Uluslararası Ekonomi ve Yenilik Dergisi, 11 (1) 2025, 121-138

International Journal of Economics and Innovation, 11 (1) 2025, 121-138

https://doi.org/10.20979/ueyd.1643272

Foreign Direct Investment and Environmental Impacts in D8 Countries: Analysis of the Pollution Haven, Pollution Halo and Environmental Kuznets Curve Hypotheses

Araştırma Makalesi /Research Article

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ABSTRACT: *Foreign direct investments are an important component of global economic integration and promote economic growth in developing countries. However, these investments can lead to environmental degradation and increase the ecological footprint, especially in countries with inadequate environmental legislation. This situation can become a factor that threatens environmental sustainability with industrialization and increasing resource consumption. The aim of this study is to test the Pollution Haven, Pollution Halo and Environmental Kuznets Curve hypotheses. For this purpose, the FMOLS long-term coefficient estimator was used based on the data from 1995 to 2022 in D8 countries. According to the results obtained, it was found that the Pollution Haven hypothesis is valid, while the Pollution Halo and Environmental Kuznets Curve hypotheses are not valid. These findings show that foreign direct investments in D8 countries can increase environmental degradation and that these countries need stricter environmental policies.*

Keywords: *Pollution Haven, Pollution Halo, Foreign Direct Investment, Ecological Footprint, EKC*

D8 Ülkelerinde Doğrudan Yabancı Yatırım ve Çevresel Etkiler: Kirlilik Cenneti, Kirlilik Halesi ve Çevresel Kuznets Eğrisi Hipotezlerinin Analizi

ÖZ: *Doğrudan yabancı yatırımlar küresel ekonomik entegrasyonun önemli bir bileşeni olarak gelişmekte olan ülkelerde ekonomik büyümeyi teşvik etmektedir. Ancak bu yatırımlar çevresel bozulmaya yol açabilmekte ve özellikle çevre mevzuatının yetersiz olduğu ülkelerde ekolojik ayak izinin artmasına neden olabilmektedir. Bu durum sanayileşme ve artan kaynak tüketimiyle birlikte çevresel sürdürülebilirliği tehdit eden bir faktör haline gelebilmektedir. Bu çalışmanın amacı Kirlilik Cenneti, Kirlilik Halesi ve Çevresel Kuznets Eğrisi hipotezlerini test etmektir. Bunun için D8 ülkelerinde 1995-2022 yılları arası verileri baz alınarak FMOLS uzun dönem katsayı tahmincisi kullanılmıştır. Elde edilen sonuçlara göre Kirlilik Cenneti hipotezinin geçerli olduğu bulgusuna ulaşılırken, Kirlilik Halesi ve Çevresel Kuznets Eğrisi hipotezlerinin geçerli olmadığı bulgularına ulaşılmıştır. Bu bulgular D8 ülkelerinde doğrudan yabancı yatırımların çevresel bozulmayı artırabileceğini ve bu ülkelerin daha katı çevre politikalarına ihtiyaç duyduğunu göstermektedir.*

Anahtar Kelimeler: *Kirlilik Cenneti, Kirlilik Halesi, Doğrudan Yabancı Yatırım, Ekolojik Ayak İzi, EKC*

Geliş Tarihi / Received: 19/02/2025 Kabul Tarihi / Accepted: 11/04/2025

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1. Introduction

The Pollution Haven hypothesis (PHV) is a theory that examines the impact of environmental regulations on international trade and investment decisions. This hypothesis proposes that countries with relatively low environmental standards become “pollution havens” by attracting polluting industries. PHV provides an important framework for understanding how environmental impacts are redistributed in the globalization process (Yoon and Heshmati, 2021). It is built on two main economic concepts. First, environmental regulations increase production costs, prompting firms in countries with strict standards to relocate to regions with looser regulations. Second, countries with weak environmental regulations may gain comparative advantage in polluting industries and specialize in these sectors (Manderson and Kneller, 2012).

