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The Effect of Foreign Direct Investment on Environmental Degradation: Evidence from Turkey

Doğrudan Yabancı Yatırımların Çevresel Bozulma Üzerindeki Etkisi: Türkiye Örneği

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Abstract

Within the major changes in climate during the past century, the scientific literature has been particularly concerned with the causes of environmental contamination. However, the relationship between foreign direct investment (FDI) inflows and environmental degradation has recently become a topic of debate in economics. The purpose of this study is to analyse the impact of FDI inflows on environmental deterioration in Turkey using the autoregressive distributed lag (ARDL) method both in the short and long runs during the period from 1990 to 2017. For this purpose, ecological footprint is used as a proxy for environmental degradation and as the dependent variable while FDI inflows are used as the independent variable. The results indicate that FDI inflows are associated with an increase in environmental degradation in the long run, lending support to the pollution haven hypothesis for Turkey. This research also includes policy implications and recommendations for further research in light of its findings.

Keywords: *Turkey, Pollution Haven Hypothesis, Pollution Halo Hypothesis, Ecological Footprint, Autoregressive Distributed Lag (ARDL) Approach*

JEL Classification: *E22, Q43, Q56*

Öz

Geçtiğimiz yüzyılda iklimdeki büyük değişikliklerle beraber, bilimsel literatür özellikle çevre kirliliğin nedenleriyle ilgilenmektedir. Bununla birlikte, doğrudan yabancı yatırım (DYY) girişleri ile çevresel bozulma arasındaki ilişki son zamanlarda ekonomide yeni bir tartışma konusu haline gelmiştir. Bu çalışmanın amacı, 1990'dan 2017'ye kadar olan dönemde, DYY girişlerinin Türkiye'deki çevresel bozulma üzerindeki etkisini Gecikmesi dağıtılımış otoregresif (ARDL) yöntemi ile hem kısa hem de uzun dönemde analiz etmektir. Bu amaçla ekolojik ayak izi çevresel bozulmanın bir temsilcisi ve bağımlı değişken olarak kullanılırken, DYY girişleri ise bağımsız değişken olarak kullanılmıştır. Sonuçlar, DYY girişlerinin uzun vadede çevresel bozulmadaki artışla ilişkili olduğunu göstermektedir ve Türkiye için kirlilik sınağı hipotezini desteklemektedir. Ayrıca bu araştırma bulgular ışığında bazı politika çıkarımları ve gelecek araştırmalar için tavsiyeler içermektedir.

Anahtar Kelimeler: *Türkiye, Kirlilik Sınağı Hipotezi, Kirlenme Hale Hipotezi, Ekolojik Ayak İzi, Gecikmesi Dağıtılımış Otoregresif (ARDL) Model Yaklaşımı*

JEL Sınıflandırması: *E22, Q43, Q56*

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1. Introduction

After commercial bank credit dried up in the 1990s, foreign direct investment (FDI) has become the world's largest source of external financing (Carkovic and Levine, 2002). As a result of the belief that FDI contributes to the growth rate of the receiving country, countries have begun to compete to attract more FDI by offering a variety of incentives, such as exemptions from import duties, income tax holidays, and infrastructure subsidies. Worldwide FDI inflows have increased by 808 percent between 1990 and 2017, from 239.4 billion to 2,175.5 billion US dollars[1]. This dramatic increase has caught the interest of researchers, and the link between FDI and economic growth has been extensively studied. Although the effect of FDI on the growth rate has been thoroughly studied for a long time, its impact on the quality of the environment has been mostly disregarded until recent decade (Koçak and Şarkgüneşi, 2018).

Environmental pollution manifested itself as sudden changes in air temperature and increases and decreases in rainfall in tropical regions, as well as the melting of glaciers at the planet's poles, and became a phenomenon known as global warming, which affects negatively not only natural life but also the economic and social lives of humans (Maslin, 2004). Within the significant changes in climate over the last century the topic of the determinants of environmental pollution is the most concerning issue in the scientific literature (Bilgili et al., 2016).

