FDI-Pollution Nexus: The Role of Corruption

W.N.W Azman-Saini[1], Yin-Li Tun[2]
[1]University Putra Malaysia, Selangor, Malaysia, ✉wazman@putra.upm.edu.my
[2]University Putra Malaysia, Selangor, Malaysia, ✉tunyinli@yahoo.com

Abstract
This study aims to re-investigate the Pollution Haven Hypothesis (PHH) by analyzing the role of corruption. We argue that the impact of foreign direct investment (FDI) on pollution in the host country is contingent on the level of corruption of the host country. By using a sample of 70 developing countries, the findings reveal that FDI do not directly influence carbon dioxide (CO2) emission. However, further investigation using threshold regression analysis uncovers that PHH only exist in countries with high level of corruption. In other words, corrupted countries absorb“dirty” FDI and therefore generate more pollution than less corrupted countries.
Keywords: foreign direct investment, pollution, corruption, pollution heaven hypothesis, threshold

Introduction
Global emissions have been a great concern by many and their impacts (such as global warming or climate chances) are felt globally. Emissions of greenhouse gases (GHG) are claimed mainly contributed by human activities and these cause global warming (IPPC, 2014). In aiming to reduce GHG, Kyoto Protocol was established and target was set to reduce GHG below the 1990 level. The Kyoto Protocol, under the United Nation Framework Convention on Climate Change, is an agreement between industrialized countries to reduce GHG emissions. The first and second commitment period (2008-2012 and 2013-2020) pursues a reduction of GHG by 5 percent and 18 percent respectively in reference to the 1990 level.

Despite the presence of the Kyoto Protocol and various environmental policies, the growth rate of GHG emissions had doubled since 1970 (IPCC, 2014). Among the type of GHG, Carbon dioxide (CO_2) occupies the largest portion and the greatest source of releasing CO_2 is from humanity usage of fossil fuel (i.e. gas, oil and coal). Additionally, it is claimed that the emerging countries are the main driver in releasing CO_2 (IPCC, 2014; Janssens-Maenhout *et al.*, 2017). Current trend of global CO_2 emissions is shown in Figure 1. Notably, CO_2 emissions from developed countries are generally stable but the one from developing countries has increased drastically. The European Joint Research Centre (JRC) attributes this trend to the large move of industrial economic activity to emerging countries (JRC, 2013). This environmental issue is gaining much attention and even some countries include environmental protection in their investment laws enactment (UNCTAD, 2017). Investment laws are commonly known for the objectives of investment promotion and protection as well as economics, social and sustainable development. Incorporating environmental protection in investment laws shed a new light on environmental issues as it indicates that they are serious to address this important issue.

As the developing countries are gaining a strong foothold in global FDI glows, there are growing literatures which recognize the potential impact in has on the host countries. These reallocations of capital are said to be one of the reason which may contribute to the increasing emission of greenhouse gases in developing countries. Furthermore, the reallocation may be linked to one contentious issue — Pollution Haven Hypothesis (PHH) — which remains as one of the hotly debated issue. PHH posits that borderless economic activity induces relocation of polluting industries’ production plant from developed to developing countries which provide lenient environmental standards. This relocation through FDI allows them to exploit some of the loopholes which enable them to curtail abatement cost. Although there are some potential negative impacts brought by FDI on host country environment, some developing countries view this impact as a trade-off for them to benefit from MNCs presence. This view predicts that the attractiveness of positive FDI spillovers is luring developing countries to offer regulatory concessions to foreign investors without gauging the actual impact on the environment.