Pollution Halo hypothesis (PHL) offers an alternative perspective to the PHV to understand the environmental impacts of globalization. Accordingly, it is suggested that foreign investments by multinational corporations (MNCs) can improve environmental performance in host countries (Ahmad et al., 2021). This hypothesis argues that MNCs can create a "halo effect" in host countries by introducing cleaner technologies, management practices and environmental standards. MNCs bring cleaner and more efficient technologies to host countries. These technologies can be adopted by local firms and improve overall environmental performance. It also brings advanced practices in environmental management (such as ISO 14001) to host countries (Christmann and Taylor, 2001). Such practices set a benchmark for local firms. These companies can then increase environmental performance throughout their supply chain by requiring their suppliers to comply with environmental standards (Zarzky, 1999). Thus, the PHL suggests that globalization can yield positive environmental outcomes.

To summarize, while PHV emphasizes the importance of harmonizing environmental standards in combating climate change, the PHL suggests that MNCs can play a positive role in combating climate change through clean technologies and environmental management practices. For example; PHV argues that countries with weak environmental regulations attract polluting industries. This situation can lead to global inequalities in combating climate change. The hypothesis in question emphasizes that climate change policies should be harmonized on a global scale. Otherwise, countries with weak regulations can increase global emissions (Duan and Jiang, 2021). The PHL argues that MNCs can improve the environmental performance of host countries by introducing clean technologies and environmental standards. MNCs can play an important role in combating climate change. For example, they can contribute to the spread of renewable energy and energy efficiency technologies (Chen et al., 2022). There is no clear consensus on the validity of either hypothesis. While some studies support the Pollution Haven hypothesis (Baek, 2016; Sarkodie and Strezov, 2019; Shahbaz et al., 2015; Chandran and Tang, 2013; Salahuddin et al., 2018; Shahbaz

et al., 2019; Lee at al., 2023; Shaari et al., 2014; Balsalobre-Lorente et al., 2022; Ren et al., 2014; Salahodjaev and Isaeva, 2024; Holtbrügge and Raghavan, 2025), while some other studies support the Pollution Halo hypothesis (Abid et al., 2022; Ben Jebli et al., 2019; Zhang and Zhou, 2016; Islam et al., 2021; Sung et al., 2018; Xie et al., 2020; Pao and Tsai, 2011; Panigrahi et al., 2025).

Another important issue is that PHV has important implications for the global impact of environmental policies. For example, PHV emphasizes the need to harmonize environmental standards across countries. Otherwise, countries with weak regulations may become havens for polluting industries. Developing countries should prioritize long-term sustainable development goals over short-term economic gains by maintaining strict environmental standards (Liu and Xu, 2021). While PHL emphasizes that environmental impacts can be positive, it also draws attention to some limitations. The effectiveness of this hypothesis largely depends on the technological and institutional capacity of the host country. In low-capacity countries, the impact of PHL may be limited. However, the impact of PHL may vary depending on sectoral dynamics. In particular, the impact tends to be weaker in polluting sectors.The environmental practices of MNCs depend on factors such as reputation and regulatory pressure. Where these factors are weak, the impact of the global value chains may be diminished (Gao et al., 2022). This situation provides a suitable framework for the next stage of the Environmental Kuznets Curve (EKC) hypothesis.

The EKC hypothesis provides a framework for how environmental degradation can be reduced in the process of economic growth (Destek et al., 2018). This hypothesis, put forward by Grossman and Krueger (1991), explains the relationship between economic growth and environmental degradation with an inverted U-shaped curve. This hypothesis was adapted from the hypothesis put forward by Kuznets (1955). At low income levels, economic growth increases environmental degradation. Environmental degradation peaks when a certain income level is reached. At high income levels, environmental degradation decreases due to environmental awareness and technological innovation. The EKC hypothesis emphasizes the role of environmental policies and technological progress in the process of economic development. However, during this process, developing countries may have difficulty achieving environmental improvement due to various economic and structural constraints (Gill et al., 2018). PHV can cause developing countries to remain in the early stages of EKC. Transfer of polluting industries increases environmental degradation in these countries. Developed countries can move to the advanced stages of EKC by shifting polluting industries outward. Moreover, these countries may improve their own EKC turning points by shifting environmental degradation to developing countries, while disrupting the EKC turning points of developing countries (Copeland, 2008). PHL argues that foreign investments by MNCs can improve environmental performance in host countries. This process can be related to the EKC as follows: Multinational corporations can reduce environmental