Since the 1990s, as globalisation gathered momentum, economists have studied the effects of economic growth on the environment based on the environmental Kuznets curve (Erataş and Uysal, 2014). According to EKC, in the early phases of economic growth, environmental pollution increases; but, beyond a certain level of growth rate, the relationship reverses and a higher growth rate results in a cleaner environment (Stern, 2014). This indicates that environmental impacts or emissions per capita are U-shaped functions of per capita income. According to both neoclassical and endogenous growth theories, it has been asserted that FDI contributes significantly to economic growth in the receiving nation (İlhan, 2007). Therefore, the relationship between FDI and economic growth has been thoroughly analysed. However, the topic of the impact of FDI on environmental degradation has received comparably less attention and is a relatively new area of study.

Most studies in the literature contend that FDI is viewed as a factor in environmental contamination, particularly in developing nations where environmental restrictions are laxer, hence attracting more FDI inflows (e.g., Kellogg, 2006; Chung, 2014; Solarin et al., 2017). Furthermore, multinational corporations have a tendency to relocate their production polluting the environment to these nations in order to circumvent certain restrictions and avoid paying environmental taxes. The pollution haven hypothesis (PHH) adopts the notion of a negative relationship between FDI and environmental degradation. According to this hypothesis, foreign investment is responsible for the poor quality of the local environment by shifting their polluting production to developing countries. On the other hand, the opposite approach asserts that FDI helps to improve environmental quality by transferring cleaner technologies to host countries, which also increases environmental awareness in those countries. This concept is known as the pollution halo hypothesis, and it claims that FDI is related to an improvement in the host country's environmental quality by adopting technologies that are believed to be more efficient and release comparatively fewer emissions (Nadeem, 2020).

Emissions of carbon dioxide (CO2) are frequently used as a proxy for environmental degradation in the literature. However, carbon dioxide (CO2) emission is only one component of pollution, and as argued by Nadeem (2020), other pollutants such as SO2 emissions and greenhouse gas (GHG) emissions are

[1]Source: World Development indicators. Available at:
https://databank.worldbank.org/reports.aspx?source=2&series=BX.KLT.DINV.CD.WD&country=

drivers of environmental deterioration. In this context, focusing on carbon dioxide emissions to evaluate environmental degradation may explain the contradictory results about the relationship between FDI and environmental degradation, which motivates us to examine conduct this study. In this study, we employed an ecological footprint to represent environmental contamination as it consists of the six demand categories: Cropland, grazing land, fishing grounds, forest products, carbon and built-up land.Our indicator is also a single unit that enables the disaggregation of indicators and the measurement of complexity. In addition, it is extremely comprehensive. It is vital not just for assessing civilization's influence on the planet's ecosystems but also for understanding the interconnected effects of climate change on the natural ecosystems upon which humanity depends. We also employed the ARDL approach to investigate the effect of FDI on environmental degradation, which enabled us to observe the effect in the long run as well as the short run. Long-run analysis is especially important because the potential deteriorating effect may be observed in the long run rather than the short run. The purpose of this study is to analyse the impact of FDI on environmental deterioration in Turkey from 1990 to 2017 by taking into account all relevant factors, with the expectation that this research will yield more reliable outcomes, which we believe is an important contribution of our analysis to the literature. The expected effect of FDI on environmental deterioration is positive, which verifies the existence of the pollution haven hypothesis given that our sample country is one of the developing nations whose environmental rules are relatively lenient compared to those of developed nations.

Turkey is an ideal country for studying the relationship between FDI and environmental degradation because of the following reasons: First of all, Turkey has accepted the Paris Agreement, which aims to limit global warming to around 2 degrees in order to avoid the negative effects of climate change. Moreover, as part of its climate action plan submitted to the UN Secretariat in 2015, Turkey pledged to reduce its emission growth by 21% by 2030. Regarding FDI inflows, Turkey is one of the Asian countries that receives the most international investment. In 2017, it attracted 3.5% of Asia's total foreign investment. Furthermore, with 21% of the overall FDI inflows in the West Asian region, it is the country that attracts the most foreign investors[2].

The remaining sections are organised as follows. The "Literature review" section provides a summary of the previous papers. The section titled "Data and methodology" describes the selected variables and the econometric approach. In the "Results and discussion" section, the empirical findings are presented and discussed. In the final section, conclusions and policy implications are presented.

2. Literature Review

Although the relationship between FDI and environmental degradation is a relatively new topic of discussion in the academic literature, it has attracted a great deal of interest from researchers, and there have been a number of studies that shed light on the topic using a wide variety of variables and econometric techniques. This section of this research aims to review some of these studies.