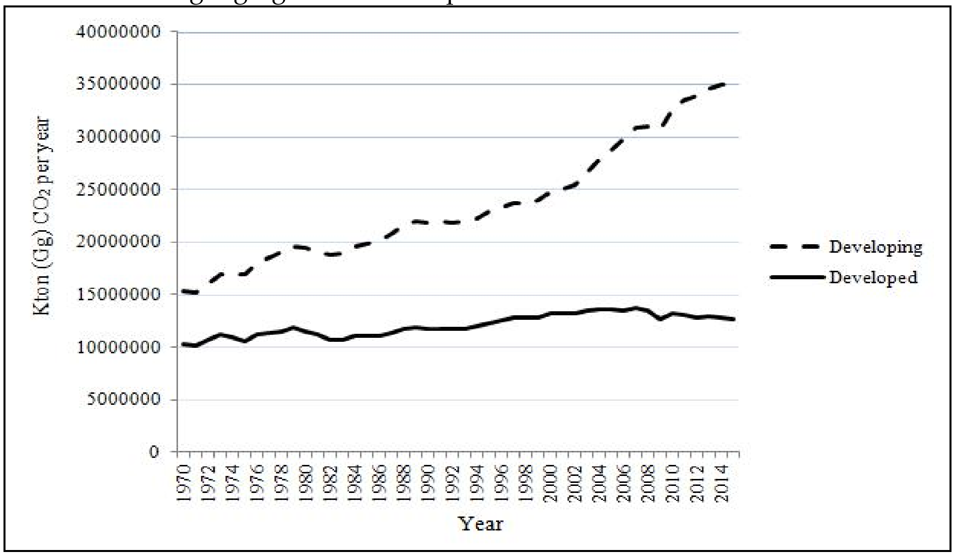

Figure 1 Global CO_2 emission of fossil fuel use and industrial process emissions

Source: Emission Database for Global Atmospheric Research

The past decade has also seen increasing trends of environmental degradation – for example, greenhouse gas emissions, deforestation, loss of biodiversity. Such patterns of environmental destruction have been driven by increased economic activity, of which FDI has been blamed as one of the contributors. This observation become so obvious for developing countries in recent years as various reports show that pollution trend is increasing and at the same time they receive more FDI.

In recent years, we also witness that developing countries are getting more popular as destinations for FDI activities. For the first time in 2012, developing countries is able to absorb more FDI inflows than developed countries and the highest proportion was recorded in 2014 when 54.7 percent of total FDI flows to developing countries (UNCTAD, 2016). Given that the trend of pollution in developing countries is also increasing, several studies have investigated the impact of FDI inflows on environmental degradation in developing countries. The result shows that the findings are inconclusive. Since corruption is generally widespread in developing (Ordover et al., 1994), this study argues that corruption in the host countries may alter the way FDI affect environmental quality. A country which is more corrupt is likely to have more pollution induced by FDI. Corruption can either be a “helping hand” or “grabbing hand”. A “helping hand” says that bribery can enhance the efficiency of commercial activities. Conversely, a “grabbing hand” views corruption as additional cost incurred by the firms. Both “helping and grabbing hands” are favourable for foreign polluted industries that intend to engage in pollution. From polluted industries perspective, “helping hand” effect from corruption provides greater freedom for MNCs to ignore regulations on environmental quality. Similarly, polluted industries are unaffected by “grabbing hand” as long as the bribery costs are lower than the abatement cost. Even though the countries possess stringent environmental policy, pervasiveness of bribery activity will cripple the effectiveness of the policy and enable the polluted industries to achieve their rent seeking activities. Therefore, we believe that corruption in the host country may alter the nature of FDI-pollution link.

The remaining of the paper is organised as follows. Section II reviews some of the past literature on FDI-pollution link. Section III specifies the empirical model and explains the data used in the analysis. It also elaborates the econometric methodology. Next, section IV provides and discusses empirical results. Section V concludes.

There are two economic rationales that are widely adopted in the literatures to explain the relationship between FDI and environment. On one hand, the classical comparative advantage trade perspective treats environment as another comparative advantage factor. Environment is considered as a factor endowment, which is embedded in the production process, and a lax environmental standard able reduces production cost. According to this rationale, a country with a lax environmental standard has a stronger comparative advantage in producing pollution-related product than those with a stringent environmental standard (Mihci et al., 2005). Terms found in literatures such as "pollution haven hypothesis (PHH)" and "race to the bottom" are extended from this rationale. PHH refers to the migration of polluting industries from developed countries (with a relatively stringent environmental standard) to developing countries (with a relatively lax environmental standard), PHH also predicts that the influx of FDI causes environmental pollution in the host country. Countries compete with each other by relaxing their environmental standard while aiming to strengthen their own comparative advantage, and these reflect the "race to the bottom" phenomenon. The "race to bottom" phenomenon is believed to jeopardize the social welfare of the citizen (Revesz, 1992).

