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Testing pollution haven hypothesis in five Southeast Asian countries

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Abstract

This paper aims to test the validity of pollution haven hypothesis in a group of five Southeast Asian countries by examining the effect of foreign direct investment and other factors on CO2 emission. Fixed effect model with instrumental variables are used in a data set for 1996-2013 period, which then points out that foreign direct investment and energy consumption contributes to pollution in Southeast Asian countries: Cambodia, Vietnam, Thailand, Philippines and Malaysia. Trade and urbanization are found to be insignificant in explaining CO2 emission.

Keywords:*foreign direct investment, pollution haven hypothesis, carbon dioxide emission, environmental stringency*

1. Introduction

Southeast Asian is considered a dynamic economic zone in the world, which has attracted a large amount of foreign direct investment (FDI). In 2018, FDI inflows into ASEAN countries reached 155 billion US dollars, accounting for 15.5% of global FDI (UNCTAD, 2019), increasing 5% in 2019 with a record level of 156 billion US dollars (UNCTAD, 2020). FDI is one of the main growth engines in the region. However, the rising level of FDI flows from developed countries to developing ones poses a concern about the environmental impacts (Zeng & Eastin, 2012).

Due to the importance of FDI-environment nexus, many economists have extensively examined the link between FDI and environmental stringency. One of noticeable theory is the Pollution Haven Hypothesis (PHH), which posits that the environmental stringency between countries influences the industrial location. Companies always minimize their operation cost by investing in countries with cheap labor, abundant natural resources and low operation cost. Meanwhile, in order to attract FDI authorities in developing countries where the operation cost is low tend to loosen their environmental regulations. As a result, developing countries become pollution havens for polluting firms and industries (M. A. Cole, 2004; G. Grossman & Krueger, 1991). PHH has been a hotly debated issue for many researchers. While some validate the hypothesis, others disapprove it. Because of contrasting results, further research is needed. In testing PHH, studies have linked environmental stringency to FDI (Dean, Lovely, & Wang, 2009; Demena & Afesorgbor, 2020; Fredriksson, List, & Millimet, 2003; Guzel & Okumus, 2020; Hanif, Faraz Raza, Gago-de-Santos, & Abbas, 2019; M. Khan, 2018; Matthew, Robert, & Per, 2006; Tang, 2015) or trade (M. A. Cole, 2004; G. Grossman & Krueger, 1991). This study aims to study the impact of FDI on pollution in a set of five ASEAN countries, including Cambodia, Malaysia, The Philippines, Thailand and Vietnam.

Originally, PHH was utilized to study the impact of trade on environment. This theory was first mentioned by Pethig (1976) and McGuire (1982) when they studied the effect of environmental regulations on firm locations, then developed by G. M. Grossman and Krueger (1992) and Copeland and Taylor (2004). G. M. Grossman and Krueger (1992) divided the environmental impact of trade into: the scale effect, the composition effect and the technique effect. The scale effect states that trade has a positive impact on the environment because trade is associated with increasing energy consumption at low income. When income reaches a certain level, pollution will be mitigated (EKC relationship). The composition effect reflects the change in structure of the economy as trade changes production pattern. The composition effect depends on countries' comparative advantage in producing pollution intensive goods and the stringency of environmental regulation.Meanwhile, the technique effect refers to the impact of the change in the technology brought about by trade. If foreign companies brings with them clean technology, they will reduce pollution in the host country. However, international trade with obsolete technology is harmful to the environment. The environmental regulation imposed by countries

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will have an impact on plant location and then trade inflows. Trade openness is used in the equation examining the effect of FDI on the environment by some studies such as Ren, Yuan, Ma, and Chen (2014); Omri, Nguyen, and Rault (2014)Ansari, Khan, and Ganaie (2019), Kahouli and Omri (2017); Solarin, Al-Mulali, Musah, and Ozturk (2017)Salehnia, Karimi Alavijeh, and Salehnia (2020); Shao, Wang, Zhou, and Balogh (2019). Following literature, trade is also included in this study.

