International Journal of Management Economics and Business, Vol. 20, No. 4, 2024
Uluslararası Yönetim İktisat ve İşletme Dergisi, Cilt 20, Sayı 4, 2024

Research Article / *Araştırma Makalesi*

DOES THE EFFECT OF FINANCIAL DEVELOPMENT ON CARBON EMISSIONS VARY BETWEEN DEVELOPED AND DEVELOPING COUNTRIES?

Emrah ÖGET[1]

ABSTRACT

This study examines the relationship between financial development and carbon emission for 21 developed and 22 developing countries throughout 2001-2020. There is heterogeneity in slope coefficient and cross-section dependence in residuals. For this reason, the second-generation panel unit root and cointegration tests were applied to investigate the integration order of the series and the long-run relationship, respectively. Additionally, this study utilized the pooled FMOLS and DOLS estimators to determine the long-run coefficients. While cointegration results confirm the long-run relationship between financial development and carbon emissions, pooled DOLS and FMOLS results show that financial development has an increasing effect on carbon emissions for both developed and developing countries. For the DOLS estimator, where statistically more significant results were obtained, individual DOLS results were examined, and it was seen that financial development reduced carbon emissions in approximately 55% of developed countries and approximately 28% of developing countries. It is understood that the positive effect of the pooled results originates from Belgium, Denmark, South Korea, and the United States, where financial development has a highly increasing effect on carbon emissions. These results cast doubt on the validity of the EKC hypothesis for these countries.

Keywords: *Financial Development, Carbon Emission, EKC hypothesis, DOLS, FMOLS*

JEL Classification: *G0, Q5, H5*

FİNANSAL GELİŞİMİN KARBON EMİSYONLARI ÜZERİNDEKİ ETKİSİ GELİŞMİŞ VE GELİŞMEKTE OLAN ÜLKELER ARASINDA FARKLILIK GÖSTERİYOR MU?

ÖZET

Bu çalışmada, 2001-2020 dönemi için 21 gelişmiş ve 22 gelişmekte olan ülke için finansal gelişme ile karbon emisyonu arasındaki ilişki incelenmektedir. Kalıntılarda eğim katsayısı ve kesit bağımlılığında heterojenlik bulunmaktadır. Bu nedenle serinin bütünleşme derecesi ve uzun dönem ilişkisini araştırmak için sırasıyla ikinci nesil panel birim kök testi ve eşbütünleşme testi uygulanmıştır. Ayrıca, bu çalışmada uzun dönem katsayılarını belirlemek için birleştirilmiş FMOLS ve DOLS tahmin edicilerinden yararlanılmıştır. Eşbütünleşme sonuçları finansal gelişme ile karbon emisyonları arasındaki uzun dönemli ilişkiyi teyit ederken, panel DOLS ve FMOLS sonuçları finansal gelişmenin hem gelişmiş hem de gelişmekte olan ülkeler için karbon emisyonları üzerinde artırıcı bir etkiye sahip olduğunu göstermektedir. İstatistiksel olarak daha anlamlı sonuçların elde edildiği DOLS tahmin edicisi

[1] Lecturer PhD., Zonguldak Bülent Ecevit University, Devrek VS, Zonguldak, Türkiye, *emrahoget@beun.edu.tr*

ISSN:2147-9208 E-ISSN:2147-9194
http://dx.doi.org/10.17130/ijmeb.1490436
Received: 27.05.2024, Accepted: 29.10.2024

için ise bireysel DOLS sonuçları incelenmiş ve gelişmiş ülkelerin yaklaşık %55'inde ve gelişmekte olan ülkelerin yaklaşık %28'inde finansal gelişmenin karbon emisyonları üzerinde azaltıcı bir etkiye sahip olduğu görülmüştür. Panel sonuçlardaki pozitif etkinin, finansal gelişimin karbon emisyonları üzerinde oldukça artan bir etkiye sahip olduğu Belçika, Danimarka, Güney Kore ve Amerika Birleşik Devletleri ülkelerinden kaynaklandığı anlaşılmaktadır. Bu sonuçlar EKC hipotezinin geçerliliğinin bu ülkeler için şüpheli olduğunu göstermektedir.

Anahtar Kelimeler: *Finansal Gelişme, Karbon Emisyonu, EKC hipotezi, DOLS, FMOLS*

JEL Sınıflandırması: *G0, Q5, H5*

1. Introduction

The most crucial factor in economic growth is the bank credits to the private sector. Individuals obtain loans for consumption and investment purposes. At the same time, businesses borrow for factories, raw materials and machinery. Governments receive loans to invest in infrastructure projects (Begum & Aziz, 2019: 45). Studies in the literature provide proof that domestic credit to the private sector has a significant impact on economic growth (Levine, 1997; Bist, 2018; Guru & Yadav, 2019). There has also been working revealing that economic growth is related to carbon (CO2) emissions (Du et al., 2019; Xiumei et al., 2011; Liu et al., 2022). In addition, according to the Environmental Kuznets Curve (EKC), which shows that there is an inverted U-shaped relationship between economic growth and the environment, environmental pollution tends to increase at low levels of economic development, but decreases with increasing economic development (Grossman & Krueger, 1995: 366). Therefore EKC hypothesis proposes economic development and growth as the driving forces of environmental degradation (Kim et. al., 2020: 1).

The finding that a relationship exists between CO_2 emissions and the domestic credits to the private sector by banks that encourage economic growth by allocating resources to private sectors in need deserves attention, which forms the basis for the present study. Due to obstacles in ensuring equitable access to energy and reducing CO_2 emissions, the link between banking sector development, renewable energy, and CO_2 emissions requires close investigation (Samour et al., 2022: 1033). In addition, it is thought that the energy transition will not be possible without the participation of the private sector in developing countries (Fadly, 2019: 552).

Sugiawan et al. (2019: 2) pointed out that investments aimed at decreasing CO_2 emissions have thus far been very costly. Investing in renewable energy sources in many developing countries has not been economically attractive. Matthaus & Mehling (2020: 2629-2630) suggested that more renewable energy investments will be needed in the future, but this will pose several new risks for developing countries. In addition, it has been stated that securing such risks in developing countries is more costly than in developed countries. Nyambuu & Semmler (2020: 367-368) pointed out that fossil fuel consumption, a key factor in raising CO_2 emissions, has decreased in North America, the EU, and OECD countries, which may have been due to the increased use of clean energy, while fossil fuel consumption has been increasing in many other developing countries.

Li et al. (2022: 1) stated that ensuring sustainable development in developing countries is more difficult when compared to developed countries due to their inefficient use of energy, technological underdevelopment, excessive dependence on agriculture, inadequate public services, rapid industrialization, and urbanization. Betzold (2016: 312) pointed out that investing in renewable energy technologies requires high upfront capital, and this is possible only with foreign aid in developing countries. Similarly, Senshaw & Kim (2018: 434) stated that, although developing countries are more willing to invest in renewable energy, they cannot achieve this without international technological and financial assistance.

