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Are Foreign Direct Investments Effective on Environmental Quality in Turkey? An Approach with Non-Linear ARDL Method

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Doğrudan Yabancı Yatırımlar Türkiye'de Çevre Kalitesi Üzerinde Etkili mi? Asimetrik ARDL Yöntemi ile Bir Yaklaşım

Serhat ÇAMKAYA*
İbrahim Halil POLAT**
Ümmügülsüm POLAT***

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Abstract

There are discussions in the literature on whether there are disadvantages in terms of environmental quality and the economic advantages provided by foreign direct investments in developing countries. These discussions, which were studied within the framework of the Pollution Haven Hypothesis, have been the subject of many empirical studies. This study aims to investigate the relationship between carbon emissions, economic growth, amount of energy use, foreign direct investments, and trade openness for Turkey within the Pollution Haven Hypothesis framework and test whether the hypothesis mentioned above is valid in Turkey. In the study, the validity of the hypothesis in Turkey was tested using the NARDL method between 1970 and 2018. The findings validate that the Pollution Haven Hypothesis is valid for Turkey in the long term. It was also determined that negative shocks in growth and energy use reduce carbon emissions, while positive shocks in energy use and trade openness increase carbon emissions in the long term. The findings that the Pollution Haven Hypothesis is not valid in the short term are among the other findings obtained from the study. Also, it was determined that the negative shock in growth and trade openness and negative and positive shock in the amount of energy use are significant in the short term.

Keywords: Environmental quality, foreign direct investments, pollution haven hypothesis, NARDL method.

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Öz

Gelişmekte olan ülkelerde doğrudan yabancı yatırımların sağladığı ekonomik avantajlar ve çevre kalitesi açısından dezavantajların olup olmadığı konusunda literatürde tartışmalar bulunmaktadır. Kirlilik Sığınağı Hipotezi çerçevesinde incelenen bu tartışmalar birçok ampirik çalışmaya konu olmuştur. Bu çalışma, Kirlilik Sığınağı Hipotezi çerçevesinde Türkiye için karbon emisyonları, ekonomik büyüme, enerji kullanım miktarı, doğrudan yabancı yatırımlar ve ticarete açıklık arasındaki ilişkiyi araştırmayı ve söz konusu hipotezin Türkiye'de geçerli olup olmadığını test etmeyi amaçlamaktadır. Çalışmada hipotezin Türkiye'deki geçerliliği 1970-2018 yıllarına ait veriler kullanılarak NARDL yöntemi ile test edilmiştir. Bulgular, Kirlilik Sığınağı Hipotezinin uzun vadede Türkiye için geçerli olduğunu doğrulamaktadır. Büyüme ve enerji kullanımındaki olumsuz şokların karbon emisyonlarını azalttığı, enerji kullanımı ve ticarete açıklığa yönelik pozitif şokların ise uzun vadede karbon emisyonlarını artırdığı belirlenmiştir. Kirlilik Sığınağı Hipotezinin kısa vadede geçerli olmadığına ilişkin bulgular da çalışmadan elde edilen diğer bulgular arasındadır. Ayrıca kısa dönemde büyüme ve ticarete açıklıktaki negatif şok ile enerji kullanım miktarındaki negatif ve pozitif şokun anlamlı olduğu tespit edilmiştir.

***Anahtar Kelimeler**: Çevre kalitesi, doğrudan yabancı yatırımlar, kirlilik sığınağı hipotezi, NARDL yöntemi.*

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* ORCİD Arş. Gör., Kafkas Üniversitesi, İİBF, İktisat Bölümü, serhatcamkaya36@gmail.com
** ORCİD Arş. Gör., Hakkari Üniversitesi, İİBF, İktisat Bölümü, ibrahimppolat@gmail.com
*** ORCİD Dr. Öğr. Üyesi, Hakkari Üniversitesi, İİBF, Maliye Bölümü, gulsumpolat4@gmail.com

1. Introduction

In recent years, the acceleration of capital mobility, the liberalization of trade, and the spread of information and communication technologies have been seen among the most basic results of globalization in the world economy. Along with the globalization of the economy, opinions regarding the contribution of the mobility of foreign direct investments not only between developed countries but also from developed countries to developing countries in the potential growth and development processes of these countries in the development process constitute a wide area of discussion in the literature. Foreign direct investments (FDI) support growth mainly through two channels: (I) by promoting the adoption of new technologies in production processes through the diffusion of capital, promoting knowledge transfer in terms of workforce training and skill acquisition, and (II) by providing better organizational arrangements with alternative management practices (Hansen and Rand, 2006).

Within the scope of globalization, it is observed that FDI activity continues to increase to a great extent worldwide, especially in the last twenty to thirty years. Thus, it is remarked that growth is supported by capital accumulation and productivity increase in countries that have succeeded in attracting these investments. In this context, the efforts of developing countries to attract the investments mentioned are observed as a normal result of this fact. However, a new area of discussion has emerged regarding the potential effects of increased FDI inputs on environmental quality despite their potential contribution to growth in national economies (Chandran and Tang, 2006). Since the beginning of the 2000s, the world has experienced the problems of global warming and climate change. It is stated that carbon emissions resulting from economic activities are at the forefront of the factors that cause global warming. It can be expressed that there is a general public consensus in most developed and developing countries that there are steps and measures to be taken to solve the problems. Various restrictive measures can be brought to foreign direct investments that can cause an increase in carbon emissions, and a more distant approach can be developed towards these investments, especially by more developed countries. On the other hand, some of the underdeveloped and/or developing countries lean towards foreign direct investments compared to other countries in order to benefit from the macroeconomic advantages of these investments. Therefore, it is considered that these countries are less willing to take precautions and necessary steps in the fight against the global warming problem. The willingness of underdeveloped and developing countries to attract investments in the face of restrictive measures adopted by developed countries has made developing countries more attractive than developed countries for FDI investors. In this context, the opinions that environmental pollution has increased due to foreign direct investments in developing countries have created a new discussion area in the literature within the framework of Pollution Haven Hypothesis (PHH).

According to PHH, FDI investors prefer investing in developing countries because of the fact that they have various incentives for investments and their restrictive practices are limited, and as a result of these investments, they cause an increase in the environmental pollution in these countries (Mutafoglu, 2012). There are many studies in the literature, which that test the validity of this hypothesis. Along with the studies that found results in favor of the hypothesis (Kearsley and Riddel, 2010; Kılıçarslan and Dumrul, 2017; Singhania and Saini, 2021; Waldkirch and Gopinath, 2008; Wang and Chen, 2014), there are also studies that showed the results that the hypothesis was invalid (Adewuyi and Awodumi, 2017; He, 2006; Tang and Tan, 2015). There is still no general consensus on this issue in the literature. In this study, unlike other studies, the Pollution Haven Hypothesis was tested for Turkey using the NARDL (Non-linear ARDL) method. Unlike the ARDL method, the NARDL method allows testing of long and short-term non-linear effects in the analysis. No known/accessed study was found in the Turkish sample for PHH analysis using the NARDL method. Therefore, the study fills this gap and shows its contribution to the literature.