On the other hand, the neo-technology trade perspective opposes the former claim that innovation of advanced or greener technology is possible with a stringent environmental standard. "Pollution haloes hypothesis", "race to the top" and "Porter hypothesis" are derived from this rationale. Pollution haloes hypothesis argues that FDI transfer better and greener technology to host country and reduces host environmental pollution (Mihci et al., 2005). Race to the top refers to raising environmental standard to stimulate the innovation of technology. Finally, Porter hypothesis explains that raising environmental standard creates innovation towards greener product or process rather than transferring polluting industries to other countries with a lax environmental standard. Polluting industries are generally more capital intensive and supply of skilled labour may not be guaranteed in the host country. This environmental stringency makes the country a net exporter of advanced environmental technologies.

For single-country studies, rapid ascent in the economic power of China has drawn researchers' attention to study its environmental issues and resulted in mixed findings. Cole et al. (2011) and He (2006) confirmed the negative externalities brought by FDI. Yet, Kirkulak et al. (2011) reached the opposite conclusion, where FDI reduces the air pollution in Chinese cities.With regard to the case of China, the origin of FDI was examined by Wang and Chen (2014) and Cole et al. (2011). Both studies split the FDI sample into two: (1) FDI from Hong Kong, Taiwan and Macau, (2) FDI from foreign investors (besides Hong Kong, Taiwan and Macau) or FDI from OECD. Both studies yielded similar results, where FDI from Hong Kong, Taiwan and Macau do not generate polluting emissions, while the opposite is true for FDI from foreign investors or OECD.

For cross-countries studies, a number of researchers investigated the FDI and emissions using granger causality and found a bidirectional causal relationship between the two variables (Hassaballa, 2014; Hoffmann et al., 2005; Pao and Tsai, 2011). This causal relationship is not evident in Gulf Cooperation Council (GCC) countries, where Al-Mulali and Tang (2013) reported that FDI has no causal relationship with CO_2 emissions and concluded that energy consumption and GDP growth contribute to pollution. Further, Jorgensen (2009) estimates on developing countries indicated that water pollution is positively related to FDI activities in the manufacturing sector. However, the estimates of Atici (2012) were in contrast with previous findings. He illustrated that the Japanese FDI on ASEAN countries do not deteriorate the environmental in host countries. Sapkota and Bastola (2017) reported that FDI has a highly positive significant effect on emission in both high-income and low-income Latin American countries. Related studies regarding PHH are summarized in Table 1.

Table 1. Literature review o FDI and Pollution/Emission

Author	Period	Country/region	Methodology	Results	Support PHH
Atici (2012)	1970-2006	ASEAN countries	RE and FE	FDI does not deteriorate host environment.	×
Al-Mulali and Tang (2013)	1980-2009	GCC countries	Panel cointegration	FDI negatively affects emission in the long run. No short-run causal relationship between emission and FDI.	×
Cole and Elliot (2005)	1989-1994	US, Brazil and Mexico	FE and RE	Higher level of pollution abatement costs in US induces OFDI from US to Brazil and Mexico.	√
Cole et al. (2006)	1982-1992	Developed and developing countries	FE	FDI leads to less stringent environmental policy.	√
Cole et al. (2011)	2001-2004	Chinese cities	FE	FDI positively affects industrial emission.	√
Dean et al. (2009)	1993-1996	Chinese provinces	Logit	Only ethically Chinese FDI is attracted by lax environmental regime.	√
Dick (2010)	1963-1987	Less developed countries	Panel OLS	Emission is positively affected by FDI.	.√
Elliot and Shimamoto (2008)	1986-1998	ASEAN countries	FE	Japanese FDI is positively affecting emissions in ASEAN countries.	√
Eskeland and Harrison (2003)	1982-1993	Mexico, Morocco, Cote d'Ivoire, Venezuela	FE and RE	FDI is related to high levels of air pollution. Higher abatement cost encourages OFDI.	√
Hassaballa (2014)	1971-2010	Developing countries	Granger causality	FDI ↔ energy use.	√
He (2006)	1994-2001	Chinese provinces	Simultaneous system	Small impact of FDI on industrial emission.	√
Hitam and Borhan (2012)	1965-2010	Malaysia	Johansen-Juselius cointegration	FDI positively affects emissions.	√
Hoffmann et al.(2005)	1971-1999	Developed and developing countries	Granger causality	Lower-income countries: $CO_2 \rightarrow$ FDI Middle-income countries: FDI $\rightarrow CO_2$ High-income countries: no causality	√
Table cont...					