It has been stated that the dominant source in the transition to renewable energy investments are domestic financing, and the private sector constitutes the majority of the total renewable investments (IFC, 2013: 3). In the OECD Environment Working Paper Ang et. al. (2017: 39) noted that domestic credits to the private sector have a positive effect on renewable investment flows in OECD and G20 countries. Therefore, the high transition cost to renewable energy sources requires private sector financing as a catalyst.

Based on the explanations above, the relationships between financial development (FD) and CO2 emissions are examined for the panels of developed and developing countries in this study. In addition, the variable of domestic credit to private sector by banks (% of GDP) (DCPSB) represents FD. This study is hoped to contribute to the literature in several ways, in that it does not only present the impact of FD on CO_2 emissions but also reveals the differences between developed and developing countries. Contradictory findings on the relationship between FD and the environment have failed to provide a lasting consensus among researchers (Charfeddine & Kahia, 2019: 200; Gök, 2020: 11618; Lv & Li, 2021: 1; Adebayo & Odugbesan, 2021: 9378).

Similar studies and differences in the literature are evaluated in Section 2, data description and variables in Section 3, economic methodology in Section 4, empirical results and discussions in Section 5 and the conclusions and policy implications are discussed in Section 6.

2. Literature Review

Although many studies have been conducted on the determinants of CO2 emissions, only the findings related to the relationships between credit to the private sector (% of GDP) representing FD and CO_2 emissions have been mentioned here.

Both domestic credit to private sector by banks (% of GDP) (DCPSB) and domestic credit to private sector (% of GDP) (DCPS) are used as a proxy for FD in the studies that have investigated the relationship between FD and CO_2 emissions. These studies can be grouped into two, namely those that revealed that CO_2 emissions increased as a result of FD, and those that showed that FD reduced CO_2 emissions.

In some of the studies, it was found that FD, measured by DCPSB, led CO_2 emissions to increase (Maji et. al., 2017; Samour et. al., 2019; Faisal et. al., 2020; Obiora et. al., 2020; Samour et. al., 2022; Shahbaz, et. al., 2022; Majumdar & Paris, 2022).

These findings were based on data from Malaysia from 1980 to 2014 by Maji et. al. (2017), from Turkiye between 1980 and 2014 by Samour et. al. (2019), from Brazil, India, China, and South African countries throughout 1993-2014 by Faisal et. al. (2020), from a total of forty-five developed, emerging, and developing countries between 1990 and 2017 by Obiora et. al. (2020), from South Africa from 1990 to 2017 by Samour et. al. (2022), from Visegrád group countries between 1990 and 2019 by Shahbaz, et. al. (2022), and from United Arab Emirates (UAE) from 1984 to 2019 by Majumdar & Paris (2022).

In some others, on the other hand, it was observed that FD, measured by DCPS, has an increasing effect on CO_2 emission (Omri, 2013; Muftau et. al., 2014; Shahbaz et. al., 2014; Boutabba, 2014; Çetin et. al., 2018; Ahmad et. al., 2018; Cheng, et. al., 2019; Anser et. al., 2020; Adebayo & Odugbesan, 2021).

These findings were based on data from Iran, Jordan, Kuwait, Lebanon, Morocco, and the United Arab Emirates between 1990 and 2011 by Omri (2013), from 11 West African countries between 1970 and 2011 by Muftau et. al. (2014), from Bangladesh from 1975 to 2010 by Shahbaz et. al. (2014), from India between 1971 and 2008 by Boutabba (2014), from Turkiye from 1960 to 2013 by Çetin et. al. (2018), from China between 1980 and 2014 by Ahmad et. al. (2018), from BRIICS countries from 2000 to 2013 by Cheng, et. al. (2019), from Saudi Arabia between 1975 and 2018 by Anser et. al. (2020), and from South Africa from 1971 to 2016 by Adebayo & Odugbesan (2021).

On the contrary, it was also shown by relatively few researchers that FD, measured by DCPS, led to a decrease in CO_2 emissions (Jalil & Feridun, 2011; Abbasi & Riaz, 2016; Mrabet & Alsamara, 2017; Dar & Asif, 2018; Lahiani, 2020; Yang et. al., 2020). In addition, some studies found that there is no statistically significant relationship between FD, measured by DCPS, and CO_2 emissions (Öztürk & Acaravci, 2013; Charfeddine & Kahia, 2019; Neog & Yadava, 2020).

These studies were based on data obtained from China over the period of 1978-2006 by Jalil & Feridun (2011), from Pakistan between 1988 and 2011 by Abbasi & Riaz (2016), from Qatar over the period of 1991-2000 by Mrabet & Alsamara (2017), from Turkiye between 1960 and 2013 by Dar & Asif (2018), from China over the period of 1977-2013 by Lahiani (2020), from 54 developing economies between 1980 and 2016 by Yang et. al. (2020), from Turkiye over the period of 1960-2007 by Öztürk & Acaravci (2013), from MENA countries between 1980 and 2015 by Charfeddine & Kahia (2019), and from India over the period of 1980-2014 by Neog & Yadava (2020).

It was also shown that FD, measured by DCPSB, has a decreasing effect on CO_2 emissions in a limited number of studies (Nwani & Omoke, 2020). This study was carried out using data from Brazil between 1971 and 2014.

In some studies, various indicators were used together to indicate FD (Acheampong, 2019; Ganda, 2019; Tsaurai, 2019; Xu et. al., 2022). Acheampong (2019) found that DCPS and DCPSB increased CO_2 emissions in forty-six sub-Saharan African countries over the period of 2000-2015. Ganda (2019) found that DCPSB is negatively related to CO_2 emission in the study examining 23 OECD countries between 2001 and 2012. On the other hand, it was also determined that DCPS is positively related to CO_2 emissions. Tsaurai (2019) revealed that only domestic credit by the financial sector led to an increase in CO_2 emissions, but this is not the case for domestic credit by the banks in the study on twelve West African countries in the period of 2003-2014. Xu et al. (2022) revealed that DCPSB and DCPS raised total CO_2 emissions for thirty-four European countries between 2000 and 2020.

