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Does pollution haven hypothesis hold in newly industrialized countries? Evidence from ecological footprint

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ABSTRACT

This study aims to investigate the validity of pollution haven hypothesis for the period from 1982 to 2013 in ten newly industrialized countries. For this purpose, we examine the relationship between real income, foreign direct investment, energy consumption and ecological footprint using with second generation panel data methodology to take into account the cross-sectional dependence among newly industrialized countries. In doing so, the possible non-linear relationship between foreign direct investment and environmental degradation is also searched. The results show that increased energy consumption and economic growth leads to increase in ecological footprint. Moreover, the U-shaped relationship between foreign direct investment and ecological footprint is confirmed in newly industrialized countries.

Keywords: Pollution haven hypothesis; ecological footprint; newly industrialized countries

1.Introduction

In recent decades, although developing countries have experienced financing constraints in infrastructure investments triggering economic growth, they have overcome this problem through foreign capital investments and achieved high growth performances. Therefore, foreign direct investment (FDI, hereafter) inflows are considered a blessing for developing countries that have a resource shortage in financing high-cost investment projects. Furthermore, the fact that it is less prone to crises due to a long-term investment perspective and that it offers international technology access and know-how management makes foreign direct investment inflows more attractive for developing countries (Nunnenkamp, 2001).

Even if developing countries implement many policies to host foreign direct investments, the driving forces and economic consequences of foreign capital inflows are still a matter of debate. For instance, excessive increases in foreign capital investment inflows of developing countries have generally explained with the cheap labor and natural resource abundance facility for multinational corporations. However, one of the most recent argument that called as *pollution haven hypothesis* (PHH) associates the FDI attractiveness of developing countries with looser environmental regulations of these countries compared to developed countries. According to this hypothesis, as a result of loose environmental regulations, the developing countries have gained the competitive advantage and dirty industries of developed countries have migrated to developing countries in order to reduce the production costs. On the other hand, the opposite hypothesis which is called as *pollution halo hypothesis* argues that the production structure of these multinational corporations is generally based on clean technology. Therefore, increasing mentioned investments spread out own modern technology to developing countries and reduce the pollution level in the developing countries. However, both hypotheses assume that there is increasing or decreasing linear relationship between FDI and environmental degradation. In fact, a possible non-linear association between the mentioned variables is generally ignored.

Based on above reasons, the main motivation of this study is to investigate the possible non-linear relationship between foreign direct investment and environmental degradation to detect the validity of pollution haven hypothesis for the period from 1982 to 2013 in 10 newly industrialized countries. There are some reasons of chosen country group. In the last three decades, the economic performances of newly industrialized countries (Brazil, China, India, Indonesia, Mexico, Malaysia, Philippines, South Africa, Thailand and Turkey) have rapidly increased compared to the rest of the world. Namely, the share of the national output of these

countries in the global output has risen from 10.7 % to 23.1% over the observed period. In addition, the strong economic performance of these countries is mostly associated with foreign investment inflows of the countries because the FDI inflows of selected countries has been risen approximately 20 times in the last 30 years (WDI, 2017).

The contribution of this study is threefold. i) this is the first study to examine the validity of the pollution haven hypothesis through an ecological footprint indicator instead of carbon emission as an indicator of environmental degradation in newly industrialized countries. The reason why we prefer the ecological footprint is that this indicator represents environmental degradation more accurately than carbon emissions (Ozturk et al., 2016; Destek et al., 2018; Ozcan et al., 2018; Ahmed et al., 2019). ii) Unlike the linear assumption, this study examines the validity of possible non-linear relationship between foreign direct investment and ecological footprint. Because, the empirical findings from the non-linear empirical model allows for more detailed policy implications. iii) Since the ignorance of the possible cross-sectional dependence may lead to invalid findings, this study employs the second-generation panel data methodologies that take into account the cross-sectional dependence among newly industrialized countries.