Javorcik and Wei (2004)	1993-1996	Eastern Europe and former Soviet Union	Probit and logit	FDI is not attracted by lax environmental regime.	×
Jorgenson (2009)	1980-2000	Developing countries	PCSE,GLS,RE	FDI positively affects water pollution but the effect is mitigated with the existence of environmental ministry and non-government organization.	√
Keller and Levinson (2002)	1977-1994	US	FE	Abatement cost negatively affects FDI.	√
Kheder and Zugravu (2012)	1990-2003	Developed and developing countries	Logit	French FDI invests more in developing countries with less environmental stringency.	√
Kirkulak et al. (2011)	2001-2007	Chinese cities	OLS,FE,RE,GLS	FDI negatively affects air pollution.	×
Lan et al. (2012)	1996-2006	Chinese cities	FE	FDI positively affects emissions in low populated capital cities only.	√
Lee (2009)	1970-2000	Malaysia	ARDL, Granger causality	FDI positively affects emission in the long run. FDI $\rightarrow$ emission	√
Leiter et al. (2011)	1998-2007	European countries	Panel descriptive statistics	Environmental regulation is negatively affected by investment.	√
List et al. (2004)	1980-1990	US	FE	Environmental regulation has no effect on FDI.	×
Mihci et al. (2005)	2000	28 OECD countries	OLS	OFDI positively affects by degree of environmental sensitivity.	√
Mulatu et al. (2010)	1990-1994	European countries	OLS	FDI positively affects emission.	√
Pao and Tsai (2011)	1992-2007	BRIC countries	Panel cointegration	FDI positively affects emission in the long run. Emission $\leftrightarrow$ FDI	√
Rafindadi et al. (2018)	1990-2014	GCC countries	MG, PMG and dynamic fixed effect	FDI negatively affects emission.	×
Rezza (2013)	1999-2005	Norwegian manufacturing sector	FE	Norwegian OFDI is not determined by host country's environmental stringency.	×
Table cont..					

Sapkota and Bastola (2017)	1980-2010	14 Latin America countries	FE and RE	FDI positively affects emission in both high and low-income countries.	√
Solarin et al. (2017)	1980-2012	Ghana	ARDL bound test	Long-run positive impact of FDI on emission.	√
Wang and Chen (2014)	2002-2009	Chinese cities	FE and RE	FDI positively affects emissions but the institutional development is able to reduce these emissions. FDI from OECD countries increases emission.	√
Wang et al. (2013)	1999-2005	Chinese cities	Two-way fixed effect	FDI causes pollution. Local institutions enhance positive impacts and mitigate negative impacts from FDI.	√
Xing and Kolstad (2002)	1985-2006	Developed and developing countries	Panel OLS	FDI positively affects emission in countries with lax environmental policies.	√

Note: the table originally adopted from Al-mulali and Tang (2013) and extended by the author.

The inconclusive results regarding PHH have led several authors to examine the intervening factors between FDI and emissions. These intervening factors include country's relative income, energy consumption, human capital, local institutions and origin of FDI. (Rafindadi*et al.*, 2018; Lan *et al.*, 2012; Wang *et al.*, 2013; Wang and Chen, 2014). All of these studies argue that the FDI-pollution nexus does influenced by the intervening factors. Existing of these factors is providing better explanations in answering why there are mixed findings in PHH realms.