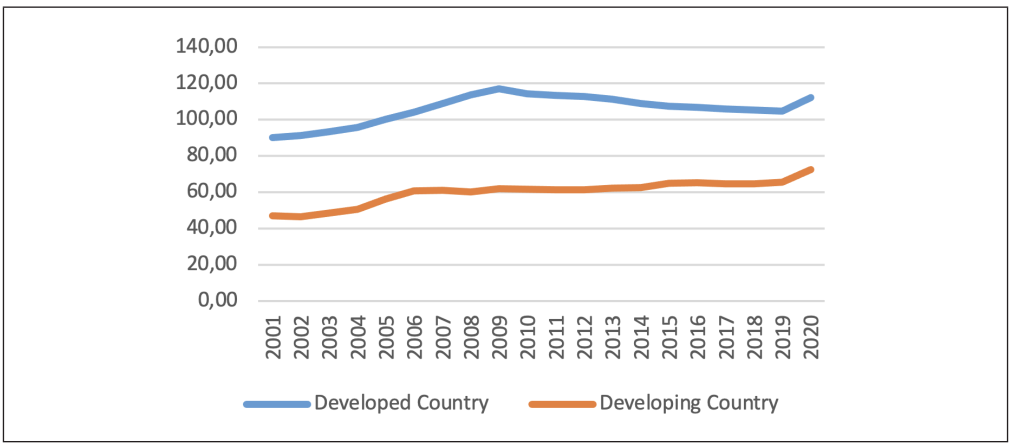
There have also been some studies that employed DCPS to indicate FD that revealed different results for different countries (Saidi & Hammami, 2015; Park et al., 2018; Ehigiamusoe & Lean, 2019).

Saidi & Hammami (2015) found that FD increased CO_2 emissions in Europe, North Asia, Latin America, and the Caribbean region, but there was no statistically significant relationship for the Middle Eastern, North African, and sub-Saharan region over the period of 1990-2012. Park et. al. (2018) found that FD increased CO_2 emissions in Austria, Germany, Hungary, and Slovenia, but it decreased CO_2 emissions in Croatia, Czech Republic, Finland, Greece, and Portugal based on data from 2001-2014. Ehigiamusoe & Lean (2019) found that FD reduces the CO_2 emissions of high-income countries while it increases CO_2 emissions in low-income countries.

3. Data Description and Variables

This study includes panel data from twenty-two[1] developed and twenty-one[2] developing countries. CO_2 emission (kt) data was taken from the recognized public database Ourworldindata and the FD indicator (DCPSB) was retrieved from the database of the World Bank annually between 2001 and 2020. The development classification of countries was determined according to the FTSE Equity Country Classification (Sep. 2022). The data range and countries were selected according to the availability of data, and some countries[3] were not included in the study due to the missing data. Figure 1. and Figure 2. compare DCPSB and CO_2 emissions in developed and developing countries, respectively.

Figure 1: Yearly Period Averages of FD

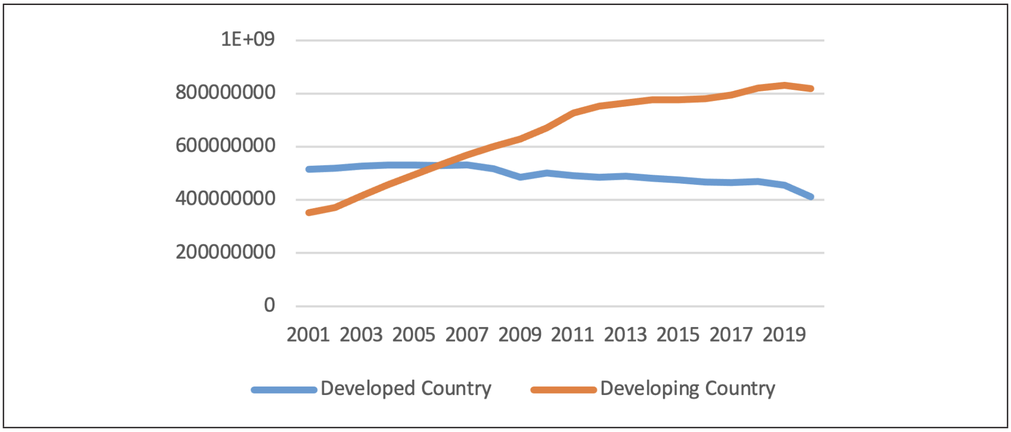


1 Australia, Austria, Belgium, Germany, Denmark, Spain, Finland, France, Hong Kong, Ireland, Israel, Italy, Japan, South Korea, Netherlands, Norway, New Zealand, Poland, Portugal, Singapore, Sweden and United States.

2 United Arab Emirates (UAE), Brazil, Chile, China, Colombia, Czechia, Egypt, Greece, Hungary, Indonesia, India, Iceland, Mexico, Malaysia, Pakistan, Philippines, Qatar, Romania, Thailand, Turkiye, South Africa.

3 Canada, Switzerland, and United Kingdom (developed countries) and Taiwan, Kuwait, and Saudi Arabia (developing countries).

Figure 2: Yearly Period Averages of CO_2 Emission (kt)



4. Econometric Methodology

It was observed that most similar studies employed the natural logarithm transformation of the variables (Park et al., 2018; Charfeddine & Kahia, 2019; Tsaurai, 2019; Faisal et al., 2020; Shahbaz et al., 2022; Samour et al., 2022).

Charfeddine & Kahia (2019: 200) used the natural logarithm transformation to reduce heteroscedasticity and non-normality in the data. Tsaurai (2019, p. 149) used the natural logarithm transformation to solve the abnormally distributed data problem. In line with the relevant literature, the natural logarithms of the variables were used in this study. The formula for relationship for the study can be shown as:

$$LNCO_{2it} = a_i + \beta_1 LNFD_{it} + \mu_{it} \tag{1}$$

where the subscript "i" represents the cross sections and the subscript "t" represents the time. The error term is represented by "μ_{it} " in Eq (1). The model was used to analyse both developed and developing countries' panels.

4.1. Cross-sectional Dependency Test

It is important to test the cross-section dependence in the heterogeneous panel. Estimators that take into account cross-sectional dependence should be used in cases where cross-sectional dependence is in question (Faisal et al., 2020: 10782). In this study, the CD test recommended by Pesaran (2004) was used to assess the cross-sectional dependence. Charfeddine & Kahia (2019: 204) stated that the Breusch and Pagan (1980) LM test is not substantial and is not well averaged for a fixed T in evaluating the cross-sectional dependence. To correct these deficiencies, Pesaran (2004: 5) suggested using the CD test based on pair-wise correlation coefficients of OLS residuals rather than squares utilized in the LM test:

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

where " $\hat{\rho}_{ij}$ " represents a sample estimate of residuals' pair-wise correlation.