The study consists of four main parts following the introduction. The second and third parts of the study consist of the relevant literature, data set, and model parts, respectively. In the fourth part, the findings and discussion part of the study were presented, and the study was completed with the conclusion part, which is the fifth part.

2. Literature Research

Pioneering studies basing the pollution haven hypothesis on the relationship between environmental quality and the globalization of the economy (Cole, 2004; Copeland and Taylor, 2004) suggested that the validity of this hypothesis seems to be quite significant theoretically should be based on empirical findings. Cole (2004) argued that the development of trade, and Copeland and Taylor (2004) argued that besides trade development, the increase in growth also affected environmental quality. Accordingly, it is important to investigate the relationship between foreign direct investments and carbon emissions in testing the validity of the Pollution Haven Hypothesis. Therefore, most of the studies on the relationship between FDI and carbon emissions have investigated this relationship within the framework of the Pollution Haven Hypothesis (Al-Mulali and Ozturk, 2015; Assamoi et al., 2020; Chen, 2021; Hoffman et al., 2005; Koçak and Şarkgüneşi, 2018; Lau et al., 2014; Liang, 2008; Mutafoglu, 2012; Rahman et al., 2019; Solarin et al., 2017; Tamazian and Rao, 2010; Zhu et al., 2016). According to this hypothesis, multinational companies operating in sectors with high pollution levels tend to shift their activities to developing countries with more flexible environmental regulations. From this point of view, the pollution haven hypothesis suggests that the flow of foreign direct investments into the country causes pollution in the country (Assamoi et al., 2020; Grossman and Krueger, 1991; Keho, 2016).

The effect of FDI on carbon emissions (CO_2), in other words, pollution, has recently been a topic of intense discussion. This subject of discussion also reflects on the empirical studies conducted within the framework of the pollution haven hypothesis. Although many studies have confirmed that this hypothesis is valid, some studies have argued that it is not. The literature of the studies testing this hypothesis is presented in Table 1.

Table 1. Summary of Literature Studies

Author(s)	Country	Period	Methodology	PHH Validity
Hoffmann et al. (2005)	112 countries	1971-1999	Panel VAR/FE/RE	Yes
He (2006)	29 Chinese cities	1994-2001	Panel GMM	No
Akbostancı et al. (2007)	Turkey	1994-1994	Panel OLS Panel LSDV/GLS	Yes
Dietzenbacher and Mukhopadhyay (2007)	India	1991/1992 1996/1997	Input-Output Analysis	No
Liang (2008)	231 Chinese cities	1996-2002	Panel OLS/FE	Yes
Waldkirch and Gopinath (2008)	Mexico	1994-2000	OLS	Yes
Tamazian et al. (2009)	BRIC	1992-2004	Panel RE	No
Tamazian and Rao (2010)	24 transition economies	1993-2004	Panel RE/GMM	No
Zheng et al. (2010)	35 Chinese cities	1997-2006	Panel OLS	No
Kearsley and Riddel (2010)	OECD	1980-2004	Panel FE	Yes
Pao and Tsai (2011)	BRICS	1980-2007	Pedroni, Kao, and Fisher cointegration Panel OLS/VECM/Granger	Yes

Table 1 (Cont.). Summary of Literature Studies

Cole et al. (2011)	112 Chinese cities	2001-2004	Panel FE/RE	Yes
Shahbaz et al. (2011)	110 developed and developing countries	1985-2006	Panel OLS/FE/RE	Yes
Mutafoglu (2012)	Turkey	1987Q1-2009Q4	Johansen cointegration/Granger causality	Yes
Çınar et al. (2012)	14 developed and developing countries	1985-2009	Pedroni/Westerlund/PMG/MG	Yes
Al-Mulali (2012)	12 Middle Eastern countries	1990-2009	Pedroni/FMOLS/Granger causality	Yes
Al-Mulali and Tang (2013)	Gulf Cooperation Council (GCC) Countries	1980-2009	Pedroni/FMOLS/Granger causality	Yes
Ren et al. (2014)	China	2000-2010	GMM	Yes
Lau et al. (2014)	Malaysia	1970-2008	ARDL/Granger causality	Yes
Omri et al. (2014)	Europe, Central Asia, Latin America, Caribbean, Middle East, North, and Sub-Saharan Africa	1990-2011	Panel GMM	Yes
Wang and Chen (2014)	China	2002-2009	Panel 2SLS/FE	Yes
Kivyiro and Arminen (2014)	Sub-Saharan Africa	1971-2009	ARDL/Granger causality	Yes
Şahinöz and Fotourehchi (2014)	Turkey	1975-2011	Johansen cointegration/Granger causality	No
Seker et al. (2015)	Turkey	1974-2010	ARDL/Hatemi-j cointegration Granger causality	Yes
Shahbaz et al. (2015)	High-, middle-, and low-income countries	1975-2010	Pedroni/FMOLS Dumitrescu and Hurlin causality	Yes
Tang and Tan (2015)	Vietnam	1976-2009	Johansen cointegration/Granger causality	No
Neequaye and Oladi (2015)	27 developing countries	2002-2008	Panel FE	Yes
Azam et al. (2015)	Indonesia, Malaysia, Thailand	1980-2012	OLS	Yes
Ghouali et al. (2015)	BRICS countries	1990-2012	Pedroni/FMOLS/DOLS /Granger causality	Yes
Al-Mulali and Ozturk (2015)	MENA countries	1996-2012	Pedroni/FMOLS Granger causality	Yes
Zhu vd. (2016)	ASEAN-5 countries	1980-2010	Panel quantile regression	No
Rafiq vd. (2016)	Developing countries	1980-2010	Panel second generation heterogeneous linear panel data models, non-linear panel data techniques	No
Kılıçarslan and Dumrul (2017)	Turkey	1974-2013	Johansen cointegration	Yes
Solarin et al. (2017)	Ghana	1980-2012	ARDL	Yes
Yıldırım et al. (2017)	Turkey	1974-2013	ARDL/Granger causality	Yes

Table 1 (Cont.). Summary of Literature Studies

Behera and Dash (2017)	South and Southeast Asian countries	1980-2012	Pedroni and Westerlund Cointegration/FMOLS/DOLS	Yes
Adewuyi and Awodumi (2017)	West African countries	1980-2010	Panel 3SLS	No
Koçak and Şarkgüneşi (2018)	Turkey	1974-2013	Maki cointegration/ DOL/Hacker and Hatemi-J causality	Yes
Mike and Kardaşlar (2018)	102 countries	2010-2015	Panel GMM	Yes
Rahman et al. (2019)	Pakistan	1975-2016	NARDL	Yes
Kurt et al. (2019)	Turkey	1974-2014	ARDL	Yes
Mike (2020)	Turkey	1971-2015	ARDL	Yes
Nathaniel et al. (2020)	Coastal Mediterranean Countries	1980-2016	Panel OLS/Panel quantile regression	Yes
Guzel and Okumus (2020)	ASEAN-5 countries	1981-2014	CCEMG/AMG	Yes
Sadik-Zada and Ferrari (2020)	26 OECD countries	1995-2011	PMG	Yes
Assamoi et al. (2020)	Ivory Coast	1980-2014	ARDL	Yes
Singhania and Saini (2021)	21 developed and developing countries	1990-2016	Panel GMM	Yes
Chen (2021)	276 Chinese cities	2003-2009	Spatial Durbin model	Yes
Danish et al. (2021)	China	1994Q1-2018Q4	DARDL/ARDL	No