This study is in line with the above findings, regards on the investigation of intervening factors that influence the impact of FDI on environment. We further argues that a higher (lower) degree of government corruptibility attracts a more (less) polluting FDI. In another related study, Cole et al. (2006) found that the interaction of FDI and corruption are negatively related to environmental stringency. They concluded that higher corruption level induces less stringent environmental policy. Yet, the conditional level of corruption on emission is not determined in their study. Similarly, the role of corruption on environmental regulation stringency has been mentioned by Damania et al. (2003) and Fredriksson and Svensson (2003). Damania et al. (2003) found that stricter environmental regulations results in lower corruption level and concluded that the corruption effect on environmental policy is greater in relatively closed economies. Meanwhile, Fredriksson and Svensson (2003) considered the joint impacts of political instability and degree of corruptibility on environmental policy formation. They highlighted that corruption has a negative effect on environmental regulation but the effect decreases as political instability increases. Both studies highlighted the direct impact of corruption but did not consider the indirect interaction or conditioning effect of corruption with FDI on emission. Javorcik and Wei (2004) and Habib and Zurawicki (2002)found that corruption has a deterrence effect on FDI. However, their study did not explicitly explain the interaction or conditioning effect of corruption on emission.

In PHH, lax environment standard are said will attract polluted industries. However, higher environment standard in the host country not necessary deter the polluted industries. This possibility can be explained by the level of corruption in the host country. Astringent environment policy in host might spawn corruption especially among the developing countries. Policy implementation and enforcement is difficult in developing than developed ones because the former does not have sufficient capabilities in term of financial, technical resources and support, and regulators' quality (Ordover et al., 1994). These insufficiencies cause the developing countries to experience low enforcement capabilities (Laffont, 1996). Therefore, developing countries tend to have a strict policy complemented with an inefficient enforcement and these breed the bribery activity for exchange licenceand permit (Rose-Ackermam, 1999). Additionally, strict policy with more red tape creates opportunities for official to get involvedin bribery activity (Shleifer and Vishny, 1993).

Model Specification and Data

This study considers a model which is commonly used in the literature (see for example,Pao and Tsai, 2011; Chandran and Tang, 2013; Seker et al., 2015; Sapkota and Bastola, 2017). The baseline model can be expressed as follows:

$$CO2_{it} = \alpha_0 + \alpha_1 GDPPC_{it} + \alpha_2 GDPPC_{it}^2 + \alpha_3 EC_{it} + \alpha_4 FDI_{it} + \alpha_5 X_{it} + \mu_i + \varepsilon_{it} \quad (1)$$

where CO_2 is carbon dioxide emission (kg per dollar of GDP), GDPPC is GDP per capita, EC is energy consumption (kg of oil equivalent) per capital and FDI is the net FDI inflows. X is a set of control variables which are hypothesized to affect emissions, μ represents the country specific effect and ε is the white noise error term. The subscripts *i* and *t* are country and time indexes, respectively. This analysis covers the 2003-2013 period using data from 70 developing countries. The set of control variables included in this study are corruption, population growth rate and industrial growth rate. The squared term of GDPPC is included in the equation (1) to test the Environmental Kuznets Curve hypothesis. Population and industrial growth contribute to emission through the increasing demand for energy for both daily life and economic activities (Dietz and Rosa, 1994; Wang *et al.*, 2013). Both of these variables are measured in annual growth rate. Carbon dioxide emission is measured in kg per dollar of GDP. Real GDP per capita is used for GDPPC. Energy consumption is measured in kg of oil equivalent per capita and this refers to use of primary energy before transformation to other end-use fuel. Net FDI inflow is expressed over GDP. The original corruption index from the ICRG database is scaled from 0 to 6 in which the highest (lowest) scores represent cleaner (corrupted) environment. However, this index is transformed such that 0 represents corruption-free environment and 6 represents corrupt environment. This transformation is done to allow the expected sign of the index to be consistent with the hypothesis which predicts that a more corrupt environment will induce more polluted FDI and therefore produce more emissions. Population growth rate is measured based on the annual growth rate of the number of residents in a country. Industrial growth rate is measured based on the annual growth rate of industrial value added. All of the variables are expected to carry positive sign except for the square term of GDPPC. The variables used are transformed into logarithmic form prior to the analysis. All data are extracted from the *World Development Indicator* database except for corruption which was extracted from the *International Country Risk Guide* (ICRG) database.