2. Literature review

The pollution haven hypothesis which argues that developing countries may attracts the multinational corporations from developed countries to lower production costs because of their cheap labor, abundant natural resources and relax environmental regulations. In addition, the governments of developing countries stimulate these firms to reduce investment-saving deficit, to provide the required external capital and to reduce the foreign trade deficit. However, it is also assumed that increased foreign direct investment inflows may cause environmental degradation by loose environmental regulations in the host country. This argument is confirmed for some developing or least developed countries by many empirical studies. For instance, Omri et al. (2014) utilized GMM approach to test the relationship between CO₂ emissions, FDI, capital stock, GDP, trade openness, urbanization, financial development and reel exchange rate the period spanning from 1990 to 2011 in 54 countries. The results confirmed the existence of PHH in these countries. Shahbaz et al. (2015) probed the linkage between CO₂ emission, foreign direct investment, GDP and energy consumption in 99 countries from 1975 to 2012. The results of FMOLS approach confirmed the PHH for 99 countries. In addition, they found an inverted U-shaped relationship between foreign direct investment and CO₂ emissions.

It is seen that many studies examining the PHH have focused on eastern Asian countries; Merican et al. (2007) utilized ARDL approach to probe the impacts of FDI on CO₂ emissions in five ASEAN (Malaysia, Thailand, Indonesia, Singapore, and the Philippines) countries spanning period from 1970 to 2001. They found that the PHH is valid in Malaysia, Thailand and Philippines. Lau et al. (2014) attempted to investigate the linkage between CO₂ emission, GDP, the square of GDP, FDI and trade openness over the period of 1980-2008 in Malaysia using ARDL bounds test. As results of this study, FDI increased environmental pollution in Malaysia. Bakhsh et al. (2017) applied three stage least square method to analyze the relationship between environmental degradation, foreign direct investment and GDP for the period of 1980-2014 in Pakistan. The results showed that FDI increases environmental degradation in Pakistan. Behera and Dash (2017) probed the link between CO₂ emission, primary energy consumption, fossil fuel energy consumption, urbanization, and FDI during the period 1980-2012 in 17 countries from South and Southeast Asian (SSEA) region and for three income-based panels (namely, high, middle and low-income panels) using panel data methods. They found that FDI has significant impacts on CO₂ emissions in total, high and middle income SSEA region. Baek (2016) used panel data method to investigate the validity of PHH for the period of 1981-2010 in five ASEAN countries utilizing FDI, GDP, energy consumption and CO₂ emission data. According to PMG estimator results, the PHH does exist in these ASEAN countries.

Some studies focused on the developing countries that have cheap labor facility; Kiviyiro and Arminen (2014) used ARDL approach to analyze the linkage between carbon emissions, GDP, GDP square, energy consumption and FDI over the period of 1971-2007 in six Sub-Saharan African countries: the Republic of the Congo, the DRC (Democratic Republic of the Congo), Kenya, South Africa, Zambia and Zimbabwe. The results of ARDL approach indicated that FDI increases CO₂ emissions in Kenya and Zimbabwe. Solarin et al. (2017) examined the relationship between CO₂ emission, GDP, GDP square, energy consumption, renewable energy consumption, fossil fuel consumption, foreign direct investment, institutional quality, urbanization and trade openness to test the PHH for Ghana from 1980 to 2012. According to ARDL method, the PHH exists for Ghana. He (2006) aimed to explore the relationship between SO₂ emissions, FDI and industrial output over the period of 1994-2001 in China's 29 provinces using panel data method. The results of analysis provided significant evidence for the PHH in China's 29 provinces. Cole et al. (2011) used data for 112 Chinese cities between 2001 and 2004 to examine the relationship between FDI, economic growth, four industrial water pollution

emissions and four industrial air pollution emissions as environmental pollution indicators. The obtained results validate the PHH because FDI increases environmental pollution in China. Wang and Chen (2014) analyzed the impacts of FDI and institutional development on industrial SO₂ emissions for the period of 2002-2009 in 287 Chinese cities. The study showed that FDI generally induces environmental pollution. Ren et al. (2014) explored the effects of trade openness, exports, imports, GDP and FDI on CO₂ emissions over the period of 2000-2010 in China's industrial sectors using the two-step GMM estimation. The results suggested that FDI increases China's CO₂ emission. Sun et al. (2017) utilized the ARDL approach to investigate the PHH for the period 1980-2012 in China using CO₂ emission, GDP, GDP square, energy consumption, foreign direct investment, economic freedom, urbanization, financial development and trade openness. The results of ARDL method revealed that the PHH is valid in China.