Note: PHH: Pollution Haven Hypothesis

Remarkable results have been suggested in studies testing the validity of the Pollution Haven Hypothesis for various analysis methods and different time periods over the Turkish sample. Mutafoglu (2012) used the data from 1987-2009 to explain the relationship between FDI flow, carbon emissions, and growth with a causality. Accordingly, the increase in foreign direct investments increases carbon emissions, and, as PHH suggests, countries with low environmental quality standards attract the attention of FDI investors. Şahinöz and Fotourehchi (2014) argued that the increase in environmental pollution could not be explained by PHH in their study using the 1975-2011 period data. Accordingly, the increase in carbon emissions is related to the non-use of advanced technologies in the manufacturing industry. However, according to the study of Seker et al. (2015) using the 1974-2010 period data, the findings showing that growth and energy use significantly increase carbon emissions, although less than other variables, confirmed the validity of PHH. According to the study conducted by Yıldırım et al. (2017), using the 1974-2013 period data, an increase in FDI increases carbon emissions up to a certain level, and after that level, the increase in FDI does not increase environmental pollution. Also, it was found that there is bidirectional causality between environmental pollution, growth and energy consumption, and FDI in the long term. In their study using the data of the same period (1974-2013), Koçak and Şarkgüneşi (2018) also stated that there is a relationship between FDI, growth, energy use, and carbon emissions in the long term and asserted that PHH is valid for Turkey. Mike (2020) analyzed the data for the period 1971-2015 in this study and argued that the increase in FDI in Turkey has an increasing effect on carbon emissions. Therefore PHH is valid for Turkey.

In the literature, using various period data and various analysis methods for Turkey, it is observed that there are various studies on whether the increase in FDI affects environmental quality,

and in this context, whether PHH is valid in Turkey. However, as far as we know, there is no study conducted for the Turkish sample using the NARDL method, which examines the non-linear relationship between the variables in both the short and long term and produces consistent results even in small samples. In this context, it is considered that this study will close this gap in the literature.

3. Method, Dataset And Model

In this study, the relationship between CO_2, economic growth (GDP), amount of energy use (ENERGY), foreign direct investments (FDI), and Trade Openness (TRADE) for Turkey were investigated within the framework of *PHH*. Empirical analyses were made using the most recent annual data for the period between 1970 and 2018. It was measured using the variables of carbon emissions (CO_2 emissions, metric tons per capita), economic growth (GDP growth per capita, % annual), amount of energy use (energy consumption per capita, gigajoules per capita), foreign direct investment (FDI, net inflows % of GDP), and trade openness (% of GDP). Among the variables considered in this analysis, the CO_2 variable was selected based on the studies of Al-Mulali and Ozturk (2015), Behera and Dash (2017), Sadik-Zada and Ferrari (2020), and Singhania and Saini (2021), and the GDP variable was selected based on the work of Tamazian and Rao (2010), Adewuyi and Awodumi (2017), and Guzel and Okumus (2020). Similarly, the FDI variable was selected based on the studies of Mutafoglu (2012), Al-Mulali (2012), Kılıçarslan and Dumrul (2017), Sadik-Zada and Ferrari (2020), and Singhania and Saini (2021) and the ENERGY variable was selected based on studies by Al-Mulali and Tang (2013), Shahbaz et al. (2015) and Singhania and Saini (2021), and the trade openness variable by Kılıç and Balan (2018), Öztürk and Saygın (2020). Except for the ENERGY variable, all data for the variables were obtained from the World Bank's World Development Indicators database. The ENERGY variable data was obtained from the BP Statistical Review of World Energy. GDP, TRADE, and FDI variables are taken as percentages, CO_2 and ENERGY variables are taken as per capita. Therefore, the natural logarithm of the per capita variables was taken to reflect the changes.

NARDL is a more comprehensive version of linear ARDL developed by Pesaran et al. (2001). The NARDL approach was developed by Shin et al. (2014). This approach allows variables to be integrated *(I(0) or I(1))* to varying degrees, just like the linear ARDL approach. This test, which has been introduced to the literature recently, has some advantages, such as obtaining long-term positive and negative coefficients and obtaining long- and short-term non-linearities. In addition, the NARDL test allows for linear and non-linear cointegration relationships. Moreover, it is noted that the small sample characteristics of this test are also very good (Shin et al., 2014). Due to these advantages of NARDL, this study was analyzed by applying the NARDL method.

The relationship between the variables can be written as in the following linear regression equation:

$$LNCO_{2t} = \varsigma_0 + \varsigma_1 GDP_t + \varsigma_2 LNENERGY_t + \varsigma_3 FDI_t + \varsigma_4 TRADE_t + u_t \quad (1)$$

Where; $LNCO_{2t}$ represents the natural logarithm of carbon emissions per capita in metric tons over the period t; GDP_t represents growth per capita in a given period t; $LNENERGY_t$ means the natural logarithm of energy use per capita in the period t; $TRADE_t$ shows the trade openness rate in the given period t and FDI_t shows the foreign direct investment in the given time period. ς_0 is the constant of the model; ς_1, ς_2, ς_3, and ς_4 are parameters and u_t represents the residuals of the model. The equation of the asymmetric cointegration model can be expressed as the following equation:

$$LNCO_{2t} = \varsigma_0 + \varsigma_1 GDP_t^+ + \varsigma_2 GDP_t^- + \varsigma_3 LNENERGY_t^+ + \varsigma_4 LNENERGY_t^- + \varsigma_5 FDI_t^+ + \varsigma_6 FDI_t^- + \varsigma_7 TRADE_t^+ + \varsigma_8 TRADE_t^- + u_t \quad (2)$$

Where; GDP_t^+ and GDP_t^- show the positive and negative components of economic growth, $LNENERGY_t^+$ and $LNENERGY_t^-$ show the positive and negative components of the amount of energy use, FDI_t^+ and FDI_t^- show the positive and negative components of foreign direct investments, $TRADE_t^+$ and $TRADE_t^-$ show the positive and negative components of the trade openness variable.