Table 1 presents some of the studies on this subject. As indicated in the table, the majority of these studies confirm the validity of the pollution haven theory (e.g., Koçak and Şarkgüneşi, 2017; Gorus and Aslan, 2019; Muhammad et al., 2021), while others conclude that the pollution halo hypothesis is valid in selected countries (e.g., Jiang et al., 2018; Didorally and Fauzel, 2020; Qamri et al., 2022). In other words, the literature has been far from consensus regarding the impact of FDI on environmental destruction.

Variables chosen to represent environmental degradation may be one of the potential explanations for the inconclusive results. As seen, mostly carbon dioxide emission is preferred to measure environmental degradation. However, neglecting other pollutants may explain the mixed findings in the literature, as discussed in the preceding section. To deal with this issue, we have employed ecological footprint.

[2] Source: United Nations Conference on Trade and Development.
Available at https://unctadstat.unctad.org/wds/TableViewer/tableView.aspx

Another possible reason behind the inconclusive finding may be the selection of sample countries. Countries with abundant natural resources, for example, may attract FDI in the primary sector, which leads to much more air pollution than other sectors. Finally, the econometric method may also play a role in explaining the mixed findings. Since it is expected that a deterioration will be observed in the long run, so an analysis based on the short run may not yield a significant result on the effect of FDI on environmental destruction.

Aware of the potential causes of the inconclusive findings in the prior research, we attempted to investigate the effect of FDI on environmental devastation in Turkey between 1990 and 2017 in light of these potential causes. According to our knowledge, there are less studies to analyse the relationship between FDI and environmental deterioration using ecological footprint.

Table 1 gives a summary of some research on the link between FDI and the environment, including authors, sample countries, study period, variables, method, and the most important results.

Table 1. Summary of the findings of some research on the link between sectoral FDI and environmental degradation

Authors	**Time period and sample countries**	**Method**	**Variable as a proxy for environmental degradation**	**Findings**
Hitam and Borhan (2012)	1965-2010, Malaysia	Johansen-Juselius cointegration test	CO_2 emissions	FDI leads to deteriorate environmental quality
Kostakis et al. (2016)	1970s-2010, Brazil and Songapore	ARDL, OLS, FMOLS	CO_2 emissions	FDI causes a worsening of environmental degradation in Brazil but not in Singapore.
Koçak and Şarkgüneşi (2017)	1974-2013, Turkey	DOLS, Bootstrap causality test	CO_2 emissions	Positive relationship between FDI and CO_2 emission.
Zomorrodi and Zhou, (2017)	2003-2014, China and 4 regions in China	Pooled OLS, Random effects	Sulphur dioxide emission and water pollutants emission	Positive but weak relationship between FDI and sulphur dioxide emission in China. In the eastern region, FDI is associated with water pollution, whereas in the other three regions, it is related to both water waste and sulphur emissions.
Jiang et al. (2018)	150 Chinese cities, 2014.	OLS, Spatial Durbin model	Air quality index	FDI improves environmental quality.
Jugurnath and Emrith, (2018)	2004-2014, 6 small island developing countries.	OLS, fixed effects	CO_2 emissions	FDI has no significant effect on environmental pollution.
Adamu et al. (2019)	1983-2014, India	DOLS, VECM	CO_2 emissions	FDI worsens the environment.
Gorus and Aslan (2019)	1980-2013, MENA countries	Panel dynamic OLS,	CO_2 emissions	FDI worsens pollution in these nations.

Table 1 continues

Authors	**Time period and sample countries**	**Method**	**Variable as a proxy for environmental degradation**	**Findings**
To et al. (2019)	1980-2016, Emerging countries in Asia	Fully modified ordinary least square, DOLS	CO_2 emissions	Relationship between FDI and environmental degradation is n inverted U-shaped.
Didorally and Fauzel(2020)	1976-2018, Mauritius	VECM	CO_2 emissions	FDI has a beneficial and considerable effect on CO2 emissions in Mauritius in the long run.
Nadeem et al. (2020)	1971-2014, Pakistan	ARDL	CO_2 emissions, CO_2 emission from solid fuel, SO_2 emission, GHG emission	Positive effect of FDI on CO_2 emission from solid fuel and GHG emission while negative effect of SO_2 emission in the long term.
Sabir et al. (2020)	1984-2019, South Asian countries	Panel ARDL	Ecological footprint	FDI exacerbates environmental degradation.
Christoforidis and Katrakilidis (2021)	1995-2014, Central and Eastern European countries	ARDL-PMG and ARDL-MG	CO_2 emissions	The relationship between FDI and environmental degradation is an inverted U-shaped.
Muhammad et al. (2021)	1991-2018, 176 developed and developing countries	Dynamic fixed effects, GMM	CO_2 emissions	FDI worsens environment in developing countries while improves it in developed countries.
Baskurt et al. (2022)	971-2015, Sweden	ARDL	Ecological footprint	FDI is associated with a better environmental standard in the long run.
Qamri et al. (2022)	1980-2018, Asian countries	Fixed effects, Random effects, IV.	CO_2 emissions	FDI leads to improvements in environmental condition.