Methods

Several studies have utilized a linear interaction specification to test the conditional effect in economic relation. However, this modeling strategy will restrict the impact of FDI on emission to be monotonically increasing with COR. However, it may be possible that the impact of FDI on pollution "kick in" only after corruption has reached certain threshold level. This possibility cannot be captured by the interaction model which therefore requires a different kind of modeling strategy. This study use threshold regression analysis to test the impact of FDI on pollution conditional on the level of corruption. The model can be expressed as follows:

$$CO_{2\,it} = \alpha_0 + \alpha_1 GDPPC_{it} + \alpha_2 GDPPC_{it}^2 + \alpha_3 EC_{it} + \alpha_5 X_{i1} + \beta_1 FDI_{it} I(COR_{it} \leq \gamma) + \beta_2 FDI_{it} I(COR_{it} > \gamma) + \mu_i + \varepsilon_{it} \quad (2)$$

Where I is the indicator function. In this model, COR (i.e. corruption index) is the threshold variable which is used to split the coefficient on FDI intoregimes or groups and γ is the unknown threshold parameter. This specification allows therole of FDI to be different depending on whether COR is below or above some unknown level γ.The impact of FDI on growth will be β_1(β_2) for countries in low (high) regime. Obviously, under the hypothesis $\beta_1 = \beta_2$ the model becomes linear.According to Hansen (1999), the estimate of γ is obtained by minimizing the sum of squared residuals obtained from a consistent estimation. For simplicity, let us assume that thresholds are estimated from the smallest to largest as follows:

$$\hat{\gamma}_1 = argminS_1(\gamma_1),$$
$$\hat{\gamma}_2 = argminS_2(\gamma_2|\hat{\gamma}_1),$$
$$\hat{\gamma}_j = argminS_j(\gamma_j|\hat{\gamma}_1,\ldots,\hat{\gamma}_{j-1}) \quad (3)$$

According to Equation (3), the hypotheses for testing the presence of threshold effect are shown as follows:

$$\gamma_1{:}H_0^1{:}\beta_1 = \beta_2, \quad H_1^1{:}\beta_1 \neq \beta_2,$$

$$\gamma_2{:}H_0^2{:}\beta_2 = \beta_3, \quad H_1^2{:}\beta_2 \neq \beta_3,$$

$$\gamma_j{:}H_0^j{:}\beta_j = \beta_{j+1}, \quad H_1^j{:}\beta_j \neq \beta_{j+1} \quad (4)$$

Hypothesis in (4) are tested by F_i:

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,

$$F_j = \frac{S_{j-1}(\hat{\gamma}_{j-1}|\hat{\gamma}_1,\ldots,\hat{\gamma}_{j-2}) - S_j(\hat{\gamma}_j|\hat{\gamma}_1,\ldots,\hat{\gamma}_{j-1})}{\hat{\sigma}_j^2} \quad (5)$$

where S_0 is the sum of squares error of the regression. If the *F*-test for *j*th can reject the null hypothesis (i.e. $\hat{\gamma}_j$ is statistically significant), this indicate that there is a threshold effect in the model. Moreover, Hansen (1996) demonstrates that the limiting distribution of this supremum statistic is non-standard and depends on numerous model specific nuisance parameters. Since tabulations of critical values are not possible, inferences are conducted via a model based bootstrap whose validity and properties have been established in Hansen (1997, 1999, and 2000). First, the coefficients are estimated through minimizing the sample residuals sum of squares. Then, a new sample is produced by the residuals' distribution under the null hypothesis, by which, the coefficients are estimated under the null and alternative hypotheses and the simulated $F_i$statistics is obtained. The process is repeated many times depending on the chosen number of replications and the *p-value* is computed based on the number of simulated statistics which exceeds the actual estimation of F_i. Once the estimate of γ has been obtained, the slope parameter follow trivially as $\beta(\gamma)$. Within this framework, we expect that the coefficient on β_2 to be positive and larger than β_1 which suggest that when corruption is high, FDI will contributes more towards pollution.

Results

The first step of the analysis is to assess the statistical properties of the data. Table 2 provides the means, standard deviations, minimum and maximum values for the variables used in the analysis. The statistics are based on data over the 2003-2013 period. Obviously, the data reveal that there are considerable variation in the data across the countries. The share of FDI in GDP ranges from -43.463% (Cyprus) to 198.31% (Cyprus). The corruption index also shows a large variation across countries, ranging from 1.43 (Singapore) to 99.53 (Myanmar). Finally, the CO_2 ranges from 0.0713 (Democratic Republic of the Congo) to 3.9330 (Mongolia).