degradation by bringing host countries closer to the EKC milestone through clean technology investments and green production practices. They also support the development of local regulations and institutional capacity.. PHL can help host countries realize EKC turning point at an earlier stage (Abid and Sekrafi, 2021).

As explained above, PHV suggests that countries with weak environmental regulations become pollution havens by attracting polluting industries. This process can have some effects in terms of ecological footprint. For example, polluting industries can consume natural resources intensively. This can increase the ecological footprint of host countries. Industries based on fossil fuel use can contribute to climate change by increasing global carbon emissions. Polluting industries can exceed biocapacity, causing problems such as deforestation, soil pollution and water resource depletion (Solarin et al., 2017). Developed countries can reduce their own ecological footprint by shifting polluting industries to developing countries, while increasing the footprint of developing countries. From the perspective of PHL, MNCs can reduce resource consumption and emissions by introducing cleaner and more efficient technologies. This can reduce the ecological footprint of host countries. MNCs can reduce environmental degradation by moving host countries to the next stage of the EKC turning points through clean technology investments and green production practices. They can also reduce the ecological footprint along the supply chain by requiring their suppliers to comply with environmental standards. Thus, PHL can contribute to reducing the global ecological footprint. However, this impact depends on the host country's capacity and the motivation of MNCs (Xiang et al., 2025).

The PHV and PHL are important tools for understanding the complex relationship between global environmental policies and international trade. However, more empirical studies are needed on the validity of the hypotheses. In particular, separating the effect of environmental regulations from other factors and examining the dynamics that may produce different results for different industries offers an important area for future research. Especially developing countries may put the issue of environmental pollution on the back burner in order to quickly achieve their economic growth targets. Some of the developing countries Turkey, Egypt, Pakistan, Iran, Malaysia and Bangladesh are among the D8 countries. In these D8 countries, the ecological footprint per capita increased from 1.86 global hectares (gha) in 1995 to 2.28 gha in 2022. In the same period, the world average increased by only 2.78%, from 2.51 gha to 2.58 gha. In contrast, the increase rate in D8 countries was 22.58% (Global Footprint Network, 2025). These data clearly show that the rate of increase in D8 countries is much higher than the world average. The D8 countries represent a significant bloc of developing economies undergoing rapid industrialization and urbanization. These countries are characterized by high population densities, increasing energy demands, and dependence on fossil fuels for economic growth. Despite their economic potential, these countries face significant environmental challenges, including deforestation, water scarcity, and high carbon emissions. Weak enforcement of environmental

regulations can make these countries attractive destinations for FDI in pollution-intensive industries. This can lead to an increase in the ecological footprint, raising concerns about long-term environmental sustainability. Therefore, it is important to examine the effects of PHV and PHL on the ecological footprint in these countries. In addition, it is observed that CO_2 emissions are generally used as dependent variable in the literature in testing the PHV, PHL and EKC hypotheses. This study tests the three hypotheses for D8 countries, whose emission growth rate is above the world average, by using the much more comprehensive ecological footprint indicator instead of the CO2 indicator. Thus, it aims to fill this gap in the literature, provide a more comprehensive understanding of the environment-economy relationship, and make policy recommendations for the problems. This approach constitutes the main motivation of the study.