In addition, some researchers focused on high income emerging countries; Pao and Tsai (2011) investigated the relationship between CO₂ emission, GDP, GDP square, energy consumption and FDI in BRIC (Brazil, Russia, India and China) countries for the period between 1980 and 2007, except for Russia (1992-2007). The result of empirical analysis is consistent with the PHH. Zakarya et al. (2015) examined the relationship between CO₂ emissions, energy consumption, GDP and FDI over the period of 1990 to 2012 in BRICS (Brazil, Russian Federation, India, China and South Africa) countries. According to analysis, FDI increases CO₂ emissions in BRICS countries thus this result is consistent with the PHH. Moreover, Al-Mulali (2012) examined the link between CO₂ emissions, GDP, energy consumption, total trade and FDI for the period of 1990-2009 in 12 Middle Eastern countries which have abundant natural resource using with panel data methods. The results of analysis validate the PHH in these countries.

On the other hand, some studies found that the pollution halo hypothesis is valid for developing countries. The pollution halo hypothesis argues that environmental degradation will be reduced along with eco-friendly technology transfer from developed countries to developing countries by foreign direct investment inflow. This hypothesis is also confirmed by some studies; Tamazian and Rao (2010) employed GMM approach to determine the impacts of GDP, inflation, FDI, financial liberalization, trade openness, price liberalization, forex and trade liberalization, institutional quality, energy consumption and energy imports on CO₂ emissions in 24 transitional countries for the period of 1993-2004. The results indicated that higher levels of FDI help to achieve lower CO₂ per capita emissions in these countries so the pollution halo

hypothesis is valid. Kirkulak et al. (2011) purposed to test the impacts of FDI on SO₂ emissions in 286 Chinese cities from 2001 to 2007 utilizing annual data of FDI, GDP, population, proportion of people working for science in the total population, proportion of FDI's output value in gross industrial output value and SO₂ emissions. The regression results indicated that FDI has negative effect on SO₂ emission suggesting that the pollution halo hypothesis is valid. Al-Mulali and Tang (2013) employed the cointegration test of Pedroni (1999) and FMOLS method to estimate the effects of FDI, energy consumption and GDP on CO₂ emissions over the period 1980-2009 in the Gulf Cooperation Council (GCC) countries. The researchers found that FDI has negative impact on CO₂ emissions thus the pollution halo hypothesis is confirmed in the GCC countries. Tang and Tan (2015) purposed to determine the effects of energy consumption, GDP and FDI on CO₂ emission spanning period from 1976 to 2009 in Vietnam. The results of analysis revealed that FDI reduces carbon emission in Vietnam thus the pollution halo hypothesis is supported in Vietnam. Zhu et al. (2016) looked the effects of FDI, economic growth, energy consumption on carbon emissions for the period of 1980-2010 in ASEAN five countries employing the panel quantile regression method. According to results of analysis, the pollution halo hypothesis is supported in ASEAN five countries. Zhang and Zhou (2016) aimed to determine the effect of FDI on CO₂ emission from 1995 to 2010 in 29 Chinese provinces using STIRPAT model. The results of panel data confirmed that FDI decreases CO₂ emissions thus the pollution halo hypothesis is confirmed.

Similar to our study, some studies used the ecological footprint as an indicator environmental degradation to observe the validity of pollution haven hypothesis. For instance, Solarin and Al-Mulali (2018) employed the Augmented Mean Group (AMG) estimation procedure to observe the nexus between FDI and environmental degradation for the period from 1982 to 2013 in 20 countries and found that there is not significant relationship between foreign investments and environment. However, Baloch et al. (2019) investigated the nexus between FDI inflows and ecological footprint in 50 Belt and Road countries spanning the period of 1990-2016 and utilized with Driskoll-Kraay panel regression model. The results of this study reveal that pollution haven hypothesis is valid for observed countries. Similarly, Fakher (2019) used the Bayesian model to observe the validity of PHH in developing countries for the period of 1996-2016 and confirmed the validity of PHH.