Table 2 Descriptive statistic

Variable	No. Obs.	Mean	Std. Division	Min.	Max.
CO_2	770	0,6244	0,5054	0,0713	3,9330
GDPPC	770	7109,6	10384,1	193,87	72671,0
Energy Consumption	770	1733,4	2734,1	155,03	21959,4
FDI	770	5,3378	10,153	-43,463	198,31
Corruption	770	60,645	22,988	1,4300	99,530
Industry growth	770	4,9913	7,7263	-35,750	79,544
Population growth	770	1,6061	1,7086	-2,0813	16,332

Table 3 reports correlation coefficients for all variables. In general, the strength of association between independent variables and CO2 is low. Additionally, only two variables are negatively related to CO2 namely GDPPC and population growth. The strongest correlation among independent variables is found for GDPPC and energy consumption (ρ =0,76). The lowest correlation is reported for population growth and corruption index (ρ =-0,0025).

Table 3 Correlation matrix

Variable	CO2	GDPPC	Energy Consumption	FDI	Corruption	Population growth	Population growth
CO2	1.0000						
GDPPC	-0.0391	1.0000					
Energy Consumption	0.3478	0.7605	1.0000				
FDI	0.0449	0.1851	0.0267	1.0000			
Corruption	0.1184	-0.6000	-0.3145	-0.1776	1.0000		
Industry growth	0.0576	-0.0217	0.0378	0.0068	0.1302	1.0000	
Population growth	-0.1508	0.4080	0.3837	-0.0063	-0.0025	0.1254	1.0000

To test the role of corruption in FDI-pollution link, Equation (2) is estimated and results are presented in Table 4. The threshold estimate is evaluated using a bootstrap method with 300 replications and 10 percent trimming percentage and the test yields a *p-value* of 0.06 which indicate there is a threshold effect among the variables. Specifically, the result shows that the threshold level of corruption is 1.5041. It should be noted that this value is in logarithmic form. By taking antilogarithm of this value, the value is 4.5[1]. Therefore, the sample can be split into two regimes, above and below 4.5 level of corruption. Looking at the coefficients on FDI across the two regimes reveal that the coefficient is positively and significant only for the high corruption regime while for low corruption regime it is insignificant. This suggests that FDI will have a positive impact on CO_2 emission only after the level of corruption is sufficiently high. This finding is consistent with the view that a more corrupt environment will attract a more polluted industry.

Table 4 Threshold regression using corruption as threshold variable

Dependence: CO_2	**Full Sample**	
	Coefficient	**s.e.**
GDPPC	1,5320***	0,3381
$GDPPC^2$	-0,1501***	0,0191
Energy Consumption	0,8069***	0,0510
FDI inflows		
$COR \leq \gamma$	0,0251	0,0161
$COR > \gamma$	0,0296*	0,0162
Population Growth	0,1056**	0,0472
Industry Growth	0,0529***	0,0169
Threshold estimate	1,5041	
LM-test for no threshold	21,99	
Bootstrap p-value	0,0600	
N	70	

Note: Asterisk *, ** and *** represent significance level of 10, 5 and 1 percent respectively.

In order to ensure that the threshold results obtained earlier are robust, three robustness checks are carried out. First, the impact of outlier observations on the estimated result is assessed. This study adopts the DFITS statistic strategy as proposed by Belsley et al. (1980). Under this strategy, outliers are defined as observations which have a high combination of residual and leverage. Figure 2 displays the scatter plot for residuals and leverage for all countries in the sample. The test result suggests that Bangladesh, Democratic Republic of Congo, Hong Kong, Qatar, Togo and Zambia are outliers.