The positive and negative components of GDP, LNENERGY, FDI, and TRADE can be summarized in a partial summary process as follows:

$$GDP_t^+ = \sum_{i=1}^{t} \Delta GDP_i^+ = \sum_{i}^{t} \max\left(\Delta GDP_i, 0\right), \&$$
$$GDP_t^- = \sum_{i=1}^{t} \Delta GDP_i^- = \sum_{i}^{t} \min\left(\Delta GDP_i, 0\right) \quad (3)$$

$$LNENERGY_t^+ = \sum_{i=1}^{t} \Delta LNENERGY_i^+ = \sum_{i}^{t} \max\left(\Delta LNENERGY_i, 0\right), \&$$
$$LNENERGY_t^- = \sum_{i=1}^{t} \Delta LNENERGY_i^- = \sum_{i}^{t} \min\left(\Delta LNENERGY_i, 0\right) \quad (4)$$

$$FDI_t^+ = \sum_{i=1}^{t} \Delta FDI_i^+ = \sum_{i}^{t} \max\left(\Delta FDI_i, 0\right), \&$$
$$FDI_t^- = \sum_{i=1}^{t} \Delta FDI_i^- = \sum_{i}^{t} \min\left(\Delta FDI_i, 0\right) \quad (5)$$

$$TRADE_t^+ = \sum_{i=1}^{t} \Delta TRADE_i^+ = \sum_{i}^{t} \max\left(\Delta TRADE_i, 0\right), \&$$
$$TRADE_t^- = \sum_{i=1}^{t} \Delta TRADE_i^- = \sum_{i}^{t} \min\left(\Delta TRADE_i, 0\right) \quad (6)$$

In the NARDL system, the long and short-run equations can be written in the following form:

$$\Delta LNCO_{2t} = \alpha_0 + \phi LNCO_{2t-1} + \beta_1^+ GDP_{t-1}^+ + \beta_2^- GDP_{t-1}^- + \gamma_3^+ LNENERGY_{t-1}^+ + \gamma_4^- LNENERGY_{t-1}^- + \lambda_5^+ FDI_{t-1}^+ + \lambda_6^- FDI_{t-1}^- + \vartheta_7^+ TRADE_{t-1}^+ + \vartheta_8^- TRADE_{t-1}^-$$
$$\sum_{i=1}^{p-1} \delta LNCO_{2t-i} + \sum_{i=0}^{q-1} \left(\theta_1^+ \Delta GDP_{t-i}^+ + \theta_2^- \Delta GDP_{t-i}^- + \theta_3^+ \Delta LNENERGY_{t-i}^+ + \theta_4^- \Delta LNENERGY_{t-i}^- + \theta_5^+ \Delta FDI_{t-i}^+ + \theta_6^- \Delta FDI_{t-i}^- + \theta_7^+ \Delta TRADE_{t-i}^+ + \theta_8^- \Delta TRADE_{t-i}^-\right) + e_t \quad (7)$$

Where, Δ denotes the difference operator, which shows the short-term dynamics. Variables expressed with level values indicate long-run dynamics, and p and q indicate lag lengths. It is possible to define long-term coefficients as

$$mi = -\beta_i \,' \,{}^{s}\!/_{\phi}, \; mi = -\gamma_i \,' \,{}^{s}\!/_{\phi}, \; mi = -\lambda_i \,' \,{}^{s}\!/_{\phi} \text{ and } mi = -\vartheta_i \,' \,{}^{s}\!/_{\phi} \quad (8)$$

.

$$\sum_{i=0}^{q-1}\left(\theta_i^+\right) \text{ and } \sum_{i=0}^{q-1}\left(\theta_i^-\right) \quad (9)$$

values show information on the effect of increases and decreases in GDP, LNENERGY, FDI, and TRADE variables on CO_2 emissions. Equation 7 is the estimated cointegration equation for NARDL. After estimating the equation, Shin et al. (2014) suggested two different approaches. The first approach is the t-test approach, called t_{BDM}, used in the study of Banerjee et al. (1998). The second

approach is the F-test approach, expressed as F_{PSS}, suggested in the study of Pesaran et al. (2001). The hypotheses in these approaches are shown in Equation 10 and Equation 11, respectively.

$$H_0 : \phi = 0 \quad H_1 : \phi < 0 \quad \text{(t-test approach)} \tag{10}$$

$$H_0 : \beta_i = \gamma_i = \lambda_i = \vartheta_i = 0 \quad H_1 : \beta_i = \gamma_i = \lambda_i = \vartheta_i \neq 0 \quad \text{(F-test approach)} \tag{11}$$

In the t-test approach, the relevant test statistic is compared with the critical value, and in the F-test approach, it is decided whether there is cointegration by comparing the relevant test statistic with the lower and upper critical values. In the case of cointegration in the NARDL method, the existence of long- and short-term non-linearity is tested with the help of the Wald test. The null hypotheses established for the long-term non-linearity between the variables are as in Equation 12, Equation 13, Equation 14, and Equation 15.

$$H_0 = \beta_1^+ = \beta_2^- \tag{12}$$

$$H_0 = \gamma_3^+ = \gamma_4^- \tag{13}$$

$$H_0 = \lambda_5^+ = \lambda_6^- \tag{14}$$

$$H_0 = \vartheta_7^+ = \vartheta_8^- \tag{15}$$

Rejecting the null hypothesis indicates that there is a long-term non-linear relationship between the related variables. The null hypothesis for short-run non-linearity is as in Equation 16:

$$H_0 = \theta_1^+ = \theta_2^- = \theta_3^+ = \theta_4^- = \theta_5^+ = \theta_6^- = \theta_7^+ = \theta_8^- \tag{16}$$

Rejecting the null hypothesis indicates the existence of a short-term non-linear relationship.

4. Findings And Discussion

It is required to determine the integration degrees of the variables before starting the time series analysis. The variables should not be quadratic integrated in linear and non-linear ARDL methods (2). In this study, Augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1979) and Phillips and Perron (PP) unit root (Perron, 1990) tests were applied to determine the integration degrees of the variables. Test results are given in Table 2. Accordingly, while $LNCO_2$, LENNERGY, and the TRADE variant are I(1) according to both the ADF and PP test, GDP variable is I(0) according to ADF and PP test, and finally, the FDI variable is I(1) in the constant model and I(0) in the constant and trend model according to the ADF test, according to the PP test, it is I(1) in constant model and constant and trend model. As can be seen, the variables are integrated with different degrees. However, it is seen that none of the four variables is I(2). Therefore, the NARDL model can be applied to these variables. In addition, descriptive statistics and graphics of the variables are given in Appendix 1.

Table 2. Unit Root Test Results

Variable	Augmented Dickey-Fuller		Phillips–Perron	
	Constant	Constant and Trend	Constant	Constant and Trend
LNCO2	-1.540	-1.443	-1.627	-3.069
GDP	-6.740***	-6.784***	-6.740***	-6.782***
LNENERGY	-1.877	-3.272	-2.013	-3.269
FDI	-1.989	-3.781**	-1.888	-2.923
TRADE	-0.967	-2.994	-0.613	-3.091
ΔLNCO2	-6.825***	-6.823***	-7.049***	-7.066***
ΔGDP	-	-	-	-
ΔLNENERGY	-6.994***	-7.151**	-6.999***	-7.189***
ΔFDI	-6.422***	-	-12.378***	-12.666***
ΔTRADE	-6.087***	-6.007***	-6.877***	-6.639***

Note: Δ denotes the difference operator, while *** and ** denote 1% and 5% significance levels. The optimum lag selected is based on the Schwarz information criterion. LN indicates that the natural logarithm of the variables is taken.