One of the fundamental challenges facing pollution haven hypothesis studies is how to measure environmental stringency. There are three commonly used measures of environmental stringency: measure of environmental regulation, extent of environmental registration and the amount of pollution emission (M. Cole, Elliott, & Zhang, 2017). Some measures of pollution emissions are pollutants such as CO2, SO2, and PM 2.5. Among these, CO2 emission, which is the main cause of global warming, is the most commonly used measure. A large number of studies use CO2 as proxy for environmental stringency such as Hoffmann, Lee, Ramasamy, and Yeung (2005); Liu, Qu, and Zhao (2019); Sapkota and Bastola (2017); Shao et al. (2019); Solarin et al. (2017); Ansari et al. (2019); Sarkodie and Strezov (2019). Following literature, this study uses CO2 as a proxy for environmental stringency.

How energy use affects environment is also a controversial issue. Energy consumption plays a vital role in economic activities and human life but energy consumption leads to CO2 emission. Particularly, fossil fuel consumption is the most serious cause of CO2 emission. Power plants, manufacturing factories, the transport sector are responsible for increasing amount of carbon dioxide in the air. Some studies use energy consumption as a control variable in studying the impact of foreign direct investment in CO2 emission such as Solarin et al. (2017); Sun, Zhang, and Xu (2017); Liu et al. (2019); Sabir, Qayyum, and Majeed (2020).

Estimating a model of CO2 emission without taking urbanization into consideration will underestimate carbon dioxide emission (Sadorsky, 2014). According to ecological modernization and urban environmental transition theories, urbanization can affect CO2 emissions positively or negatively. The theory of ecological modernization states that in early stage of development, countries consider economic growth as priority. Therefore, urbanization or income increases rapidly at the expense of environmental quality. However, as the economy growth reaches a certain level and environment becomes highly polluted, the need for cleaner environment arises. At this stage, pollution level is reduced thanks to better technology and urbanization (Crenshaw & Jenkins, 1996; Mol & Spaargaren, 2000). Similarly, the theory of urban environmental transition postulates that the development of cities is associated with manufacturing factories that impede the environment. Nevertheless, as cities become wealthier, environmental degradation is decreased as cleaner technology and strict environmental regulations are applied. Simultaneously, the demand for more pollution intensive products increases as cities becomes more prosperous. Taking the two effects into consideration, the net effect of urbanization on pollution is still ambiguous (McGranahan, 2001). When examining foreign direct investment and cO2 emission nexus, several studies such as M. A. Cole and Elliott (2005), M. A. Cole and Fredriksson (2009), Omri et al. (2014), Azam, Khan, Zaman, and Ahmad (2015), Solarin et al. (2017) included urbanization in the model.

2. Review of Literature

According to pollution haven hypothesis, multinational companies are tempted to produce their pollution intensive goods in developing countries where the environmental regulations and enforcement are weaker. While some researchers validated pollution haven hypothesis regarding FDI and environmental stringency (Cai, Lu, Wu, & Yu, 2016; M. A. Cole & Elliott, 2005; Hoffmann et al., 2005; Millimet & Roy, 2016; Pao & Tsai, 2011; Sarkodie & Strezov, 2019; Tang, 2015; Xing & Kolstad, 2002), other disapproved this hypothesis (Atici, 2012; Kahouli & Omri, 2017; Kearsley & Riddel, 2010; List, McHone, & Millimet, 2004). Some other studied found mixed results of pollution haven hypothesis (Fredriksson et al., 2003; Naughton, 2014; Rezza, 2013). The validation of pollution haven hypothesis also depends on the type of FDI (Rezza, 2013; Tang, 2015). Tang (2015) found that inward FDI is sensitive to environmental stringency but export-oriented FDI is more sensitive to local market-oriented FDI. Some research analyze pollution haven hypothesis at country or regional level (Cai et al., 2016; Dean et al., 2009; Guzel & Okumus, 2020; List & Co, 2000; Sarkodie & Strezov, 2019; Wolfgang & Arik, 2002; Xing & Kolstad, 2002). Other studies are conducted at firm or industry level (Chung, 2014; Hanna, 2010; Javorcik & Wei, 2003; Kahouli & Omri, 2017). The various results are due to different methodologies, variables, countries and time periods.