The possible contributions of this study to the literature are as follows: i) There are limited number of studies on PHV (Pollution Haven hypothesis) and PHL (Pollution Halo hypothesis) and this study makes a significant contribution to the expansion of this literature. ii) While most of the existing studies use CO_2 emissions, which is an air pollution indicator, this research fills an important methodological gap in the literature by using the ecological footprint indicator, which is a more comprehensive measure in environmental impact assessment. iii) The study allows for an integrated examination of these hypotheses by testing the EKC (Environmental Kuznets Curve) hypothesis together with PHV and PHL, and provides an empirical and theoretical contribution to the literature. iv) This research, which is conducted specifically for D8 countries, addresses an important gap in the region-specific literature by examining the relationship between foreign capital investments, economic growth and environmental degradation. In this group of countries, which are of critical importance in terms of global environmental dynamics, it appears that the environmental impacts of foreign investments have not been sufficiently investigated. v) The Levin, Lin and Chu (LLC) unit root test, Im, Pesaran and Shin (IPS) unit root test, Pedroni-Kao cointegration tests and Fully Modified Ordinary Least Squares (FMOLS) long-term coefficient estimation methods applied in the study provide a comprehensive analysis opportunity. vi) In addition, this study is the first comprehensive study in which the three hypotheses in question (PHH, PHL and EKC) are analyzed together with the mentioned methods in the D8 countries. vii) It is expected that the policy recommendations developed based on the research findings will be guiding in reducing the environmental impacts of both foreign direct investments and economic growth. In this context, the study can contribute to the shaping of sustainable development policies.

The continuation of the study is as follows: In the first stage, a literature review was conducted, then the methodological framework and data set of the study were presented. After the completion of the empirical analyses, the findings were

discussed. The study was concluded with the conclusion and policy recommendations section.

2. Literature Review

The Pollution Haven hypothesis argues that environmental quality decreases in countries with foreign direct investments (FDI) inflows. This theory was proposed by Walter and Ugelow (1979). The main purpose of its proposal was to investigate whether FDI transfers pollution-intensive industries to the host country. It was later developed by Baumol and Oates (1988) to examine the impact of FDI on environmental quality. The Pollution Halo hypothesis, which argues the opposite of PHV, was put forward by Birdsall and Wheeler (1993). This hypothesis argues that FDI's bring environmental improvements to host countries by bringing green technology (Yi et al., 2023).

Some studies confirm the Pollution Haven hypothesis. For example, Javed et al., (2023), found that FDI contributed to the increase in CO_2 emissions in Italy between 1971 and 2019. Similarly, Sarkodie and Strazov (2019), demonstrated that foreign direct investment reduced environmental quality based on CO_2 emission data in developing countries during 1982–2016, employing the Driscoll Kraay method. Wencong et al., (2023), employed ARDL and panel quantile regression analyses for the period 1998–2019 to argue that FDI has a positive impact on CO_2 emissions in transition economies, suggesting that it contributes to environmental pollution. They also concluded that the EKC hypothesis does not hold. In another study, Khalil and Inam (2006), examined the environmental (CO_2) impact of trade-related factors in Pakistan using an error correction model and found that FDI reduces environmental quality. Liu et al., (2021), used an advanced panel method based on correlation tests in the case of China and determined that FDI negatively affects environmental quality. Zheng et al., (2024), demonstrated the validity of the PHV in both the short and long term. Ren et al., (2014), conducted a study using FDI data from 18 sectors and concluded that such investments increase CO_2 emissions. Adjei-Mantey and Adams (2023), argued that FDI raises CO_2 emissions and reduces environmental quality in 29 Sub-Saharan African countries. Huang et al. (2022) applied the feasible generalized least squares method and found a positive association between FDI inflows and carbon emissions. Essandoh et al., (2020), similarly observed that FDI increases CO_2 emissions in low-income countries.