Although different results are obtained according to the used methodology and observed countries, it is seen that most of previous studies focused on carbon dioxide emission as indicator of environmental degradation. It is known that multinational corporations producing

in developing countries do not only increase carbon dioxide emissions but also exploit the various environmental wealth of these countries. Based on this reason, this study employed ecological footprint developed by Wackernagel and Rees (1998) which includes cropland, grazing land, fishing grounds, forest land, built-up land and carbon footprint as indicator of environmental degradation instead of carbon dioxide emission. In addition, the limited number studies that used the ecological footprint as an indicator of environmental degradation ignored the possible quadratic relationship between FDI and ecological footprint.

3. Data and methodology

This study aims to examine the effect of foreign direct investment on environmental degradation in ten newly industrialized countries for the period of 1982-2013. For this purpose, we investigate the relationship between ecological footprint, economic growth, foreign direct investment and energy consumption. Following Shahbaz et al. (2015), we also utilized with the square of foreign direct investment to take into account the non-linear term of foreign direct investment. The panel version of empirical model as follows;

$$\ln EF_{it} = a_0 + a_1 \ln Y_{it} + a_2 \ln FDI_{it} + a_3 \ln FDI_{it}^2 + a_4 \ln EC_{it} + e_{it} \quad (1)$$

where $\ln EF$, $\ln Y$, $\ln FDI$, $\ln FDI^2$ and $\ln EC$ are the natural log of the ecological footprint per capita, real GDP per capita, foreign direct investment per capita, the square of per capita foreign direct investment inflow and energy consumption per capita. In addition, i , t and e_{it} indicate cross-section, time period and residual term, respectively. The ecological footprint per capita is measured in the sum of cropland, grazing land, fishing grounds, forestland, carbon and built-up land footprints, the real GDP and the real foreign direct investment are measured in 2010 constant US dollars, energy consumption per capita is measured in kg of oil equivalent. The data of real GDP per capita, FDI per capita and energy consumption per capita are obtained from World Development Indicators and ecological footprint data is retrieved from Global Footprint Network. In regard with the examined hypothesis, the pollution haven hypothesis is confirmed if FDI has monotonically increasing effect on ecological footprint ($a_2 > 0$ and $a_3 > 0$); the pollution halo hypothesis is supported in case of the FDI has monotonically decreasing effect on environmental degradation ($a_2 < 0$ and $a_3 < 0$); the U-shaped curve is confirmed in case of $a_2 < 0$ and $a_3 > 0$ and the inverted U-shaped curve is valid if $a_2 > 0$ and $a_3 < 0$.

Ignoring the cross-sectional dependence for panel data may lead to wrong estimations due to the high integration all over the world. Therefore, we first test the validity of cross-sectional

dependence among newly industrialized countries using with Pesaran's (2004) cross-sectional dependence (CD hereafter) test. The CD test is constructed as follows:

$$CD = \sqrt{\left(\frac{2T}{N(N-1)}\right)} \sum_{i=1}^{N-1} \sum_{j=i+1}^N (\hat{\rho}_{ij}) \square N(0,1) \quad (2)$$

where N and T states respectively the cross-section dimension and the time period. In addition, $\hat{\rho}_{ij}$ is the sample estimate of the pairwise correlation of the residuals.

In order to consider the cross-sectional dependence, we used well-known and frequently used unit root test developed by Pesaran (2007). The computation of the cross-sectional ADF (*CADF*) regression is as following:

$$\Delta y_{it} = a_i + \rho_i y_{it-1} + \beta_i \bar{y}_{t-1} + \sum_{j=0}^k \gamma_{ij} \Delta \bar{y}_{it-1} + \sum_{j=0}^k \delta_{ij} y_{it-1} + \varepsilon_{it} \quad (3)$$

where a_i is deterministic term, k is the lag order, \bar{y}_t is the cross-sectional mean of time t . Following above equation, t -statistics are obtained with the computation of individual ADF statistics. Furthermore, *CIPS* is retrieved from the average of *CADF* statistic for each i as follows;

$$CIPS = \left(\frac{1}{N}\right) \sum_{i=1}^N t_i(N, T) \quad (4)$$

The critical values of *CIPS* for different deterministic terms are given by Pesaran (2007).