Table 2.1 Summary of literature review on pollution haven hypothesis

Author	Countries	Period	Methods	Pollution haven hypothesis
Xing and Kolstad (2002)	US	1985-1990	Ordinary Least Squares, Instrumental Variable	Yes for heavily polluting industries and not for less polluting industries
Dean et al. (2009)	China	1993-1996	Nested and Conditional logit	Yes for polluting industries from Macao, Taiwan and Hong Kong; No for Chinese non ethically
M. A. Cole and Elliott (2005)	US outward to Mexico, Brazil	1984–1994	Fixed effect, random effect	Yes
Pao and Tsai (2011)	Brazil, Russian Federation, India, and China(BRIC countries)	1980-2007	Vector Error Correction Model	Yes
Rezza (2013)	Norwegian	1996-2005	Fixed effect	No for average FDI but Yes for vertical FDI
Kahia, Ben Jebli, and Belloumi (2019)	Six African countries	1971-2009	Autoregressive Distributed Lag	Yes
Naughton (2014)	28 OECD countries	1990-2000	Ordinary Least Squares	Mixed result, Increase environmental stringency increases FDI at low regulation but decrease FDI at high regulation
Tang (2015)	United States	1999-2003	Generalized Method of Moments (GMM-IV)	Yes, export oriented FDI is more sensitive to environmental regulation than import oriented FDI
Cai et al. (2016)	China	1992–2001	Difference- in-Difference- in - Differences	Yes
Bakirtas and Cetin (2017)	Indonesia, Mexico, South Korea, Turkey, Australia	1982-2011	Panel VAR model	Yes
Kahouli and Omri (2017)	14 home countries and 29 host countries joining six regional trade agreements	1990-2011	Fixed effect, random effect and System Generalized Method of Moments	No
Koçak and Şarkgüneşi (2018)	Turkey	1974-2013	Structural break co-integration, DOLS	Yes
Destek and Okumus (2019)	Ten newly industrialized countries	1982-2013	Error correction based cointegration	No, the U-shaped relationship between FDI and ecological footprint
Hanif et al. (2019)	Emerging Asian economies	1990-2013	ARDL model	Yes
Liu et al. (2019)	29 provinces in China	1996-2015	Fixed effects panel data partially linear additive model	No, the N-shaped relationship between FDI and Co2 emission
M. A. Khan and Ozturk (2020)	17 Asian countries	1980-2014	Modified ordinary least squares	Yes

Recently, there have been an increasing number of studies examining pollution haven hypothesis in Southeast Asian countries, a dynamic economic region. When studying pollution haven hypothesis in Southeast Asian countries, most studies used the same of 5 countries sample, including Singapore, Thailand, Philippines, Malaysia, Indonesia (Baek, 2016; Guzel & Okumus, 2020; Merican, Yusop, Noor, & Law, 2007; Zhu, Duan, Guo, & Yu, 2016) to examine the effect of FDI on CO2 emission. The reason for choosing these countries is their data availability for a long period of time.

Merican et al. (2007) used ARDL technique to test the impact of FDI on CO2 emission in these countries in the 1970-2001 period. Their results found that FDI contributed to pollution in Thailand, Malaysia and The Philippines while FDI had a negative relation with pollution in Indonesia. The result is insignificant for Singapore. Using panel data approach with pooled mean group estimator, Baek (2016) studied FDI-income-energy-environment nexus and confirmed the existence of pollution haven hypothesis. Similarly, income and energy consumption are found to have a detrimental impact on environment quality. Guzel and Okumus (2020) also examined pollution haven hypothesis in this five sample countries for the 1981-2014 period. Accounting for cross sectional dependence and slope heterogeneity, they found that inward FDI exacerbated CO2 emission. Zhu et al. (2016) utilized panel quantile regression to examine the impact of FDI, economic growth and energy consumption on CO2 emission. Their results indicate that the effect of independent variables vary across quantiles. There is not enough evidence to validate PHH in lower income countries where FDI is negatively associated with CO2 emission. However, in middle and high-income countries, FDI is positively associated with pollution, confirming pollution halo hypothesis. Using co-integration and granger causality approach, Chandran and Tang (2013) also studied the dynamic relationship between CO2 emission, FDI, energy consumption in road transport and economic growth in the same set of ASEAN 5 countries, but the pollution haven hypothesis is not confirmed in these countries.

Most studies about PHH in Southeast Asian countries often focus on the five countries group Singapore, Thailand, Philippines, Malaysia, and Indonesia because of data availability for a long period. However, recently Vietnam and Cambodia has emerged as a new attractive destination for FDI investors. However, this research examines the pollution haven hypothesis in Southeast Asian region by studying the impact of FDI on CO2 emission in a different set of countries, namely Cambodia, Thailand, Vietnam, Philippines, and Malaysia.