3. Data and Methodology

This study employs Turkey's time series data from 1990 to 2017 in order to analyse the effect of FDI on environmental degradation. In order to accomplish this, ecological footprint is employed as the dependent variable. Ecological Footprint measures the amount of biologically productive land and water area needed to produce the food, fibre, and renewable raw materials an individual, population, or activity consumes, as well as to absorb the carbon dioxide emissions they generate. Cropland, grazing land, fishing grounds, forest products, carbon and built-up land footprints are the six demand categories evaluated. FDI inflows are used as the independent variable and measured in current U.S.

dollars. The proportion of people living in urban areas to the total population, energy consumption per capita, the gross domestic product, and financial development are considered as determinants of environmental quality since these variables are commonly used in the literature as control variables. The details of all the variables, such as definition, unit, source, etc., are explained in Table 2.

Table 2. Data Description

Variable	Symbol	Definition	Unit	Source
Ecological footprint	LnEFP	The Ecological Footprint is the only metric that assess both the amount of nature we possess and the amount of nature we consume.	Natural log	Global Footprint Network
Foreign direct investment	LnFDI	Foreign direct investment refers to the net inflows of investment to acquire a long-term management interest (10 percent or more of voting stock) in a company operating in an economy other than the investor's.	Natural log	World Development Indicator
Urban population	UP	Urban population refers to the ratio of people living in urban areas to total population.	Percentage	World Development Indicator
Energy consumption	EC	Oil equivalent per capita (Kg)	Kg	World Development Indicator
Gross domestic Product	LnGDP	It is the sum of the gross value added by all resident producers in the economy, plus any product taxes, minus any subsidies not included in the product value.	Natural log	World Development Indicator
Financial development	FD	It assesses the extent to which financial institutions and markets are developed in terms of their depth, access, and efficiency.	Index	International Money Fund

Table 3 shows descriptive statistics for dependent, independent, and control variables. We can see that the maximum value of the ecological footprint was 3.528 in 2017, while its minimum value was 2.293 in 1990. Similarly, the lowest value of FDI was 20,225 in 1994, and the highest was 23,816 in 2007. However, the value closest to the maximum is taken in the latter years of the period. The pattern of the variables during the period makes us question if the data has a trend.

Table 3. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
LnEFP	28	2.88	0.341	2.293	3.528
LnFDI	28	21.96	1.398	20.225	23.816
UP	28	66.98	4.736	59.203	74.644
EC	28	14965.36	3355.221	10345.27	21773.73
LnGDP	28	9653.22	1982.368	5303.01	11835.26
FD	28	0.39	0.101	0.1958	0.5289

As seen from figures 1 and 2, both the ecological footprint and FDI have a trend. To save space, we only focus on the target variables (LnEFP and LnFDI); however, intercepts and trends are taken into consideration when unit root tests are employed for control variables as well.