On the other hand, some studies support the Pollution Halo hypothesis. For instance, Rafindadi et al., (2018), found that FDI plays a role in reducing CO_2 emissions in the Arab Gulf countries. Similarly, Atici (2012), using random and fixed effects panel analysis, concluded that an increase in FDI leads to lower CO_2 emissions, thereby confirming the Pollution Halo hypothesis. Moreover, Apergis et al., (2023), investigated the relationship between FDI and CO_2 emissions in BRICS countries between 1993 and 2012 and found that FDI flows lead to a decline in CO_2 emissions. Additionally, Zhang and Zhou (2016), explored the

national and regional impact of FDI on China's CO_2 emissions using provincial panel data from 1995 to 2010 and validated the Pollution Halo hypothesis. Shaari et al., (2014), analyzed data from 15 developing countries from 1992 to 2012 and obtained results consistent with the Pollution Halo hypothesis.

When the relevant literature is examined, it is observed that most studies utilize CO_2 emissions as the primary environmental indicator. However, this study adopts the ecological footprint, which includes land use, water consumption and other environmental factors in addition to CO_2 emissions, as a criterion, bringing a more holistic perspective to environmental impact analysis. In addition, it has been observed that existing studies on the environmental impacts of foreign direct investment have largely focused on developed countries, BRICS economies or certain regional groups (such as Sub-Saharan Africa, Arab Gulf countries). In contrast, research conducted specifically for the D8 countries is quite limited. However, these countries have a critical importance in terms of examining environmental impacts due to their rapid industrialization processes, high population densities and developing economy dynamics. This study aims to fill the regional gap in the literature by analyzing the environmental consequences of FDI specifically for the D8 countries. On the other hand, the time periods in the existing literature have generally been limited to relatively short periods of 10-20 years. This study provides an opportunity to interpret environmental impacts more consistently by using a 27 year long-term dataset. In addition to testing the Environmental Kuznets Curve hypothesis, it makes an important contribution to the literature by evaluating the Pollution Haven and Pollution Halo hypotheses in the context of D8 countries.

3. Model, Data and Method

In this study, which examines the effects of foreign direct investments and economic growth on the ecological footprint, the period 1995-2022 is taken as basis for D8 countries (Turkey, Egypt, Pakistan, Iran, Malaysia, Bangladesh). Ecological footprint per capita (global hectares), GDP per capita (constant 2015 US$), foreign direct investment, net inflows (%GDP) variables are included in the empirical model. Data for the ecological footprint were obtained from the Global Footprint Network, while GDP and FDI data were sourced from the World Development Indicators (WDI) database. The empirical equation formulated from these variables is as follows:

$$\log EF_{it}=\alpha_0+ \alpha_1 \log FDI_{it}+ \alpha_2 \log GDP_{it}+ \alpha_3 \log GDP^2_{it} +\mu_{it} \quad (1)$$

EF in Equation (1) represents the ecological footprint; FDI represents foreign direct investments; GDP represents per capita income; GDP^2 represents per capita income squared; and μ represents the error term. All variables were transformed into logarithmic form for the analysis. Stationarity of variables was examined using IPS and LLC unit root tests. IPS test, introduced by Im, Pesaran and Shin (2003), was specifically designed to evaluate the stationarity of panel data series

by taking into account cross-sectional dependency and heterogeneity. On the other hand, LLC test, developed by Levin, Lin and Chu (2002), is a widely used method to test unit roots in panel data, working under the assumption of a common unit root parameter among all units. Pedroni cointegration test was used for cointegration analysis. This method, developed by Pedroni (1999), is used to evaluate the existence of cointegration relationships between variables in panel data. Pedroni test is versatile, can be applied to models with both constant and trend terms, and produces seven separate test statistics, including four within-dimension and three between-dimension statistics. Similarly the Kao (1999) cointegration test is a method used to test the cointegration relationship in panel data models. FMOLS (Fully Modified Ordinary Least Squares) estimators were used to estimate the long-run coefficients. The FMOLS approach, developed by Phillips and Hansen (1990), is used to estimate long-term coefficients once a cointegration relationship has been established, addressing issues such as autocorrelation and endogeneity among the series to provide more reliable coefficient estimates.