The first T→∞ and then N→∞ CD test asymptotically follows a normal distribution. Hypotheses are shown as below (Charfeddine & Kahia, 2019: 204);

$H_0: \rho_{ij} = \rho_{ij} = 0 \; for \; all \; i \neq j$

$H_1: \rho_{ij} = \rho_{ij} \; for \; some \; i \neq j$

4.2. Slope Homogeneity

For panel data models, it is extremely important to examine the slope homogeneity as well as the cross-section dependency problem. Because slope coefficients are assumed to be homogeneous between individual units in many panel data models (Pesaran & Yamagata, 2008: 50). Therefore, the $\hat{\Delta}$ and adj. $\tilde{\Delta}$ statistics proposed by Pesaran & Yamagata (2008) were used to assess the homogeneity of the slope coefficients and test statistics are shown in Eq. (3) (Pesaran & Yamagata, 2008: 57).

$$\hat{\Delta} = \sqrt{N}\left(\frac{N^{-1}\hat{S} - k}{\sqrt{2k}}\right) \quad and \quad \tilde{\Delta}_{adj} = \sqrt{N}\left(\frac{N^{-1}\tilde{S}_2 - k_2}{\sqrt{\frac{2k(T-k-1)}{T+1}}}\right) \tag{3}$$

where, $\hat{S}$, represents the Swamy test statistics and hypotheses for evaluating the homogeneity of the slope coefficient β with vector k x 1 are shown below (Pesaran & Yamagata, 2008: 52).

H_0: $\beta_i = \beta$ for all i.

H_1: $\beta_i \neq \beta_j$ for a non - zero fraction of pairwise slopes for i≠j.

4.3. Panel Unit Root Test

In this study, the CIPS test, which is frequently used in the literature, was used (Park et. al., 2018; Charfeddine & Kahia, 2019; Faisal et. al., 2020; Shahbaz, et. al., 2022).

Pesaran (2007: 255) stated that classical unit root tests are restrictive for cross-country regressions because of the assumtion of cross-section independent. Therefore Pesaran (2007) suggested the CADF test. In the CADF test, it is assumed that the error term consists of an unobservable common effect and individual specific error to each series (Pesaran, 2007: 268). Accordingly, a heterogeneous panel data regression is expressed as in Eq. (4) (Pesaran, 2007: 268):

$$\Delta y_{it} = \alpha_i + \beta_i y_{i,t-1} + \gamma_i f_t + \mu_{it}$$
$$H_0: \beta_i = 0 \qquad for \; all \; i \; (the \; series \; is \; not \; stationary) \tag{4}$$

H_1: $\beta_i<0$, i=1,2,3,…,N_1; $\beta_i=0$, i=N_1+1,N_1+2,….,N (series is stationary)

The cross-sectional augmented DF (CADF) regression is expressed as follows Eq. (5) (Pesaran, 2007: 269):

$$\Delta y_{it} = \alpha_i + b_i y_{i,t-1} + c_i \bar{y}_{t-1} + d_i \Delta \bar{y}_t + \mu_{it} \tag{5}$$

The cross-section mean of y_{it} can be expressed as the common factor and is calculated as $N^{-1}\sum_{j=1}^{N} y_{jt}$ Its lagged values are represented as $\bar{y}_{(t-1)}, \bar{y}_{(t-2)}, \ldots, N$.. The CIPS statistics are expressed as the cross-sectional average of the t-ratio $t_i\,(N,T)$ of the OLS coefficient $(\hat{b}_i)$ of $y_{i,t-1}$ in the CADF regression (Pesaran, 2007: 298). CIPS test statistics are shown in Eq. (6) (Pesaran, 2007: 276):

$$CIPS = N^{-1}\sum_{i=1}^{N} t_i(N,T) \tag{6}$$

4.4. Panel Cointegration Test

In case of cross-section dependence, it is recommended to use second generation cointegration tests (Ganda, 2019: 6764; Ehigiamusoe & Lean, 2019: 22621). In this study the second-generation cointegration procedure proposed by Westerlund (2007) was used, in line with other works in the relevant literature (see: Park et. al., 2018; Ehigiamusoe & Lean, 2019; Charfeddine & Kahia, 2019; Faisal et. al., 2020).

Westerlund (2007) proposed four panel cointegration tests based on the OLS estimate $(\hat{a}_i)$ of the regression error correction parameter (a_i) and the t-ratio without any common factor constraints.

These tests are shown in equations (7) and (8) as group mean statistics (G_t and G_a and as panel statistics (P_t and P_a) (Westerlund, 2007: 716-718).

$$G_t = \frac{1}{N}\sum_{i=1}^{N}\frac{\hat{a}_i}{SE(\hat{a}_i)} \quad and \quad G_a = \frac{1}{N}\sum_{i=1}^{N}\frac{T\hat{a}_i}{\hat{a}_i(1)} \tag{7}$$

$$P_t = \frac{\hat{a}}{SE(\hat{a})} \quad and \quad P_a = T\hat{a} \tag{8}$$

where $(\hat{a}_i)$ is calculated as $1-\sum_{j=1}^{p_i}\hat{a}_{ij}$ and p_i represents the lag order. $SE(\hat{a}_i)$ is the standard error of the regression error correction term OLS estimate $(\hat{a}_i)$. The lag order p_i is allowed to vary between individuals. It has been stated that tests based on $\hat{a}_i(1)$ perform less when p_i is large (Westerlund, 2007: 716).

The hypotheses for panel statistics and group mean statistics are as follows, respectively (Westerlund, 2007: 712):

$$H_0: a_i = 0 \; for\; all\; i \quad versus \quad H_1^p: a_i = a < 0 \; for\; all\; i.$$

$$H_0 \; is\; tested \quad versus \quad H_1^g: a_i < 0 \; for\; at\; least\; some\; i.$$

4.5. Long Run Coefficient Estimation

Dynamic OLS estimator (DOLS) proposed by Stock & Watson (1993) and the Fully Modified OLS (FMOLS) estimator proposed by Pedroni (2001) were used for long-term coefficient estimations because it has been shown that conventional OLS is not suitable for cointegrated panels and causes spurious results (Ehigiamusoe & Lean, 2019: 22615). In addition, it is stated that DOLS and FMOLS applications are suitable for heterogeneous cointegrated panels because they account for the endogeneity problem in regressors and eliminate serial correlations between error terms (Dogan & Seker, 2016: 434). The panel DOLS estimator can be expressed in Eq. (9) as follows:

$$y_{it} = a_0 + a_1 x_{it} + \sum_{i=-l}^{i=l} \theta_i x_{it} + u_{it} \tag{9}$$

where a is the cointegration vector and l is the length of lead and lag of the regressor.

It has been suggested that while a parametric approach is used in the DOLS method, the FMOLS method is a non-parametric approach and DOLS provides better results even though it does not take into account the cross-section heterogeneity for small samples (Park et. al., 2018: 30711; Ehigiamusoe & Lean, 2019: 22615). Therefore, the FMOLS method was also used to evaluate the cross-sectional heterogeneity and it was desired to compare the results.