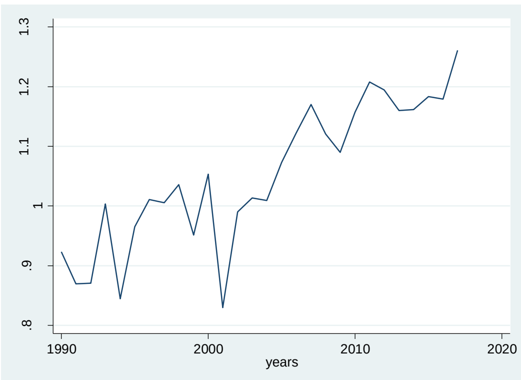

Figure 1. Historical trends of LnEFP

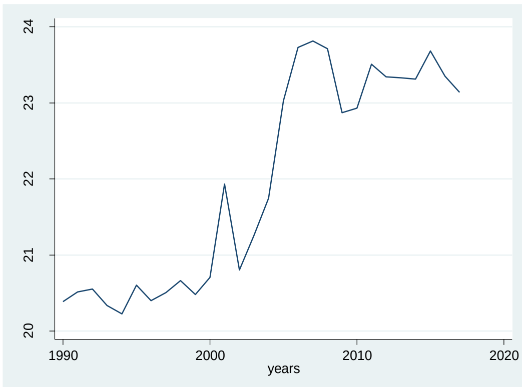

Figure 2. Historical trends of LnFDI

The econometric procedure consists of three stages: the unit root test, the ARDL bounds test for the long run cointegration analysis, and the analysis of the short and long run elasticities.

Firstly, to examine the stationary of each series we applied two famous unit root tests, Augmented Dickey-Fuller (ADF) test introduced by Dickey and Fuller (1979) and Philips-Perron test developed by

Philips and Perron (1988). The estimation of ADF tests is based on the following model (Belaid and Abderrahmani, 2013):

$$\Delta yt = \rho \Delta yt\text{-}1 + c + bt + \sum_{j=2}^{p} \varphi j \Delta yt\text{-}j\text{+}1 + \varepsilon \text{ (with} > \varepsilon t > BB(0,\sigma_{\varepsilon}^{2})) \tag{1}$$

This model containing constant and trend uses the null hypothesis stating that there is no unit root. PP unit root test employs a similar approach, but its identification of serial correlation is based on a non-parametric correction. (Belaid and Abderrahmani, 2013).

Due to its various advantages, the bounds test approach for cointegration is commonly utilised in the literature. Initially, the method assists in overcoming challenges such as the endogeneity problem and the difficulty to test hypotheses on estimated (Nadeem et al., 2020). A further advantage of Bounds tests is that this technique can be used when the variables are cointegrated at I(0) or I(1), or even in mixed order (I(0) or I(1)) unless they are cointegrated in second difference form (I(2)). The other main advantage of the method is its applicability to studies with small sample sizes. The cointegration methods of Engle and Granger (1987) and Johansen (1988, 1995) are unreliable for small sample sizes (Narayan and Narayan, 2005). Finally, in contrast to the OLS regression and error correction model (ECM), the ARDL regression employs unequal error correction term (ECT) coefficients to look for cointegration between variables (Sun et al., 2017). ARDL bounds test was utilised in this study because of the aforementioned benefits based on the following equation:

$$\Delta Y_{t} = \beta_0 + \sum \beta_i \Delta y_{t-1} + \sum \gamma_j \Delta x_{1t-j} + \sum \delta_k \Delta x_{2t-j} + \theta ECT_{t-1} \tag{2}$$

$$\Delta Yt = \beta_0 + \sum \beta_i \Delta y_{t-1} + \sum \gamma_j \Delta x_{1t-j} + \sum \delta_k \Delta x_{2t-j} + \xi_0 Y_{t-1} + \xi_1 X_{1t-1} + \xi_2 Y_{2t-1} + e_t \tag{3}$$

Before proceeding with the bounds test, we first estimate the unrestricted error correction model as written below:

$$\Delta CE_t = \delta + \sum_{i=1}^{k} \alpha_0 \Delta CE_{t-i} + \sum_{i=0}^{k} \alpha_1 \Delta FDI_{t-i} + \sum_{i=0}^{k} \alpha_2 \Delta GDP_{t-i} + \sum_{i=0}^{k} \alpha_3 \Delta EU_{t-l} + \sum_{i=0}^{k} \alpha_4 \Delta Z_{t-1} +$$
$$\lambda_0 lnCE_{t-i} + \lambda_1 lnFDI_{t-l} + \lambda_2 lnGDP_{t-l} + \lambda_3 lnEU_{t-l} + \lambda_4 lnZ_{t-l} + \alpha_5 B + \alpha_6 T + \varepsilon_t \tag{4}$$

Where Δ presents the first difference operator and CE refers to unrestricted error correction model (Sun et al., 2017). The null hypothesis suggestion the absence of cointegration among the variables is expressed in equation 4 ($\gamma_0 = \gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = 0$). The short version of the equation can be written as follows:

$$\Delta lnCE_t \; \delta + \sum_{i=1}^{k} \gamma_0 \Delta lnCE_{t-l} + \sum_{i=0}^{k} \gamma_1 \Delta lnFDI_{t-i} + \sum_{i=0}^{k} \gamma_2 \Delta lnGDP_{t-i} + \sum_{i=0}^{k} \gamma_3 \Delta lnEU_{t-i} + \sum_{i=0}^{k} \gamma_4 \Delta lnZ_{t-i}$$
$$+ \gamma_5 B + \gamma_6 T + \gamma_7 ECT_{t-1} + k_t \tag{5}$$