To look at the long-term relationships of the variables, F_{PSS} and t_{BDM} tests were applied. According to the results in Table 3, the F_{PSS} test statistics value is greater than the upper critical value at the 5% significance level. Similarly, the t_{BDM} test statistical value is greater than the absolute critical value at the 5% significance level. According to the results of both tests, it can be said that there is a cointegration relationship between the variables.

Table 3. Limit Test

Statistics		Significance	Critical Values I(0)	(1)
F_{PSS}	5.007	5%	2.86	4.01
t_{BDM}	-4.351	5%	-4.18	

Note: For the F_{PSS} statistic k=3, the unconstrained fixed model in the Case III table from Pesaran et al. (2001) and for the t_{BDM} statistic k=3, the critical values in the Banerjee et al. (1998) study were taken.

After deciding that there is cointegration, Wald statistics were used in order to determine whether this cointegration is linear or non-linear. According to the Wald statistics in Table 4, it is observed that the test statistics of GDP, FDI, and TRADE variables are significant in the long term. Thus, the effects of growth, foreign direct investments, and trade openness variable on carbon emissions, in the long run, are non-linear. In the short term, it is observed that only the amount of energy used has a non-linear effect on carbon emissions.

Table 4. Testing the Non-Linear Effect

Wald Statistics	F-Statistics	Probability
W_{LR}^{GDP}	33.21***	0.000
W_{LR}^{FDI}	10.13**	0.013
$W_{LR}^{LNENERGY}$	1.77	0.220
W_{LR}^{TRADE}	12.84***	0.007
W_{SR}^{GDP}	2.34	0.164
W_{SR}^{FDI}	0.01	0.925
$W_{SR}^{LNENERGY}$	4.15*	0.076
W_{SR}^{TRADE}	0.11	0.749

Note: W_{LR} and W_{SR} represent long- and short-term asymmetries, respectively. ***, **, and * indicate 1%, 5%, and 10% significance levels, respectively, and LN represents the natural logarithm of the variables.

The long- and short-term estimation results obtained from the NARDL model are presented in Table 5. When the short-term non-linear coefficients are examined, it is observed that the negative shock in the one-term lagged value of the GDP variable and both positive and negative shocks for the

FDI, LNENERGY, and TRADE variables are statistically significant. From this point of view, it is observed that a negative shock or decrease in growth in the short term will reduce carbon emissions. When the effect of foreign direct investments on carbon emissions is analyzed in the short term, it is seen that an increase in foreign direct investments or a positive shock will reduce carbon emissions. This result shows that PHH is not valid in the short run. It was determined that increases in the amount of energy use in the short term would increase carbon emissions, while decreases will reduce carbon emissions. Finally, it was found that increases and decreases in the amount of trade openness will reduce carbon emissions in the short term.

Table 5. NARDL Model Results

Variable	Short-Term Coefficient	Std. Deviation	t-Statistics
$\Delta LNCO2_{t-1}$	1.232**	0.555	2.22
$\Delta LNCO2_{t-2}$	0.249	0.409	0.61
$\Delta LNCO2_{t-3}$	-0.316	0.265	-1.19
ΔGDP_t^+	0.001	0.002	0.56
ΔGDP_{t-1}^+	0.001	0.004	0.23
ΔGDP_{t-2}^+	0.002	0.006	0.92
ΔGDP_t^-	0.009**	0.004	2.39
ΔGDP_{t-1}^-	-0.019**	0.008	-2.36
ΔGDP_{t-2}^-	-0.007	0.006	-1.15
ΔFDI_t^+	-0.007	0.031	-0.25
ΔFDI_{t-1}^+	-0.065**	0.033	-1.96
ΔFDI_{t-2}^+	-0.080*	0.041	-1.93
ΔFDI_t^-	-0.007	0.045	-0.17
ΔFDI_{t-1}^-	-0.164***	0.041	-3.98
ΔFDI_{t-2}^-	0.007	0.032	0.22
$\Delta LNENERGY_t^+$	0.964***	0.280	3.44
$\Delta LNENERGY_{t-1}^+$	-0.524	0.405	-1.29
$\Delta LNENERGY_{t-2}^+$	-0.048	0.255	-0.19
$\Delta LNENERGY_t^-$	-0.581	0.539	-1.08
$\Delta LNENERGY_{t-1}^-$	-2.056**	0.910	-2.26
$\Delta LNENERGY_{t-2}^-$	-0.390	0.687	-0.57
$\Delta TRADE_t^+$	0.006	0.004	1.43
$\Delta TRADE_{t-1}^+$	-0.006**	0.003	-2.07
$\Delta TRADE_{t-2}^+$	-0.010**	0.003	-2.88
$\Delta TRADE_t^-$	-0.011**	0.004	-2.40
$\Delta TRADE_{t-1}^-$	-0.001	0.005	-0.21
$\Delta TRADE_{t-2}^-$	-0.003	0.004	-0.62
C	0.767***	0.143	5.38
Variable	**Long-Term Coefficient**	**F-Statistics**	**Probability**
L_{GDP}^+	0.005	3.06	0.118
L_{GDP}^-	-0.009**	10.37	0.021
L_{FDI}^+	0.036**	3.07	0.012
L_{FDI}^-	-0.018	2.422	0.158
$L_{LNENERGY}^+$	0.671***	133.6	0.000
$L_{LNENERGY}^-$	-0.908***	26.18	0.001
L_{TRADE}^+	0.005***	12.34	0.008
L_{TRADE}^-	0.002	0.876	0.377

Note: Δ denotes the difference operator, while ***, ** and *; 1%, 5%, and 10% indicate the significance levels. LN indicates that the natural logarithm of the variables is taken.

According to the results in Table 5, it is observed that the negative shock in growth is significant in the long term and will have a reducing effect on carbon emissions. It is observed that the positive shock in the foreign direct investment variable is significant in the long term. From this point of view, it can be said that increases in foreign direct investments in the long term will increase carbon emissions. This result is similar to the findings of studies such as Gopinath (2008), Mutafoglu (2012), Ren, et al. (2014), Seker et al. (2015), Koçak and Sarkgunesi (2018), Solarin et al. (2017), Rahman

et al., (2019), Mike (2020) and Chen (2021) in the literature and confirms that the Pollution Haven Hypothesis is valid for Turkey in the long run. When we look at the variable of the amount of energy use, it is observed that both positive and negative shocks are statistically significant. In other words, increases and decreases in the amount of energy use have positive and negative effects on carbon emissions, respectively. Finally, in the long term, the positive shock of the trade openness variable is significant and increases carbon emissions.

For the NARDL model to be used for estimation, some assumptions must be provided. These assumptions are given in Table 6. These results show that there are no autocorrelation and changing variance problems in the established model, the assumption of normality is provided, and the model is set up correctly. Therefore, the NARDL model can be used for prediction purposes.