4. Empirical Analysis

Firstly, the stationarity of the variables was tested with LLC and IPS unit root tests. According to the results obtained in Table 1, while all variables contain unit roots in their level values, they become stationary in their first difference values.

Table 1: Levin-Lin-Chu and Im-Pesaran-Shin Unit Root Test Results

	LLC Unit Root Test				**IPS Unit Root Test**			
	Constant		**Constant and Trend**		**Constant**		**Constant and Trend**	
	I(0)		**I(0)**		**I(0)**		**I(0)**	
	t-stat.	**Prob.**	**t-stat.**	**Prob.**	**t-stat.**	**Prob.**	**t-stat.**	**Prob.**
EF	-0.15	0.440	3.232	0.999	-0.79	0.214	0.5573	0.711
FDI	0.526	0.700	5.090	1.000	-1.15	0.123	0.1951	0.577
GDP	2.958	0.998	0.037	0.514	2.80	0.997	-1.053	0.146
GDP^2	3.450	0.999	-0.24	0.402	3.05	0.998	-1.190	0.116
	I(1)		**I(1)**		**I(1)**		**I(1)**	
EF	-3.42	0.000***	-1.55	0.059*	-2.14	0.016**	-1.535	0.062*
FDI	-7.43	0.000***	-5.84	0.000***	-3.76	0.000***	-3.295	0.000***
GDP	-4.42	0.000***	-3.62	0.000***	-5.17	0.000***	-4.239	0.000***
GDP^2	-4.18	0.000***	3.647	0.000***	-2.53	0.005**	-1.546	0.061*

Note: ***,**,* indicate 1%, 5%, 10% significance level, respectively.

After determining the stationarity status of the variables, the cointegration relationship was tested. For this, the Pedroni cointegration test was used. In the results given in Table 2, the existence of a cointegration relationship between the variables was determined at 6 statistical values.

Table 2: Pedroni Cointegration Test Results

	Statistic	Prob.
Common AR Coefs.		
Panel v-Statistic	1.7141	0.043**
Panel rho-Statistic	-2.6354	0.004**
Panel PP-Statistic	-5.3029	0.000***
Panel ADF-Statistic	-2.3105	0.010**
	Statistic	**Prob.**
Individual AR Coefs.		
Panel rho-Statistic	-0.8463	0.1987
Panel PP-Statistic	-3.7494	0.000***
Panel ADF-Statistic	-2.4298	0.007**

Note: ***,**,* indicate 1%, 5%, 10% significance level, respectively.

In order to strengthen the cointegration relationship between the variables, the Kao cointegration test was also performed. According to the results given in Table 3, the existence of the cointegration relationship between the variables was confirmed.

Table 3: Kao Cointegration Test Results

	t-statistic	Prob.
ADF	1.5502	0.060*
Residual Variance	0.004173	
HAC Variance	0.002153	

Note: ***,**,* indicate 1%, 5%, 10% significance level, respectively.

After determining the cointegration relationship, the coefficient testing phase can be started. Accordingly, the FMOLS long-term coefficient estimator was used.

Table 4: FMOLS Long-Term Coefficient Estimation Results

	Coefficient	Prob.
FDI	0.7192	0.000***
GDP	20.3810	0.000***
GDP^2	22.57453	0.000***

Note: ***,**,* indicate 1%, 5%, 10% significance level, respectively.

According to the FMOLS long-term coefficient estimation results presented in Table 4, it is observed that foreign direct investments increase the ecological footprint. This result indicates that the PHV hypothesis is valid but the PHL hypothesis is invalid. This finding is in line with the studies of Khalil and Inam, 2006; Ren et al., 2014; Strazov, 2019; Essandoh et al., 2020; Liu et al., 2021; Adjei-Mantey and Adams, 2023; Javed et al., 2023; Sarkodie and Wencong et al., 2023; Salahodjaev and Isaeva, 2024; Holtbrügge and Raghavan, 2025. In developing countries, foreign direct investment is often directed towards energy-intensive sectors such as manufacturing, mining and petrochemicals. Increased production in these sectors can lead to over-consumption of natural resources and increased carbon emissions, which can increase the ecological footprint.