Pedroni (2000: 101-102) proposed the use of FMOLS estimator, which can be used for cointegrated panel data models and takes into account the heterogeneity present in fixed effects as well as short-run dynamics, to overcome the endogeneity problem of regressors. The panel FMOLS estimator used in the present study to determine the coefficients is shown in Eq. (10) (Pedroni, 2000: 102-103):

$$\hat{\beta}^*_{NT} - \beta = \left(\sum_{i=1}^{N} \hat{L}_{22i}^{-2} \sum_{t=1}^{T} (x_{it} - \bar{x}_i)^2 \right)^{-1} \sum_{i=1}^{N} \hat{L}_{11i}^{-1} \hat{L}_{22i}^{-1} \left(\sum_{t=1}^{T} (x_{it} - \bar{x}_i) \mu^*_{it} - T\hat{\gamma}_i \right) \tag{10}$$

$\hat{L}_i$ is expressed as a lower triangular decomposition of the asymptotic covariance estimate $\hat{\Omega}_i$ and x_i represents the independent variable. Calculations of μ^*_{it} and $\hat{\gamma}_i$ in Eq. (10) are shown in Eq. (11). $\hat{\beta}^*_{NT}$ converges to the true value at the rate of $T\sqrt{N}$:

$$\mu^*_{it} = \mu_{it} - \frac{\hat{L}_{21i}}{\hat{L}_{22i}} \Delta x_{it} \; and \; \hat{\gamma}_i \equiv \hat{\Gamma}_{21i} + \hat{\Omega}^o_{21i} - \frac{\hat{L}_{21i}}{\hat{L}_{22i}} \left(\hat{\Gamma}_{22i} + \hat{\Omega}^o_{22i} \right) \tag{11}$$

$\hat{\Gamma}_i$ where a represent a weighted sum of autocovariances estimates and $\hat{\Omega}^o_i$ represents the contemporaneous covariance estimate (Pedroni, 2000: 99).

5. Empirical Findings

Cross-section dependency and homogeneity are particularly crucial factors in panel data analysis. There may be increases in CO_2 emissions in neighbouring countries depending on the increase in CO_2 emissions in a given country, and this, in turn, may cause cross-section dependency. Slope homogeneity may be a result of country-specific characteristics. Therefore, it is highly likely that misleading results will be obtained from estimation techniques that ignore homogeneity and cross-sectional dependence.

Table 1: Results of The Slope Homogeneity Test.

	Δ	Δ_{adj}
Developed Countries	13.127* (0.000)	14.238* (0.000)
Developing Countries	27.206* (0.000)	29.509* (0.000)

* Is statistically significant at 1%. Values in parentheses are p values.

Table 2: Results of The Cross-sectional Dependence Test.

	Developed Country		Developing Country	
	$LNCO_2$	LNFD	$LNCO_2$	LNFD
CD Test	28.06* (0.000)	11.00* (0.000)	18.88* (0.000)	17.53* (0.000)

* Is statistically significant at 1%. Values in parentheses are p values.

Table 3: Results of The Panel Unit Root Test.

Variable	Level		First Difference		Order of Integration
	Constant	Constant and Trend	Constant	Constant and Trend	
Developed					
$LNCO_2$	-0.677 (0.249)	-0.926 (0.177)	-10.806* (0.000)	-8.141* (0.000)	I(I)
LNFD	3.690 (1.000)	0.317 (0.625)	-7.383* (0.000)	-5.775* (0.000)	I(I)
Developing					
$LNCO_2$	-0.987 (0.162)	1.314 (0.906)	-7.881* (0.000)	-6.586* (0.000)	I(I)
LNFD	-0.051 (0.480)	-0.727 (0.204)	-7.541* (0.000)	-5.809* (0.000)	I(I)

* Is statistically significant at 1%. Values in parentheses are p values.

According to the Westerlund (2007) test results shown in Table 4, the null hypothesis of no cointegration for developed countries was rejected at the level of 1% according to Gt statistics and at the level of 10% according to the Pt statistics. The null hypothesis of no cointegration was rejected at the 5% level according to the Pt statistics for developing countries. Therefore, there is evidence for the existence of a long-term relationship between the variables.

Table 4: Results of The Panel Cointegration Test

Developed	Value	Z-value	P-value
G_t	-3.240	-7.808	0.000
G_a	-1.776	4.727	1.000
P_t	-8.541	-1.608	0.054
P_a	-2.972	1.359	0.913
Developing			
G_t	-1.452	1.663	0.952
G_a	-2.456	3.945	1.000
P_t	-8.317	-1.693	0.045
P_a	-4.744	-0.531	0.298

Statistics are performed for the fixed model. AIC max lag length: 3, AIC max lead length: 2 and lrwindow: 3.

The pooled DOLS and FMOLS results used to estimate the long-term coefficients due to cointegration are shown in Table 5. The results of the DOLS estimator showed that financial development has a significant positive effect on CO_2 emissions at the 1% significance level for developed and developing countries. A one-unit increase in financial development causes an increase of approximately 2.06% in CO_2 emissions in developed countries and an increase of approximately 0.65% in developing countries in the long run. In addition, the adjusted R square values were quite high, calculated as 75% and 81% for developed and developing countries, respectively. The results for the FMOLS estimator were not statistically significant for developed countries. However, FMOLS results did not differ much from DOLS results for developing countries. Both the DOLS estimator giving better results for panels with small sample characteristics and the high R square values for DOLS estimation suggested that the results obtained from the DOLS estimator were found to be reliable. The countries included in the study are very diverse. Herrerias et. al. (2013: 1485) stated that in such a case, the DOLS model overcomes the difficulties by allowing for heterogeneity. It is also reported that the DOLS estimator is the best estimator in the case of cross-sectional dependence (Herrerias et. al., 2013: 1488). Finally, the results of the individual DOLS estimation were included in the study, aiming to reveal any difference between the countries.

Table 5: Results of Pooled DOLS and FMOLS Tests.

	DOLS			**FMOLS**		
	Coef.	**Rescaled S.E.**	**z-value**	**Coef.**	**Rescaled S.E.**	**z-value**
Developed FD	2.056326*	0.3879706	5.30	0.2159256	0.3531586	0.61
Constant	9.681878*	1.947511	4.97	18.89626*	1.764318	10.71
R^2	0.8853			0.0240		
Adj. R^2	0.7516			0.0333		
Developing FD	0.6465936*	0.0698997	9.25	0.7530455*	0.1497784	5.03
Constant	17.28198*	0.2892078	59.76	16.83351*	0.616583	27.30
R^2	0.9127			0.6415		
Adj. R^2	0.8110			0.6205		

* Is statistically significant at 1%. Lag length is selected as 3 and lead length is selected as 2. Westerlund (2007) refers to the model chosen after the cointegration test. Bartlett Kernel, Newey-West fixed bandwidth was used for coefficient covariance.

According to the results shown in Table 6 regarding the individual DOLS estimation, FD negatively affects CO_2 emissions in approximately 55% and 24% of developed and developing countries, respectively. The reason for the high positive effect in the pooled DOLS results may be that the increasing effect of FD on CO_2 emissions is quite high in Belgium, Denmark, South Korea, and the United States (even greater than in developing countries).