The ARDL bounds test employs the joint F-statistic and the asymptotic distribution under the null hypothesis of no cointegration based on the preceding equations (Sun et al., 2007). The bounds test calculates lower critical bound (LCB) and upper critical bound (UCB) values. If the F-statistic exceeds the critical upper bound, the null hypothesis is rejected. However, the null hypothesis will not be rejected if the F-statistic is less than the lower bound value. If the F-statistic lies between the two critical values, the result will be considered inconclusive.

4. Empirical Results and Discussion

Before implementing the ARDL method, it is necessary to ensure that the model variables are stationary at level I(0), or first difference I(1), or mixed order, but none of the variables are I(2).

4.1. Unit Root Test

Table 4 displays the results of the unit root test we performed using both ADF and PP. It is worth mentioning that the null hypothesis of the ADF and PP tests is that there is a unit root. As observed, all variables are stationary in the first difference, with the exception of LnEFP and FD, which exhibit various cointegration orders across tests. Evidently, the order of cointegration is (1) for LnEFP based on the ADF test, although it is stationary in both forms, i.e., level and first difference forms, according to the PP test. As for FD, it becomes stationary at both forms, i.e., I(0) and I(1), for the ADF test and I(1) for the PP test.

Table 4. Results of Unit Root Tests (ADF and PP)

Variables	ADF Unit Root test		PP Unit Root test		Order of Cointegration
	At level	First Difference	At level	First Difference	
LnEFP	-3.004 (0.131)	-5.494*** (0.000)	-5.127*** (0.000)	-9.663*** (0.000)	I(0), I(1)
LnFDI	-2.052 (0.573)	-3.559** (0.035)	-2.089 (0.552)	-5.037*** (0.000)	I(1)
UR	-2.998 (0.133)	-4.962*** (0.000)	-1.331 (0.879)	-4.656*** (0.000)	I(1)
EC	-1.482 (0.835)	-3.962*** (0.009)	-1.845 (0.682)	-5.858*** (0.000)	I(1)
FD	-3.159* (0.092)	-3.974*** (0.009)	-3.050 (0.118)	-6.512*** (0.000)	I(0), I(1)
LNGDP	-1.076 (0.932)	-3.539** (0.035)	-1.183 (0.913)	-4.946*** (0.000)	I(1)

The unit root tests have been employed by using trend and intercept model. P values are reported in parentheses. (*) denotes 10% significant level, (**) denotes 5% significant level, (***) denotes 1% significant level.

In addition to the previous unit root tests, we also applied the Zivot-Andrews unit root test, which can be applied in the existence of a structural break. Table 6 demonstrates that all variables are cointegrated at the first difference form except for financial development and GDP, which are stationary at level.

Table 5. Result of Zivot-Andrews Unit Root Test

Variables	Zivot-Andrews Unit Root Test		Order of Cointegration
	At level	First Difference	
LnEFP	-4.05 (-4.42)	-8.94^{***} (-4.42)	I(1)
LnFDI	-3.12 (-4.42)	-5.93^{***} (-4.42)	I(1)
UR	-3.67 (-4.42)	-7.20^{***} (-4.42)	I(1)
EC	-3.33 (-4.42)	-5.96^{***} (-4.42)	I(1)
FD	-4.23^{*} (-4.42)	-6.86^{***} (-4.42)	I(0)
LNGDP	-7.16^{***} (-4.42)	-8.98^{***} (-4.42)	I(0)

The unit root tests have been employed by using trend and intercept model. The critical t values are reported in parentheses at 5% significant level. (*) denotes 10% significant level, (**) denotes 5% significant level, (***) denotes 1% significant level.