Table 6. Diagnostic Test Results

Tests	Statistics	Probability
Breusch-Godfrey autocorrelation	22.25	0.327
Breusch–Pagan–Godfrey changing variance	2.05	0.152
Ramsey RESET	2.81	0.148
Jarque-Bera normality	0.34	0.844

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

5. Conclusion

In this study, the relationship between foreign direct investments and carbon emissions was analyzed for Turkey within the framework of the Pollution Haven Hypothesis. This hypothesis was tested with the data of the 1970-2018 period for Turkey. It was also examined in this study whether economic growth, the amount of energy use, and the rate of trade openness were also effective on carbon emissions.

Firstly, the stationarity test of the series was carried out with ADF and PP unit root tests in the study. Then, the cointegration relationship between the variables was investigated using the NARDL method, which allows to investigation of the cointegration relationship between the series integrated with different degrees.

Empirical findings suggest that an increase in foreign direct investment or a positive shock will reduce carbon emissions in the short run. This result shows that PHH is not valid in the short run. It is also determined that a negative shock or decrease in growth in the short term will reduce carbon emissions. Moreover, it was determined that increases in the amount of energy use in the short term would increase carbon emissions, while decreases will reduce carbon emissions. Finally, it was found that increases and decreases in the amount of trade openness will reduce carbon emissions in the short term. It is observed that the positive shock in the foreign direct investment variable is significant in the long term. From this point of view, it can be said that increases in foreign direct investments in the long term will increase carbon emissions. This result confirms that the Pollution Haven Hypothesis is valid for Turkey in the long term. In addition, when we look at the variable of the amount of energy used in the long term, it is observed that both positive and negative shocks are statistically significant. In other words, increases and decreases in the amount of energy use have positive and negative effects on carbon emissions, respectively. Finally, in the long term, the positive shock of the trade openness variable is significant and increases carbon emissions.

As a result of the study, the findings show that foreign direct investment in Turkey, a developing country, negatively impacts Turkey's environmental quality. The most important reason for it is that global companies, which are trying to reduce their production costs, transfer their pollution-causing sectors to developing countries such as Turkey. In this context, while policies focused on increasing foreign direct investments to the country are followed, the effects of these investments on environmental quality should also be taken into account. According to the findings obtained from the

study, foreign direct investments reduce the environmental quality in the long run. Therefore, it is thought within the scope of the findings obtained from the study that it is required to support the inclusion of technologies that will reduce carbon emissions more in the production processes and implement the policies for the necessary incentives and regulations in this regard. Also, it would be appropriate to state that it is necessary to consider the practices in developed countries while determining the policies that will affect the environmental quality in Turkey. For example, renewable energy usage areas in production should be emphasized more. Also, incentive policies such as tax deductions/exemptions can be brought forward for investments that supply high-tech goods with less energy density.

References

Adewuyi, A. O., and Awodumi, O. B. (2017). Biomass energy consumption, economic growth and carbon emissions: fresh evidence from West Africa using a simultaneous equation model. *Energy, 119*, 453-471. https://doi.org/10.1016/j.energy.2016.12.059

Akbostancı, E., Tunç, G. İ., and Türüt-Aşık, S. (2007). Pollution haven hypothesis and the role of dirty industries in Turkey's exports. *Environment and Development Economics, 12*(2), 297-322. https://doi.org/10.1017/S1355770X06003512

Akçay, S. and Karasoy, A. (2018). Doğrudan yabancı yatırımlar ve karbondioksit emisyonu ilişkisi: Türkiye örneği. *Ankara University Ankara Üniversitesi SBF Dergisi*, *73*(2), 501-526. https://doi.org/10.1501/SBFder_0000002507

Artan, S; Hayaloğlu, P. and Seyhan, B. (2015). Türkiye'de çevre kirliliği, dışa açıklık ve ekonomik büyüme ilişkisi. *Yönetim ve Ekonomi Araştırmaları Dergisi*, *13*(1), 308-323. https://dergipark.org.tr/tr/pub/yead/issue/21806/234380

Al-Mulali, U. (2012). Factors affecting CO2 emission in the Middle East: a panel data analysis. *Energy, 44*, 564-569. https://doi.org/10.1016/j.energy.2012.05.045

Al-Mulali, U., and Ozturk, I. (2015). The effect of energy consumption, urbanization, trade openness, industrial output, and the political stability on the environmental degradation in the MENA (Middle East and North African) region. *Energy, 84*, 382-389. https://doi.org/10.1016/j.energy.2015.03.004

Al-Mulali, U., and Tang, C. F. (2013). Investigating the validity of pollution haven hypothesis in the Gulf Cooperation Council (GCC) Countries. *Energy Policy, 60*, 813–819. https://doi.org/10.1016/j.enpol.2013.05.055

Assamoi, G. R., Wang, S., Liu, Y., and Gnangoin, Y. T. (2020). Investigating the pollution haven hypothesis in Cote D'Ivoire: evidence from Autoregressive Distributed Lag (ARDL) approach with structural breaks. *Environmental Science and Pollution Research, 27*, 16886–16899. https://doi.org/10.1007/s11356-020-08246-w

Azam, M., Khan, A. Q., Zaman, K., and Ahmad, M. (2015). Factors determining energy consumption: evidence from Indonesia, Malaysia and Thailand. *Renewable and Sustainable Energy Reviews, 42*, 1123-1131. https://doi.org/10.1016/j.rser.2014.10.061

Banerjee, A., Dolado, J., and Mestre, R. (1998). Error-correction mechanism tests for cointegration in a single-equation framework. *Journal of Time Series Analysis, 19*(3), 267-283. https://doi.org/10.1111/1467-9892.00091

Behera, S. R., and Dash, D. P. (2017). The effect of urbanization, energy consumption, and foreign direct investment on the carbon dioxide emission in the SSEA (South and Southeast Asian) region. *Renewable and Sustainable Energy Reviews, 70*, 96-106. https://doi.org/10.1016/j.rser.2016.11.201

Chandran, V., and Tang, C. F. (2013). The impacts of transport energy consumption, foreign direct investment and income on CO2 emissions in ASEAN-5 economies. *Renewable and Sustainable Energy Reviews, 24*, 445-453. https://doi.org/10.1016/j.rser.2013.03.054

Chen, B. (2021). Industrial agglomeration and the pollution haven hypothesis: evidence from Chinese prefectures. *Journal of the Asia Pacific Economy*. Early online publication. https://doi.org/10.1080/13547860.2021.1892567

Cole, M. A. (2004). Trade, the pollution haven hypothesis and the environmental Kuznets curve: examining the linkages. *Ecological Economics, 48*(1), 71-81. https://doi.org/10.1016/j.ecolecon.2003.09.007

Cole, M. A., Elliott, R. J., ve Zhang, J. (2011). Growth, foreign direct investment, and the environment: evidence from Chinese cities. *Journal of Regional Science, 51*(1), 121-138. https://doi.org/10.1111/j.1467-9787.2010.00674.x