Table 6: Result of The Individual DOLS Parameter Estimates

Developed Country		Developing Country	
Country	**Coef.**	**Country**	**Coef.**
Australia	0.13*	UAE	0.78*
Austria	-2.19*	Brazil	0.38*
Belgium	1.60*	Chile	1.44*
Germany	0.37*	China	0.76*
Denmark	2.45*	Colombia	0.77*
Spain	-0.52*	Czechia	-0.61*
Finland	0.59*	Egypt	-0.52*
France	-1.26*	Greece	-0.15*
Hong Kong	0.01	Hungary	0.41*
Ireland	-0.08***	Indonesia	1.49*
Israel	-1.12**	India	0.05
Italy	-0.58*	Iceland	0.16*
Japan	-0.15***	Mexico	0.04
South Korea	1.49*	Malaysia	1.63*
Netherlands	-2.29*	Pakistan	-0.97*
Norway	0.16*	Philippines	0.90*
New Zealand	0.55*	Qatar	1.19*
Poland	-0.19***	Romania	-0.74*
Portugal	-0.06	Thailand	1.03*
Singapore	-1.34*	Turkiye	0.18*
Sweden	-0.87*	South Africa	0.65*
United States	1.89*		

*, **, and *** are statistically significant at 1%, 5%, and 10%, respectively.

When similar studies in which DCPSB was used to represent FD are evaluated, empirical findings seem to support studies having found that FD increases CO_2 emissions, carried out by Maji et. al. (2017) on data from Malaysia; Samour et. al. (2019) on data from Turkiye; Faisal et. al. (2020) on data from Brazil, China, and South Africa; Samour et. al. (2022) on data from South Africa; and Majumdar & Paris (2022) on data from United Arab Emirates. In addition, the findings of the present study are in line with Neog & Yadava's (2020) results, which revealed that FD has no statistically significant effect on CO_2 emissions, based on data from India.

The results are extended for the results of studies using DCPS to represent FD. Accordingly, the findings of this study support the finding that FD increases CO_2 emissions in the case of the United Arab Emirates, Turkiye, and South Africa (Omri, 2013; Çetin et. al., 2018; Adebayo & Odugbesan, 2021). The findings of this study are also in line with the study done by Abbasi & Riaz (2016), which revealed that FD decreased CO_2 emissions in Pakistan. Finally, our findings support the results of Park et. al. (2018), which showed that FD increased CO_2 emissions in Hungary and reduced CO_2 emissions in Czechia, Finland, and Greece.

6. Conclusion and Policy Implication

The present study aimed to determine the relationship between CO_2 emission and FD in 22 developed and 21 developing countries between the years 2001 and 2020. Slope homogeneity and cross-section dependence are particularly important in order not to cause false inferences for panel data models. In this study, the CD test was used to evaluate the cross-section dependence, and the delta tests were used to assess the slope homogeneity. Due to the slope heterogeneity of the series in question and the presence of cross-section dependence in the dataset, the CIPS test was used to identify the order of integration. The unit root test results showed that the integration order of the series is first differences for all models. Westerlund (2007) cointegration tests were used to investigate if there existed a cointegration relationship after the calculations on data characteristics. Having revealed the existence of a long-term relationship between the series, DOLS and FMOLS methods were used for long-term coefficient estimations.

FMOLS and DOLS suggested a positive effect of FD on CO_2 emissions. Since statistically more significant results were obtained, individual statistics on the DOLS estimator were examined. As a result, it was revealed that FD reduced CO_2 emissions in approximately 55% of developed countries and approximately 24% of developing countries, which revealed that FD can contribute to reducing CO_2 emissions. However, it was also found that FD significantly increases CO_2 emissions in some developed countries, namely Belgium, Denmark, South Korea, and the United States. Moreover, these effects were found to be even greater than in developing countries. In this respect, the validity of the EKC hypothesis may be deemed doubtful.

The findings of this study highlight the importance of the efficient use of FD in reducing CO_2 emissions. Governments of countries where FD serves to increase CO_2 emissions should work on incentive policies to convert bank credits into renewable investments. In addition, credit to the private sector businesses that may pollute the environment should be kept limited or tied to strict rules. Achieving this may help to decrease the costs of companies and CO_2 emissions in the long run and accelerate economic growth.

Lastly, the scope of this study may be extended by using different FD indicators. In addition, the effect of FD on CO_2 emissions may be determined individually for each sector and problematic sectors can be identified.

Conflict of Interest
The author declare that there is no conflict of interest.

Funding Statement
The author did not receive support from any organization for the submitted work.

Data Availability Statement
The data used in this study are available from Ourworldindata and the World Bank.

Compliance of Ethical Standard Statement
The research complies with the required ethical standards.

Contribution Statement of Researchers
The study has a single author. Therefore, the author’s contribution rate is 100%.

References

Abbasi, F., & Riaz, K. (2016). CO_2 emissions and financial development in an emerging economy: An augmented VAR approach. *Energy Policy,* 90, 102-114. https://doi.org/10.1016/j.enpol.2015.12.017

Acheampong, A. O. (2019). Modeling for insight: Does financial development improve environmental quality? *Energy Economics,* 83, 156-179. https://doi.org/10.1016/j.eneco.2019.06.025

Adebayo, T. S., & Odugbesan, J. A. (2021). Modeling CO_2 emissions in South Africa: Empirical evidence from ARDL based bounds and wavelet coherence techniques. *Environmental Science and Pollution Research,* 28, 9377–9389. https://doi.org/10.1007/s11356-020-11442-3

Ahmad, M., Khan, Z., Rahman, Z. U., & Khan, S. (2018). Does financial development asymmetrically affect CO_2 emissions in China? An application of the nonlinear autoregressive distributed lag (NARDL) model. *Carbon Management*, 9(6), 631-644. https://doi.org/10.1080/17583004.2018.1529998

Ang, G., Röttgers, D., & Burli, P. (2017). The empirics of enabling investment and innovation in renewable energy. *OECD Environment Working Papers*, No. 123, OECD Publishing, Paris. https://doi.org/10.1787/67d221b8-en

Anser, M. K., Yousaf, Z., Zaman, K., Nassani, A. A., Alotaibi, S. M., Jambari, H. & Kabbani, A. (2020). Determination of resource curse hypothesis in mediation of financial development and clean energy sources: Go-for-green resource policies. *Resources Policy,* 66, 1-14. https://doi.org/10.1016/j.resourpol.2020.101640

Begum, H., & Aziz, S. I. (2019). Impact of domestic credit to private sector on gross domestic product in Bangladesh. *IOSR Journal of Economics and Finance*, 10(1), 45-54. doi: 10.9790/5933-1001014554

Betzold, C. (2016). Fuelling the Pacific: Aid for renewable energy across Pacific Island countries. *Renewable and Sustainable Energy Reviews,* 58, 311-318. https://doi.org/10.1016/j.rser.2015.12.156