To test the validity of the long-run relationship between variables, we used error correction based cointegration method developed by Westerlund (2007). In testing procedure, there is four statistics (G_t, G_a, P_t, P_a) to test the null hypothesis of there is no cointegration. The test can be performed by testing the significance of the error correction term in the constrained panel error correction model. The main error correction model of the test can be written as follows:

$$\Delta Y_{it} = \delta'_i d_t + a_i Y_{i,t-1} + \lambda'_i X_{i,t-1} + \sum_{j=1}^{p_i} a_{ij} \Delta Y_{i,t-j} + \sum_{j=-q_i}^{p_i} \gamma_{ij} X_{i,t-1} + \mu_{it} \quad (5)$$

where d_t refers to the deterministic terms; $d_t = 0$ (no deterministic term), $d_t = 1$ (with constant term) and $d_t = (1, t)'$ (with constant term and trend). Moreover, a_i determines the speed at which the system returns to the equilibrium, after an unpredictable shock.

Pesaran (2006) developed a new estimator that takes into account the cross-sectional dependence. Based on the Eq.1 the residual term (e_{it}) is a multifactor residual term and constructed as follows;

$$e_{it} = \lambda_i' UF_t + u_{it} \quad (6)$$

where UF_t is the $m \times 1$ vector of unobserved common factors. In addition Pesaran (2006) utilizes with cross-sectional averages to deal with cross-sectional dependence of residuals as observable proxies for common factors.

4. Empirical results

In the first step, we examine the possible cross-sectional dependence among newly industrialized countries by using CD test of Pesaran (2004). As a seen in Table 1, the null hypothesis of there is no cross-sectional dependence is rejected thus we confirm the cross-section dependency among selected countries. This means a shock in one of the newly industrialized countries may easily be transmitted to the other countries. In this direction, we should use second generation panel data methodologies which take into account the cross-sectional dependence among countries.

[INSERT TABLE 1 HERE]

In the second step, we investigate the stationary properties of the variables using with augmented IPS (CIPS) unit root test of Pesaran (2007). As a shown in Table 2, the null of unit root is not rejected for the level form of variables. However, the null hypothesis is rejected and all variables have become stationary for first differenced forms of variables. This finding means all variables are integrated of order one.

[INSERT TABLE 2 HERE]

In the next step, we examine the existence of the long-run relationship between variables. In doing so, we utilized with cointegration test of Westerlund (2007). The results are illustrated in Table 3. When we evaluated the results of error correction based cointegration test of Westerlund (2007), we found that Gt and Ga statistics do not reject the null hypothesis. On the other hand, Pt and Pa statistics confirms the long-run relationship between variables. These

conflicting results may be sourced from that while Gt and Ga statistics are computed with the assumption of unit-specific error correction parameters and accepted as mean-group tests. However, Pt and Pa tests calculated under the assumption of common error-correction parameter across cross-section units. Based on these reasons, our results can be interpreted as the existence of the long-run relationship between ecological footprint, real income, foreign direct investment and energy consumption is supported with the assumption of common error-correction parameters. Fortunately, the finding of weak cointegration does not pose a problem in that the CCE estimator can be used without the need for pre-testing procedure such as cointegration.