Then, the re-estimation is carried out using a new sample which excludes outliers and the results are presented in Table 5. The results reveal that the bootstrapped *p-value* is less than 5% which suggest the threshold effect is significant. Furthermore, only the coefficient on FDI for high corruption regime is significant which is consistent with the earlier result. Therefore, our previous conclusion of the important role of corruption in moderating FDI-pollution link is unchanged. Secondly, the sensitivity of the *p-value* of the threshold value (1.5041) is evaluated using different combinations of bootstrap replications and trimming percentage. The results are presented in Table 6. Again, we are able to reject the null of no threshold consistently. This suggests the threshold effect found earlier is not influenced by the trimming percentage and number of bootstrap replications. Finally, we evaluate the possibility of having double threshold instead of single threshold in the model. The sample is split further but the test yields a *p-value* of 0.2167[2]. This suggests that a single threshold model is sufficient. Overall, the previous interpretations for a single threshold FDI-pollution model remains intact. Our finding that corruption plays an important role in shaping the impact of FDI on pollution is robust.

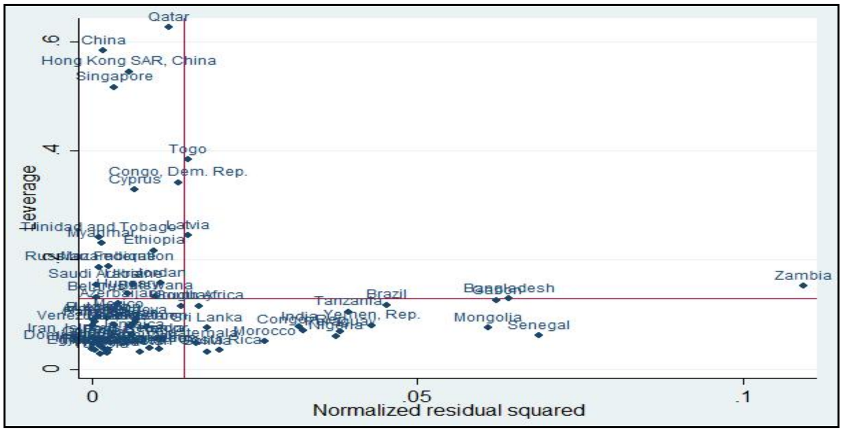

Figure 2 Potential outliers by using DFIT Statistic

Table 5 Exclusion of outliers

Dependence: CO_2	**Outlier Excluded**	
	Coefficient	**s.e.**
GDPPC	0,8951**	0,3651
$GDPPC^2$	-0,1121***	0,0207
Energy Consumption	0,7298***	0,0527
FDI inflows		
$COR \leq \gamma$	0,0265	0,0161
$COR > \gamma$	0,0317*	0,0162
Population Growth	0,0719	0,0503
Industry Growth	0,1183***	0,0250
Threshold estimate	1,5041	
LM-test for no threshold	26,33	
Bootstrap p-value	0,0200	
N	64	

Note: Asterisk *, ** and *** represent significance level of 10, 5 and 1 percent respectively.

Table 6. Bootstrapped *p-values*

Threshold estimate: 1.5041	*Trimming percentage*				
LM-test for no threshold: 21.99	10	15	20	25	30
Bootstrap Replication:					
300	0,0600	0,0592	0,0588	0,0577	0,0563
500	0,0599	0,0591	0,0583	0,0575	0,0573
1000	0,0586	0,0574	0,0568	0,0561	0,0558
5000	0,0525	0,0518	0,0496	0,0473	0,0459

Conclusions

The objective of this study is inspired by the conflicting findings on the pollution haven hypothesis. This study argues that this finding may be due to the failure to account for the role of corruption in FDI-pollution link. Specifically, this study hypothesis that the level of corruption in the host county may alter the locational choice of "dirty" FDI which contribute to more pollution in the host country.A sample of 70 developing countries over the 2003-2013 period is used. Methodologically, this study adopts a regression model characterized by threshold effects that allows FDI to have a nonlinear effect on pollution. This technique can accommodate the economically appealing possibility that the positive impact of FDI on pollution 'kicks in' only after host countries have reached a certain threshold level of corruption. The result of threshold regression analysis reveals that there is threshold effect in the FDI-pollution link. Specifically, we find that FDI contributes to pollution only after the level of corruption in the host countries has exceeded a certain threshold level. We are able to reproduce the results of the analysis even with the exclusion of outliers.

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