Bist, J. P. (2018). Financial development and economic growth: Evidence from a panel of 16 African and non-African low-income countries. *Cogent Economics & Finance,* 6, 1-17. https://doi.org/10.1080/23322039.2018.1449780

Boutabba, M. A. (2014). The impact of financial development, income, energy and trade on carbon emissions: Evidence from the Indian economy. *Economic Modelling,* 40, 33-41. https://doi.org/10.1016/j.econmod.2014.03.005

Charfeddine, L., & Kahia, M. (2019). Impact of renewable energy consumption and financial development on CO_2 emissions and economic growth in the MENA region: A panel vector autoregressive (PVAR) analysis. *Renewable Energy,* 139, 198-213. https://doi.org/10.1016/j.renene.2019.01.010

Cheng, C., Ren, X., Wang, Z., & Yan, C. (2019). Heterogeneous impacts of renewable energy and environmental patents on CO_2 emission - Evidence from the BRIICS. *Science of the Total Environment,* 668, 1328-1338. https://doi.org/10.1016/j.scitotenv.2019.02.063

Çetin, M., Ecevit, E., & Yücel, A. G. (2018). The impact of economic growth, energy consumption, trade openness, and financial development on carbon emissions: Empirical evidence from Turkey. *Environmental Science and Pollution Research,* (25), 36589–36603. https://doi.org/10.1007/s11356-018-3526-5

Dar, J. A., & Asif, M. (2018). Does financial development improve environmental quality in Turkey? An application of endogenous structural breaks based cointegration approach. *Management of Environmental Quality: An International Journal*, 29(2), 368-384. https://doi.org/10.1108/MEQ-02-2017-0021

Dogan, E., & Seker, F. (2016). Determinants of CO_2 emissions in the European Union: The role of renewable and non-renewable energy. *Renewable Energy,* 94, 429-439. https://doi.org/10.1016/j.renene.2016.03.078

Du, Q., Zhou, J., Pan, T., Sun, Q., & Wu, M. (2019). Relationship of carbon emissions and economic growth in China's construction industry. *Journal of Cleaner Production,* 220, 99-109. https://doi.org/10.1016/j.jclepro.2019.02.123

Ehigiamusoe, K. U., & Lean, H. H. (2019). Effects of energy consumption, economic growth, and financial development on carbon emissions: Evidence from heterogeneous income groups. *Environmental Science and Pollution Research,* 26, 22611–22624. https://doi.org/10.1007/s11356-019-05309-5

Fadly, D. (2019). Low-carbon transition: Private sector investment in renewable energy projects in developing countries. *World Development,* 122, 552-569. https://doi.org/10.1016/j.worlddev.2019.06.015

Faisal, F., Azizullah, Tursoy, T., & Pervaiz, R. (2020). Does ICT lessen CO_2 emissions for fast-emerging economies? An application of the heterogeneous panel estimations. *Environmental Science and Pollution Research,* 27, 10778–10789. https://doi.org/10.1007/s11356-019-07582-w

FTSE Russell (Sep. 2022). FTSE Classification of Equity Markets [Annual Announcement]. Available online: https://research.ftserussell.com/products/downloads/FTSE-Country-Classification-Update_latest.pdf

Ganda, F. (2019). The environmental impacts of financial development in OECD countries: A panel GMM approach. *Environmental Science and Pollution Research,* 26, 6758–6772. https://doi.org/10.1007/s11356-019-04143-z

Gök, A. (2020). The role of financial development on carbon emissions: A meta regression analysis. *Environmental Science and Pollution Research,* 27, 11618–11636. https://doi.org/10.1007/s11356-020-07641-7

Grossman, G. M., & Krueger, A. B. (1995). Economic growth and the environment. *The Quarterly Journal of Economics*, 110(2), 353-377. https://doi.org/10.2307/2118443

Guru, B. K., & Yadav, I. S. (2019). Financial development and economic growth: Panel evidence from BRICS. *Journal of Economics, Finance and Administrative Science,* 24(47), 113-126. https://doi.org/10.1108/JEFAS-12-2017-0125

Herrerias, M. J., Joyeux, R. & Girardin, E. (2013). Short-and long-run causality between energy consumption and economic growth: Evidence across regions in China. *Appl. Energy,* 112, 1483-1492. https://doi.org/10.1016/j.apenergy.2013.04.054

International Finance Corporation (IFC). 2013. *Mobilizing Public and Private Funds for Inclusive Green Growth Investment in Developing Countries,* A Stocktaking Report Prepared for the G20 Development Working Group. Washington, DC 20433.

Jalil, A., & Feridun, M. (2011). The impact of growth, energy and financial development on the environment in China: *A cointegration analysis*. *Energy Economics*, 33(2), 284-291. https://doi.org/10.1016/j.eneco.2010.10.003

Kim, D. H., Wu, Y. C., & Lin, S. C. (2020). Carbon dioxide emissions and the finance curse. *Energy Economics,* 88, 1-16. https://doi.org/10.1016/j.eneco.2020.104788

Lahiani, A. (2020). Is financial development good for the environment? An asymmetric analysis with CO_2 emissions in China. *Environmental Science and Pollution Research,* 27, 7901–7909. https://doi.org/10.1007/s11356-019-07467-y

Levine, L. (1997). Financial development and economic growth: Views and agenda. *Journal of Economic Literature,* 35(2), 688-726. Available at https://www.jstor.org/stable/2729790

Li, F., Zhang, J., & Li, X. (2022). Research on supporting developing countries to achieve green development transition: Based on the perspective of renewable energy and foreign direct investment. *Journal of Cleaner Production,* 372, 1-17. https://doi.org/10.1016/j.jclepro.2022.133726

Liu, H., Wong, W.-K., Cong, P. T., Nassani, A. A., Haffar, M., & Abu-Rumman, A. (2022). Linkage among urbanization, energy consumption, economic growth and carbon emissions. Panel data analysis for China using ARDL model. *Fuel,* 332, 1-7. https://doi.org/10.1016/j.fuel.2022.126122

Lv, Z., & Li, S. (2021). How financial development affects CO_2 emissions: A spatial econometric analysis. *Journal of Environmental Management,* 277, 1-10. https://doi.org/10.1016/j.jenvman.2020.111397

Maji, I. K., Habibullah, M. S., & Saarİ, M. Y. (2017). Financial development and sectoral CO_2 emissions in Malaysia. *Environmental Science and Pollution Research,* 24, 7160-7176. https://doi.org/10.1007/s11356-016-8326-1

Majumdar, S., & Paris, C. M. (2022). Environmental impact of urbanization, bank credits, and energy use in the UAE—A tourism-induced EKC model. *Sustainability,* 14, 1-14. https://doi.org/10.3390/su14137834