[INSERT TABLE 3 HERE]

[INSERT TABLE 4 HERE]

Next, we used common correlated effect (CCE) estimator of Pesaran (2006) to obtain the coefficients of variables. In case of the panel results, as a seen in Table 4, CCE-mean group estimation results show that increasing real income per capita increases environmental degradation. This finding shows that the increase in economic activity still accelerates environmental degradation and consistent with the studies of Ahmed et al. (2019) and Baloch et al. (2019) which found the ecological footprint increasing impact of economic growth. Moreover, the environmental degradation increasing impact of energy consumption is also validated. These findings mean that the energy portfolio of newly industrialized countries is still predominantly composed of fossil energy sources and this finding is consistent with Solarin and Al-Mulali (2018). In addition, the significant signs of the coefficient of foreign direct investment and the coefficient of the square of foreign direct investment are found opposite. Therefore, the validity of pollution haven hypothesis and pollution halo hypothesis is rejected and the existence of non-linear form is confirmed. The negative sign of the coefficient of the foreign direct investment and the positive sign of the square of foreign direct investment implies the U-shaped relationship between foreign direct investment and ecological footprint. This finding is inconsistent with the work of Shahbaz et al. (2015) which found the inverted U-shaped relationship between foreign direct investment and environmental degradation. This inconsistency may be sourced from used environmental degradation indicator. Namely, Shahbaz et al. (2015) utilized with CO₂ emission as an indicator of environmental degradation

but this study used ecological footprint which covers carbon footprint as well as different degradation indicators.

In case of country-specific results, it can be seen that the U-shaped relationship between foreign direct investment and ecological footprint is found in Brazil, China, Malaysia, Thailand and Turkey. In addition, increased real income per capita increases the ecological footprint per capita in China, Indonesia, Philippines, South Africa, Thailand and Turkey. Similarly, increasing energy consumption increases the ecological footprint in China, India, South Africa, Thailand and Turkey. However, based on the finding of cross-sectional dependence among countries, the group-mean results are more reliable for policy implications.

5. Conclusions and policy implications

This paper examines the validity of the pollution haven hypothesis by investigating the relationship between real income, foreign direct investment, energy consumption and ecological footprint for the period from 1982 to 2013 in ten newly industrialized countries: Brazil, China, India, Indonesia, Malaysia, Mexico, Philippines, South Africa, Thailand and Turkey. In addition, the square of foreign direct investment is used as explanatory variable to take into account the possible non-linear relationship between foreign direct investment and ecological footprint. In doing so, second generation panel data methodologies are employed to consider the cross-sectional dependence among selected countries.

In case of group mean results, we found that increased energy consumption and economic growth leads to increase in ecological footprint. Moreover, we found that the significant signs of the coefficients of foreign direct investment and the square of the foreign direct investment are opposite thus the validity of both pollution haven hypothesis and pollution halo hypothesis are rejected and the U-shaped relationship between foreign direct investment and ecological footprint is confirmed. This finding means that environmental degradation decreases to a certain level with increasing foreign direct investment, and after this level, increasing foreign direct investment increases environmental degradation. In case of individual country results, the results show that the sign of the coefficient of foreign direct investment is negative and the sign of the coefficient of the square of foreign direct investment is positive in Brazil, China, Malaysia, Thailand and Turkey. Therefore, the U-shaped relationship between foreign direct investment and ecological footprint is found for these countries. In addition, we found that increased energy consumption increases ecological footprint in China, India, South Africa,

Thailand and Turkey and economic growth leads to increase in ecological footprint in China, Indonesia, Philippines, South Africa, Thailand and Turkey.

The existence of the U-shaped relationship between foreign direct investment and environmental degradation may be sourced from the production structure of foreign firms. It is well-known fact that the production structure of mentioned countries is mainly based on fossil energy consumption and the energy efficiency level of domestic companies is lower than foreign companies. Therefore, the clean-technology based production activities of foreign companies initially reduces the environmental degradation in newly industrialized countries because of the relatively modern production structure. However, in the later stages, the loose environmental regulations of the host country led foreign companies to aim low-cost production instead of considering environmental quality. This situation creates a difficult dilemma for governments of these countries because the foreign investments have a key role on economic development processes of these countries.

In regard with policy implications, this study suggests that the laws which mandate the use of clean technology should be applied to the domestic investors who are producing with fossil energy consumption in order not to reduce the domestic competitive power of foreign investors. In addition, the governments should provide tax-incentives and subsidies for foreign investors to use eco-friendly technology instead of taking prohibitive measures. Moreover, the implementation of these laws should not only focus on the targets of reducing carbon emission, but also prevents the activities causing damage to water resources, forest areas and agricultural lands.

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