Copeland, B. R. and Taylor, M. S. (2004). Trade, growth, and the environment. *Journal of Economic Literature, 42*(1), 7-71. https://www.aeaweb.org/articles?id=10.1257/002205104773558047

Çınar, S., Yılmazer, M., and Aprazlı Fazlılar, T. (2012). Kirlilik yaratan sektörlerin ticareti ve çevre: gelişmiş ve gelişmekte olan ülkeler karşılaştırması. *Doğuş Üniversitesi Dergisi, 13*(2*)*, 212-226. http://journal.dogus.edu.tr/index.php/duj/article/view/321/pdf

Danish, Khan, S. U.-D., and Ahmad, A. (2021). Testing the pollution haven hypothesis on the pathway of sustainable development: accounting the role of nuclear energy consumption. *Nuclear Engineering and Technology.* Early online publication. https://doi.org/10.1016/j.net.2021.02.008

Dickey, D. A., and Fuller, W. A. (1979). Distribution of the estimators for autoregressive series with a unit root. *Journal of the American Statistical Association, 74*, 427-431. https://doi.org/10.2307/2286348

Dietzenbacher, E., and Mukhopadhyay, K. (2007). An empirical examination of the pollution haven hypothesis for India: towards a green leontief paradox? *Environmental and Resource Economics, 36*, 427-449. https://doi.org/10.1007/s10640-006-9036-9

Ghouali, Y. Z., Belmokaddem, M., Sahraoui, M. A., and Guellil, M. S. (2015). Factors affecting CO2 emissions in the BRICS countries: a panel data analysis. *Procedia Economics and Finance, 26*, 114-125. https://doi.org/10.1016/S2212-5671(15)00890-4

Grossman, G. M., and Krueger, A. B. (1991). Environmental impacts of a North American free trade agreement. *NBER Working Papers, 3914.* National Bureau of Economic Research. https://www.nber.org/papers/w3914

Guzel, A. E., and Okumus, İ. (2020). Revisiting the pollution haven hypothesis in ASEAN-5 countries: new insights from panel data analysis. *Environmental Science and Pollution Research, 27*, 18157-18167. https://doi.org/10.1007/s11356-020-08317-y

Hansen, H., and Rand, J. (2006). On the causal links between FDI and growth in developing countries. *World Economy, 29*(1), 21-41. http://dx.doi.org/10.1111/j.1467-9701.2006.00756.x

He, J. (2006). Pollution haven hypothesis and environmental impacts of foreign direct investment: the case of industrial emission of sulfur dioxide (SO2) in Chinese provinces. *Ecological Economics, 60*, 228-245. https://doi.org/10.1016/j.ecolecon.2005.12.008

Hoffman, R., Lee, C.-G., Ramasamy, B., and Yeung, M. (2005). FDI and pollution: a Granger causality test using panel data. *Journal of International Development, 17*, 311-317. https://doi.org/10.1002/jid.1196

Kearsley, A., and Riddel, M. (2010). A further inquiry into the pollution haven hypothesis and the environmental Kuznets curve. *Ecological Economics, 69*, 905-919. https://doi.org/10.1016/j.ecolecon.2009.11.014

Keho, Y. (2016). Do foreign direct investment and trade lead to lower energy intensity? Evidence from selected African countries. *International Journal of Energy Economics and Policy, 6*(1), 1-5. https://www.econjournals.com/index.php/ijeep/article/view/1280

Kılıçarslan, Z., and Dumrul, Y. (2017). Foreign direct investments and CO2 emissions relationship: the case of Turkey. *Business and Economics Research Journal, 8*(4), 647-660. https://doi.org/10.20409/berj.2017.73

Kılıç C., and Balan, F. (2018) Is there an environmental Kuznets inverted-U shaped curve? *Panoeconomicus, 65*(1), 79-94. https://doi.org/10.2298/PAN150215006K

Kivyiro, P., and Arminen, H. (2014). Carbon dioxide emissions, energy consumption, economic growth, and foreign direct investment: causality analysis for Sub-Saharan Africa. *Energy, 74*, 595-606. https://doi.org/10.1016/j.energy.2014.07.025

Koçak, E., and Şarkgüneşi, A. (2018). The impact of foreign direct investment on CO2 emissions in Turkey: new evidence from cointegration and bootstrap causality analysis. *Environmental Science and Pollution Research, 25*, 790-804. https://dx.doi.org/10.1007/s11356-017-0468-2

Kurt, Ü., Kılıç, C., and Özekicioğlu, H. (2019). The effect of foreign direct investments on CO2 emissions: ARDL boundary test approach for Turkey. *Selcuk University Journal of Social Sciences Vocational School, 22*(1), 213-224. https://doi.org/10.29249/selcuksbmyd.487139

Lau, L.-S., Choong, C.-K., and Eng, Y.-K. (2014). Investigation of the environmental Kuznets curve for carbon emissions in Malaysia: do foreign direct investment and trade matter? *Energy Policy, 68*, 490–497. https://doi.org/10.1016/j.enpol.2014.01.002

Liang, F. (2008). Does foreign direct investment harm the host country's environment? Evidence from China. *International Finance eJournal*. Early online publication. http://dx.doi.org/10.2139/ssrn.1479864

Mike, F. (2020). Kirlilik sığınağı hipotezi Türkiye için geçerli mi? ARDL sınır testi yaklaşımından bulgular. *Doğuş Üniversitesi Dergisi, 21*(2), 107-121. http://journal.dogus.edu.tr/index.php/duj/article/view/1259

Mike, F., and Kardaşlar, A. (2018). Doğrudan yabanci sermaye yatirimlarinin çevre kirliliği üzerine etkisi. *Yönetim ve Ekonomi Araştırmaları Dergisi, 16*(3), 178-191. https://doi.org/10.11611/yead.377182

Mutafoglu, T. H. (2012). Foreign direct investment, pollution, and economic growth: evidence from Turkey. *Journal of Developing Societies, 28*(3), 281-297. https://doi.org/10.1177/0169796X12453780

Nathaniel, S., Aguegboh, E., Iheonu, C., Sharma, G., and Shah, M. (2020). Energy consumption, FDI, and urbanization linkage in coastal mediterranean countries: Re-assessing the pollution haven hypothesis. *Environmental Science and Pollution Research, 27*(28), 35474-354787. https://doi.org/10.1007/s11356-020-09521-6

Neequaye, N. A., and Oladi, R. (2015). Environment, growth, and FDI revisited. *International Review of Economics and Finance, 39*, 47-56. https://doi.org/10.1016/j.iref.2015.06.002

Omri, A., Nguyen, D. K., and Rault, C. (2014). Causal interactions between CO2 emissions, FDI, and economic growth: evidence from dynamic simultaneous-equation models. *Economic Modelling, 42*, 382-389. https://doi.org/10.1016/j.econmod.2014.07.026