3. Materials and Methods

This research utilizes annual panel data covering the 1996-2013 period for the following developing countries in Southeast Asia: Cambodia, Malaysia, The Philippines, Thailand and Vietnam. The data is taken from the World Bank data source: World Development Indicators. Energy use in Vietnam is not available before 2013 so the time span for the whole countries is limited from 1996 to 2013 in order to have a balanced panel data set. Based on existing literature, the following variables are included in the model to examine the impact of FDI on CO2 emission in five Southeast Asian countries.

Table 3.1. Description of data source

Variable	Definition
CO2	Metric tons per capita
Energy	Energy use (kg of oil equivalent per capita)
Fdi	Foreign direct investment, net inflows (% of GDP)
Trade	Sum of exports and imports of goods and services as percentage of GDP
Urban	Urban population as percentage of total population

The panel data approach is commonly utilized to capture both time series and cross sectional dimensions (Shen, Wang, Liu, & Chu, 2019). Following literature, this research uses fixed effect and random effect to examine the effect of FDI on CO2 emission on ASEAN-5 countries. The model is specified as follows:

$$\ln CO2_{it} = \beta_o + \beta_1 \ln FDI_{it} + \beta_2 \ln Urban_{it} + \beta_3 \ln energy_{it} + \beta_4 \ln trade_{it} + \alpha_i + \gamma_t + \varepsilon_{it}$$

CO2 emission is used as a proxy for environmental stringency. Variables are transformed into natural logarithmic form; γ_t is time varying attributes of country and α_i stands for time invariant unobserved country heterogeneity. In a panel data setting, pooled OLS produced bias estimates when the unobserved country specific α_i is correlated with the error term. Therefore, in order to produce efficient and unbiased estimates fixed effect and random effect model is estimated, then a valid model is chosen by Hausman test (Hausman, 1978). Under the null hypothesis that independent variables are uncorrected with error terms, random effect model is appropriate. On the contrary, fixed effect model is chosen if the null hypothesis is rejected. Some previous studies pointed out the endogeneity of FDI (Bao, Chen, & Song, 2011; Liang, 2008; Wang & Chen, 2014): FDI may affect pollution but pollution is also likely to affect FDI. FDI companies may find polluted regions less attractive so invest less in these regions. In this case, instrumental variables are used as a proxy for the endogenous variable FDI. Following literature, FDI one lag period is chosen as the instrumental variable for FDI.

4. Results and Discussion

From the Hausman test, the P value = 0.00< 0.05 so the null hypothesis is rejected, fixed effect model is chosen. However, given the endogeneity of FDI, fixed effect model with instrumental variable – one lag period of FDI is the appropriate model. In the fixed effect –IV model, FDI has a significantly positive effect on CO2 emission in the five ASEAN countries. A one percent increase in FDI is associated with 0,19% increase in pollution. In all three-equation models, energy consumption significantly leads to CO2 emission. The magnitude of pollution associated with energy consumption is relatively high

Table 4.1: Empirical results of foreign direct investment on CO2 emission

Dependent variable: lnCo2			
	Fixed effect	Random effect	Fixed effect -IV
lnfdi	0.371086	0.0544584	0.1990858*
lntrade	0.187382*	-0.0751434	0.0399807
lnurban	0.0683066	0.6610371*	0.7829563
lnenergy	1.107509*	1.178216*	0.7662949*
Instrumental variable: FDI one lag period			

Note: * indicates significant at 5% level

5. Conclusions

This article aims to examine the effect of CO2 emission in five ASEAN countries, namely Cambodia, Thailand, Vietnam, the Philippines, and Malaysia using data from World Development Indicator in 1996-2013 period. Trade and urbanization do not cause the increase in CO2 emission. However, the pollution haven hypothesis is confirmed in these countries. The result for ASEAN countries is similar to Baek (2016), Guzel and Okumus (2020), Merican et al. (2007), Zhu et al. (2016). Although FDI is considered to be the engine of growth in this dynamic economic zone, it is important for these countries to be careful in attracting FDI. Host countries should assess environmental impacts of FDI projects before implementing. In addition, as energy consumption is proved to worsen environment, ASEAN countries should use energy effectively and have programs to develop clean renewable energy sources instead of using fossil fuels.

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