4.2. ARDL Bounds Test

The ARDL bounds test is used to determine whether there is a long run cointegration between the variables included in the four models in Table 6. As the base model, Model 1 is used with the natural logarithm of ecological footprint as the dependent variable and the natural logarithms of FDI, UP, EC, and GDP as the regressors. We also check the robustness of the results with the inclusion of more control variables in each subsequent specification. The results of the bound test are reported in Table 3. The null hypothesis of the bound test suggests that the variables are not cointegrated. As long as the estimated F-statistics for a model exceed the upper critical bounds (UCB), the null hypothesis is rejected, and it is concluded that the variables are cointegrated over the long run. In our analysis, we are able to reject the null hypothesis in all models, demonstrating that there is a cointegration at a 5% significant level. Therefore, we will apply the ARDL approach to analyse the effect of FDI on ecological footprint in both the short and long term.

Table 6. The Results of ARDL Bound and Diagnostics Tests

ARDL Bounds Test					Diagnostic Tests			
No	Models	F-stat	UCB (5%)	Lag	LM test Chi2	White test Chi2	CUSUM	JB Chi2
1	LnEFP=f(LnFDI,UP,EC,GDP)	4.871^{***}	4.01	(1,1,0,1)	0.497	27.00	stable	0.611
2	LnEFP=f(LnFDI,UP,EC,GDP,D)	3.826^{**}	3.79	(1,1,0,1,1)	5.995	27.00	stable	0.763
3	LnEFP=f(LnFDI,UP,EC,GDP,GDP2,D)	3.373^{**}	3.61	(1,1,0,1,1,1,1)	4.966	27.00	stable	0.787
4	LnEFP=f(LnFDI,UP,EC,GDP,GDP2,D, FD)	4.67^{***}	4.57	(1,1,0,1,1,1,1,1)	5.95	27.00	stable	0.388

To verify the validity of models, specific diagnostic tests must be applied. As seen in Table 3, the Breusch-Godfrey test is used to determine whether the model has serial correlation. The value of Chi2 is lower than the critical value, hence we fail to reject the null hypothesis in all models, indicating there is no serial correlation. The white test is also used to examine heteroscedasticity, revealing that we cannot reject the null hypothesis favouring homoscedasticity. As a result, our models are free from heteroscedasticity. Finally, the findings of the CUSUM test for stability and the Jarque-Bera test for normality show that the error terms are distributed normally, and all models are stable.

4.3. Effect of FDI on Environmental Degradation in the Short and Long run.

Table 7 shows the regression results estimated by the ARDL approach in the short and long run by taking ecological footprint as the dependent in four different models. It can be seen from the table that FDI has entered into all models positively and statistically significant in the long run. Consequently, the table illustrates that FDI is associated with a decline in environmental quality: 1% increase in FDI raises environmental degradation in Turkey by a minimum of 0.0293% and a maximum of 0.053% throughout the period between 1990 and 2017. The results lend support to the validity of the pollution haven hypothesis and are consistent with the studies by Adamu et al. (2019), Nadeem et al. (2020), and Sabir et al. (2020).

The coefficients of urban population are negative and significant in all models, indicating that an increase in urban population is associated with better environmental conditions. The possible reason behind the negative relationship may be that population growth in urban areas leads to an increase in urban resource utilisation efficiency, which in turn contributes to improvements in environmental quality as argued by Chen et al. (2008). The finding of the promoting environment effect is compatible with the outcomes found by Nadeem et al. (2020). Energy consumption as a driver of environmental deterioration is included in the models, and its effect is positive and significant, showing that more energy consumption is related to poorer environmental quality in Turkey. This finding is in line with most studies in the literature (e.g., Hitam and Borhan, 2012; Adamu et al., 2019; Sabir et al., 2020). The last control variable included in the base model is GDP. Its coefficient is positive and significant, showing that a higher economic growth is associated with deteriorating environmental quality, which supports the study of Koçak and Şarkgüneşi, (2018) and Gülmez et al., (2020).

The years 1999, 2001, and 2009 are considered as crisis years given that Turkey experienced a negative growth rate throughout those years, so that dummy variable is used to assess the effect of those years on environmental degradation in models 2 to 5. Dummy variables enter all the regressions as negative but only significant in model 3, which confirms the positive link between GDP and environmental deterioration. In Model 3, we include the square of GDP to check the validity of the Environmental Kuznets Curve (EKC) in Turkey. It shows up with a positive and significant coefficient, which does not confirm the validity of EKC in Turkey. However, its destructive impact on the environment is diminishing, which may be an indication that the next phase of economic growth will help to enhance environmental quality. The last control variable is financial development, which is used in Model 4, and it seems to have an insignificant effect on environmental degradation.