Moreover, FDI generally increases energy demand; if the energy infrastructure in the host country is inadequate or predominantly reliant on fossil fuels, environmental degradation may ensue. The use of polluting energy sources, especially coal and oil, can have a negative impact on the ecological balance. Relatively weak environmental regulations in developing countries may allow foreign investors to operate with more flexible standards. Accordingly, strict environmental policies in developed countries direct investors to regions with fewer restrictions, which can increase environmental damage. If the technology transfer that comes with FDI is not environmentally friendly, the process can result in more pollution and resource consumption. In addition, FDI can stimulate economic growth, increase the consumption and overuse of natural resources, which further increases the ecological footprint. At the same time, the acceleration of infrastructure projects and urbanization by FDI can lead to additional environmental problems such as deforestation, soil degradation, and water pollution. Therefore, the environmental impacts of FDI vary depending on the regulatory framework of the host country, energy policies and the nature of technology transfer.

According to the results conveyed in Table 4, economic growth increases the ecological footprint both in the initial phase and in the later stages. According to this result, the EKC hypothesis is not confirmed. This finding is consistent with the studies of Rehman and Liu and Ran, 2016; Rashid, 2017; Destek et al., 2018. As GDP increases, industrialization, manufacturing growth, and energy consumption typically increase, which can lead to higher natural resource consumption and environmental degradation (such as increased carbon emissions, air pollution, and water pollution). Especially in developing countries, economic growth may generally occur together with environmentally harmful activities. The positive coefficient of GDP^2 shows that the effect of economic growth on environmental degradation continues at an increasing rate. In other words, as economic growth increases, environmental degradation accelerates. This situation reveals that environmental sustainability policies and clean technology investments are inadequate, especially in developing countries. While economic growth triggers environmental degradation in these countries, environmental protection measures, regulations and resources allocated to green technologies may not reach sufficient levels. Weak environmental legislation and lack of effective implementation may accelerate this process and further increase the ecological costs of economic development. Environmentally harmful activities can continue, especially in energy-intensive sectors such as manufacturing, mining and petrochemicals. Energy production in these countries is largely based on fossil fuels such as coal, oil and natural gas. As the economy grows, energy demand increases, which can increase carbon emissions. Fossil fuel use is an important factor explaining the environmental cost of GDP growth in these countries. In addition, inadequate investment in renewable energy and energy efficiency projects can further exacerbate environmental problems. Moreover,

rapid population growth and uncontrolled urbanization can increase the ecological costs of economic growth by increasing pressure on natural resources. Weak environmental policies, fossil fuel dependency and lack of clean technology investments, especially in countries such as the D8 countries that focus on industrialization and energy-intensive sectors, can be cited as the main reasons for this situation.

5. Conclusion and Policy Recommendations

This study examined the effects of FDI and GDP on the ecological footprint in D8 countries with data covering the period 1995-2022. Additionally, IPS-LLC unit root test, Pedroni-Kao cointegration tests and FMOLS long-term coefficient estimator were used. According to the results, it was determined that FDI increased the ecological footprint. This result is consistent with the studies of Sarkodie and Wencong et al., 2023; Salahodjaev and Isaeva, 2024; Holtbrügge and Raghavan, 2025.In line with this result, it was determined that the PHV hypothesis was valid but the PHL hypothesis was invalid. Foreign investors shift their environmentally harmful activities to this region due to the relatively weak environmental regulations in these countries. In developing countries such as the D8 countries, environmental regulations and control mechanisms may generally be inadequate. This may cause foreign investors to shift their environmentally harmful activities to these countries. For example, polluting industries (such as chemistry, mining, energy production) may operate in these countries with lower costs and fewer restrictions. In these countries, foreign investments may generally be directed to sectors that cause high carbon emissions, such as energy, mining, and manufacturing. In particular, the intensive use of fossil fuels such as coal and oil in energy production can significantly increase the ecological footprint. Due to the inadequacy of green technologies, foreign investors may tend to use old and polluting technologies in order to operate in these countries with lower costs. The primary goal of developing countries is to achieve economic growth. This may cause the environmental impacts of foreign investments to be generally left in the background. Due to foreign investments, urbanization and industrialization rates may increase. These factors may create pressure on waste management and water resources in terms of pollution. All of these factors listed are among the factors that increase the ecological footprint.