Öztürk, S., and Saygin, S. (2020). Türkiye'de 1974-2016 döneminde yapısal kırılma altında kişi başına reel gelir, doğrudan yabancı yatırımlar, ticari açıklık ve karbon emisyonları arasındaki ilişki. *Sosyoekonomi*, *28*(44), 69-90. https://doi.org/10.17233/sosyoekonomi.2020.02.04

Pao, H.-T., and Tsai, C.-M. (2011). Multivariate granger causality between CO2 emissions, energy consumption, FDI (foreign direct investment) and GDP (gross domestic product): evidence from a panel of BRIC (Brazil, Russian Federation, India, and China) countries. *Energy, 36*, 685-693. https://doi.org/10.1016/j.energy.2010.09.041

Perron, P. (1990). Testing for a unit root in a time series with a changing mean. *Journal of Business and Economic Statistics, 8*(2), 153-162. https://doi.org/10.2307/1391977

Pesaran, M. H., Shin, Y., and Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics, 16*, 289–326. https://doi.org/10.1002/jae.616

Rafiq, S., Salim, R., and Nielsen, I. (2016). Urbanization, openness, emissions, and energy intensity: a study of increasingly urbanized emerging economies. *Energy Economics, 56*, 20-28. https://doi.org/10.1016/j.eneco.2016.02.007

Rahman, Z., Chongboa, W., and Ahmad, M. (2019). An (a)symmetric analysis of the pollution haven hypothesis in the context of Pakistan: a non-linear approach. *Carbon Management, 10*(3), 227–239. https://doi.org/10.1080/17583004.2019.1577179

Ren, S., Yuan, B., Ma, X., and Chen, X. (2014). International trade, FDI (foreign direct investment) and embodied CO2 emissions: a case study of Chinas industrial sectors. *China Economic Review, 28*, 123–134. https://doi.org/10.1016/j.chieco.2014.01.003

Sadik-Zada, E. R., and Ferrari, M. (2020). Environmental policy stringency, technical progress and pollution haven hypothesis. *Sustainability, 12*(9), 3880. https://doi.org/10.3390/su12093880 .

Seker, F., Ertugrul, H. M., and Cetin, M. (2015). The impact of foreign direct investment on environmental quality: a bounds testing and causality analysis for Turkey. *Renewable and Sustainable Energy Reviews, 52*, 347-356. https://doi.org/10.1016/j.rser.2015.07.118

Shahbaz, M., Nasreen, S., and Afza, T. (2011). Environmental consequences of economic growth and foreign direct investment: evidence from panel data analysis. *Munich Personal RePEc Archive*. https://mpra.ub.uni-muenchen.de/32547/.

Shahbaz, M., Nasreen, S., Abbas, F., and Anis, O. (2015). Does foreign direct investment impede environmental quality in high-, middle-, and low-income countries? *Energy Economics, 51*, 275-287. https://doi.org/10.1016/j.eneco.2015.06.014

Shin, Y., Yu, B., and Greenwood-Nimmo, M. (2014). Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework. R. Sickles, and W. Horrace (Ed.), *Festschrift in Honor of Peter Schmidt* in (s. 281-314). Springer.

Singhania, M., and Saini, N. (2021). Demystifying pollution haven hypothesis: role of FDI. *Journal of Business Research, 123*, 516-528. https://doi.org/10.1016/j.jbusres.2020.10.007

Solarin, S. A., Al-Mulali, U., Musah, I., and Ozturk, I. (2017). Investigating the pollution haven hypothesis in Ghana: an empirical investigation. *Energy, 124*, 706-719. https://doi.org/10.1016/j.energy.2017.02.089

Şahinöz, A. and Fotourehchi, Z. (2014). Kirlilik emisyonu ve doğrudan yabancı sermaye yatırımları: Türkiye için "kirlilik sığınağı hipotezi" testi. *Sosyoekonomi, 21*(21), 187-210. https://dergipark.org.tr/en/pub/sosyoekonomi/issue/21081/226983

Tamazian, A., and Rao, B. (2010). Do economic, financial and institutional developments matter for environmental degradation? Evidence from transitional economies. *Energy Economics, 32*(1), 137-145. https://doi.org/10.1016/j.eneco.2009.04.004

Tamazian, A., Chousa, J. P., and Vadlamannati, K. C. (2009). Does higher economic and financial development lead to environmental degradation: evidence from BRIC countries. *Energy Policy, 37*(1), 246–253. https://doi.org/10.1016/j.enpol.2008.08.025

Tang, C. F., and Tan, B. W. (2015). The impact of energy consumption, income and foreign direct investment on carbon dioxide emissions in Vietnam. *Energy, 79*, 447-454. https://doi.org/10.1016/j.energy.2014.11.033

Waldkirch, A., and Gopinath, M. (2008). Pollution control and foreign direct investment in Mexico: an ındustry-level analysis. *Environmental and Resource Economics, 41*, 289-313. https://doi.org/10.1007/s10640-008-9192-1

Wang, D. T., and Chen, W. Y. (2014). Foreign direct investment, institutional development, and environmental externalities: evidence from China. *Journal of Environmental Management, 135*, 81-90. https://doi.org/10.1016/j.jenvman.2014.01.013

World Bank Open Data. (2021, 2 June). https://data.worldbank.org/

Yıldırım, M., Destek, M. A., and Özsoy, F. N. (2017). Doğrudan yabancı yatırımlar ve kirlilik sığınağı hipotezi. *C.Ü. İktisadi ve İdari Bilimler Dergisi, 18*(2), 99-111. https://dergipark.org.tr/en/pub/cumuiibf/issue/32189/330140

Zheng, S., Kahn, M. E., and Liu, H. (2010). Towards a system of open cities in China: home prices, FDI flows and air quality in 35 major cities. *Regional Science and Urban Economics, 40*(1), 1-10. https://doi.org/10.1016/j.regsciurbeco.2009.10.003

Zhu, H., Duan, L., Guo, Y., and Yu, K. (2016). The effects of FDI, economic growth and energy consumption on carbon emissions in ASEAN-5: evidence from panel quantile regression. *Economic Modelling, 58*, 237–248. https://doi.org/10.1016/j.econmod.2016.05.003

Appendix

Appendix 1. Descriptive Statistics and Graphs of Variables

	LNCO2	GDP	LNENERGY	FDI	TRADE
Mean	1.002506	2.742175	3.656131	0.791656	36.37222
Median	1.010522	3.168091	3.720274	0.424053	37.66492
Maximum	1.634559	9.509983	4.363868	3.623502	62.54741
Minimum	0.200982	-7.147846	2.713216	0.019501	9.099744
Std. Dev.	0.383662	4.003076	0.456145	0.860643	14.87508
Skewness	-0.209934	-0.745525	-0.266240	1.533354	-0.362988
Kurtosis	1.988688	2.999712	1.986155	4.811285	1.880555
Jarque-Bera	2.448042	4.539094	2.677474	25.89947	3.634571
Probability	0.294045	0.103359	0.262177	0.000002	0.162466
Observations	49	49	49	49	49