Finally, the coefficient of error correction term (EC) has the correct sign (negative) and is significant, ranging from –0.966 to 1.082, as it is expected to have a negative value between 0 and -2. Therefore, the results of the EC models support the conclusion that the model converges towards the long run.

Table 7. Results of ARDL (1,1,0,1,1,1,1,1) methods

Dependent Variable (LnEFP)	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Long run results				
LnFDI	0.0293* (0.073)	0.041** (0.049)	0.0531*** (0.008)	0.0525** (0.035)
UP	-0.0309* (0.074)	-0.0445** (0.027)	-0.0386** (0.021)	-0.0385** (0.046)
EC	0.0054*** (0.007)	0.0061*** (0.005)	0.00469*** (0.009)	0.00479** (0.015)
LnGDP	0.0207** (0.042)	0.0264** (0.022)	0.00646** (0.049)	0.0146** (0.022)
Dummy		-0.0216 (0.583)	-0.0844* (0.089)	-0.0720 (0.198)
$LnGDP^2$			0.00146*** (0.006)	0.00664* (0.070)
FD				-0.00355 (0.293)
Short run results				
ECT	-1.0706*** (0.000)	-1.082*** (0.000)	-0.997*** (0.001)	-0.966*** (0.006)
LnFDI	-0.0179 (0.323)	-0.0178 (0.508)	-0.0555 (0.269)	-0.0506 (0.335)
EC	0.00274 (0.262)	0.00111 (0.676)	-0.00737 (0.737)	-0.00517 (0.836)
LnGDP	0.0199 (0.23)	-0.00342 (0.969)	0.194 (0.585)	0.0368 (0.584)
Dummy		-0.0254 (0.464)	0.0466 (0.174)	0.0368 (0.334)
$LnGDP^2$			0.00314 (0.865)	0.00137 (0.948)
FD				0.211 (0.570)
constant	1.656 (0.135)	2.184* (0.070)	1.513* (0.101)	1.446 (0.236)

The choice of lag length is based on Akanke's Information Criterion (AIC), Schwarz's Information Criterion (SIC). (*) denotes 10% significant level, (**) denotes 5% significant level, (***) denotes 1% significant level.

Conclusion

FDI is widely accepted as a driver of economic growth in the host nation by delivering much-needed capital, introducing cutting-edge technology, creating jobs, and enhancing skill acquisition (Aitken and Harrison, 1999). The world's FDI inflows have increased dramatically, particularly over the past three decades, which has aroused the interest of economists, and the impact of FDI on economic growth has been thoroughly examined. However, its impact on environment has been overlooked, and the relationship between FDI and environmental degradation has recently piqued the interest of economists (Koçak and Şarkgüneşi, 2017).

Two basic theories have been employed to analyse the impact of foreign investments on environmental degradation. Although the majority of studies support the pollution haven hypothesis, some have backed up the opposite, the pollution halo hypothesis. The core tenet of the studies supporting the former hypothesis is that FDI may assist developing countries in modernising and enhancing the quality of their capital stock, which may result in improvements in environmental quality (Jiang et al., 2018; Jugurnath and Emrith, 2018). On the other hand, according to the latter hypothesis, foreign investors have shifted companies with high levels of pollution to developing countries in order to benefit from the availability of plentiful natural resources, cheaper labour and, more crucially, to escape heavy environmental costs in their home country.

This study examines the effect of FDI inflows on environmental degradation in Turkey by using the ARDL method, which enables us to observe its impact in both the short and long runs. To the best of our knowledge, there are less studies to analyse the relationship between FDI and environmental deterioration using ecological footprint, as the existing studies employ CO2 emissions as a proxy for environmental destruction. The results indicate that FDI inflows are associated with an increase in environmental degradation, lending support to the presence of the pollution haven hypothesis for Turkey, which is consistent with numerous previous studies (e.g., Lau et al., 2014; Koçak and Şarkgüneşi, 2017; Solarin et al., 2017; Rafindadi et al., 2018).

Our findings suggest that Turkey needs to attract FDI inflows in industries associated with a less polluted environment. Furthermore, employing eco-friendly technologies should be encouraged, particularly in polluting industries. This study could be expanded by focusing on FDI inflows to different sectors, whose effects on the environment may differ or even be opposite. Given that FDI inflows from developed nations may be more closely associated with the introduction of green technology, the origin country of FDI may be taken into account in future research.

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