It has been found that economic growth increases environmental degradation in D8 countries. This finding indicates that the EKC hypothesis is not valid for these countries. It is known that energy demand increases as economic growth increases. When this demand is met by fossil fuels instead of renewable energy sources, it can accelerate environmental degradation. Environmental regulations and policies can often be inadequate. This situation can increase the environmental costs of economic growth. Weak environmental standards, especially in the industry and energy sectors, can cause polluting activities to increase uncontrolledly. This unsustainable structure of growth can increase

environmental degradation and this effect can accelerate over time. Population growth and consumption habits in D8 countries can further increase the environmental effects of economic growth. Increasing population can put more pressure on natural resources. In addition, consumption-oriented growth models can increase waste production and environmental degradation. Finally, D8 countries may not yet have the technological and institutional capacity to reduce environmental degradation, suggesting that the environmental costs of economic growth continue to increase.

The practical implications of this study may be important for policy makers in the D8 countries. The findings suggest that without stricter environmental regulations, these countries risk becoming pollution havens and attracting industries that contribute to environmental degradation. To mitigate this, D8 countries should adopt and implement international environmental standards, especially in sectors that are heavily dependent on foreign investment. For example, incentives could be provided to foreign investors who adopt cleaner technologies and participate in sustainable projects such as renewable energy and waste management. This approach has been successfully implemented in countries where FDI has been directed to green technologies, resulting in reduced carbon emissions (Zhang and Zhou, 2016). Furthermore, D8 countries should prioritize the transition from fossil fuels to renewable energy sources. This transition can not only reduce environmental degradation but also increase energy security. For example, Malaysia has made significant strides in solar energy production, which has contributed to a reduction in the ecological footprint (Shaari et al., 2014). International cooperation and technology transfer agreements can play an important role in this transition. For example; Foreign investment in renewable energy has been facilitated through partnerships with global organizations (Holtbrügge and Raghavan, 2025).

In general, the findings of the study indicate the lack of sustainable development policies in D8 countries. Urgent policy measures are needed to control the environmental impacts of foreign investments and to reduce the environmental costs of economic growth. Some policy recommendations will be made in line with these results. D8 countries should raise their environmental protection standards to international levels and implement these regulations effectively. In particular, strict control mechanisms should be established to prevent environmentally harmful activities of foreign investors. Foreign investors should be directed towards environmentally friendly technologies and sustainable projects. In this context, incentives should be provided in areas such as renewable energy, energy efficiency and waste management. D8 countries should reduce their dependence on fossil fuels in energy production and invest in renewable energy sources (solar, wind, hydroelectric). This transition will both reduce environmental degradation and increase energy security. D8 countries should increase their access to environmentally friendly technologies and encourage local production of these technologies. International cooperation and technology

transfer agreements can accelerate this process. A balance should be established between economic growth and environmental sustainability. In this context, policies and projects should be developed in line with sustainable development goals. D8 countries should strengthen international cooperation in the field of environmental protection and sustainable development. Cooperation should be made with global organizations, especially in green financing and technology transfer. Education and awareness campaigns should be organized to increase environmental protection awareness. Society's participation in environmentally friendly practices should be encouraged.

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