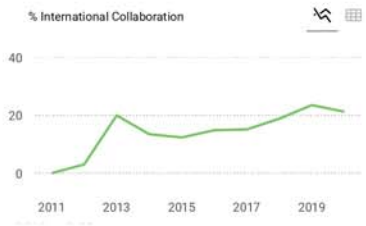

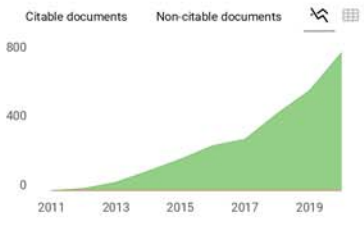

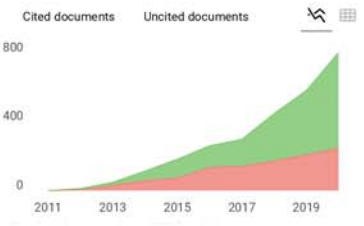

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