Matthaus, D., & Mehling, M. (2020). De-risking renewable energy investments in developing countries: A multilateral guarantee mechanism. *Joule*, 4(12), 2627-2645. https://doi.org/10.1016/j.joule.2020.10.011

Mrabet, Z., & Alsamara, M. (2017). Testing the Kuznets Curve hypothesis for Qatar: A comparison between carbon dioxide and ecological footprint. *Renewable and Sustainable Energy Reviews,* 70, 1366-1375. https://doi.org/10.1016/j.rser.2016.12.039

Muftau, O., Iyoboyi, M., & Ademola, A. S. (2014). An empirical analysis of the relationship between CO_2 emission and economic growth in West Africa. *American Journal of Economics*, 4(1), 1-17. https://doi.org/10.5923/j.economics.20140401.01

Neog, Y., & Yadava, A. K. (2020). Nexus among CO_2 emissions, remittances, and financial development: A NARDL approach for India. *Environmental Science and Pollution Research,* 27, 44470–44481. https://doi.org/10.1007/s11356-020-10198-0

Nwani, C., & Omoke, P. C. (2020). Does bank credit to the private sector promote low-carbon development in Brazil? An extended STIRPAT analysis using dynamic ARDL simulations. *Environmental Science and Pollution Research,* 27, 31408–31426. https://doi.org/10.1007/s11356-020-09415-7

Nyambuu, U., & Semmler, W. (2020). Climate change and the transition to a low carbon economy – Carbon targets and the carbon budget. *Economic Modelling,* 84, 367-376. https://doi.org/10.1016/j.econmod.2019.04.026

Obiora, S. C., Bamisile, O., Opoku-Mensah, E., & Frimpong, A. N. (2020). Impact of banking and financial systems on environmental sustainability: An overarching study of developing, emerging, and developed economies. *Sustainability*, 12(19), 1-21. https://doi.org/10.3390/su12198074

Omri, A. (2013). CO_2 emissions, energy consumption and economic growth nexus in MENA countries: Evidence from simultaneous equations models. *Energy Economics,* 40, 667-664. https://doi.org/10.1016/j.eneco.2013.09.003

Our World in Data. (n.d.). *CO_2 emissions* [data]. Retrieved 10.02.2022 from https://ourworldindata.org/co2-emissions

Öztürk, İ., & Acaravci, A. (2013). The long-run and causal analysis of energy, growth, openness and financial development on carbon emissions in Turkey. *Energy Economics,* 36, 262-267. https://doi.org/10.1016/j.eneco.2012.08.025

Park, Y., Meng, F., & Baloch, M. A. (2018). The effect of ICT, financial development, growth, and trade openness on CO_2 emissions: An empirical analysis. *Environmental Science and Pollution Research,* 25, 30708–30719. https://doi.org/10.1007/s11356-018-3108-6

Pedroni, P. (2001). "Fully modified OLS for heterogeneous cointegrated panels", Baltagi, B.H., Fomby, T.B. and Carter Hill, R. (Ed.) *Nonstationary Panels, Panel Cointegration, and Dynamic Panels (Advances in Econometrics, Vol. 15)*, Emerald Group Publishing Limited, Bingley, pp. 93-130. https://doi.org/10.1016/S0731-9053(00)15004-2

Pesaran, M. H. (2004). General diagnostic tests for cross-sectional dependence in panels. *Cesifo Working Paper* 1229, 1-39. Retrieved from www.cesifo.org/. Accessed 11.02.2022.

Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross-section dependence, *Journal of Applied Econometrics,* 22, 265-312. https://doi.org/10.1002/jae.951

Pesaran, M. H. & Yamagata, T. (2008). Testing slope homogeneity in large panels, *Journal of Econometrics,* 142(1), 50-93. https://doi.org/10.1016/j.jeconom.2007.05.010

Saidi, K., & Hammami, S. (2015). The impact of CO_2 emissions and economic growth on energy consumption in 58 countries. *Energy Reports,* 1, 62-70. https://doi.org/10.1016/j.egyr.2015.01.003

Samour, A., Isiksal, A. Z., & Resatoglu, N. G. (2019). Testing the impact of banking sector development on Turkey's CO_2 emissions. *Applied Ecology and Environmental Research,* 17(3), 6497-6513. https://doi.org/10.15666/aeer/1703_64976513

Samour, A., Moyo, D., & Tursoy, T. (2022). Renewable energy, banking sector development, and carbon dioxide emissions nexus: A path toward sustainable development in South Africa. *Renewable Energy,* 193, 1032-1040. https://doi.org/10.1016/j.renene.2022.05.013

Senshaw, D. A., & Kim, J. W. (2018). Meeting conditional targets in nationally determined contributions of developing countries: Renewable energy targets and required investment of GGGI member and partner countries. *Energy Policy,* 116, 433-443. https://doi.org/10.1016/j.enpol.2018.02.017

Shahbaz, M., Ilarslan, K., Yıldız, M., & Vo, X. V. (2022). Investigation of economic and financial determinants of carbon emissions by panel quantile regression analysis: The case of Visegrád countries. *Environmental Science and Pollution Research,* 29, 60777–60791. https://doi.org/10.1007/s11356-022-20122-3

Shahbaz, M., Uddin, G. S., Rehman, I. U., & Imran, K. (2014). Industrialization, electricity consumption and CO_2 emissions in Bangladesh. *Renewable and Sustainable Energy Reviews,* 31, 575-586. https://doi.org/10.1016/j.rser.2013.12.028

Stock, J. H. & Watson, M. (1993). A simple estimator of cointegrating vectors in higher order integrated systems, *Econometrica,* 61, 783–820. https://doi.org/10.2307/2951763

Sugiawan, Y., Kurniawan, R., & Managi, S. (2019). Are carbon dioxide emission reductions compatible with sustainable well-being? *Applied Energy,* 242, 1-11. https://doi.org/10.1016/j.apenergy.2019.03.113

Tsaurai, K. (2019). The impact of financial development on carbon emissions in Africa. *International Journal of Energy Economics and Policy*, 9(3), 144-153. https://doi.org/10.32479/ijeep.7073

Westerlund, J. (2007). Testing for error correction in panel data. *Oxford Bulletin of Economics and Statistics*, 69(6), 709-748. https://doi.org/10.1111/j.1468-0084.2007.00477.x

World Bank (n. d.). Domestic credit to private sector by banks (% of GDP) [data]. Retrieved from https://data.worldbank.org/. Accessed 10.02.2022.

Xiumei, S., Min, Z., & Ming, Z. (2011). Empirical study on the relationship between economic growth and carbon emissions in resource-dependent cities based on vector autoregression model. *Energy Procedia,* 5, 2461-2467. https://doi.org/10.1016/j.egypro.2011.03.423

Xu, B., Li, S., Afzal, A., Mirza, N., & Zhang, M. (2022). The impact of financial development on environmental sustainability: A European perspective. *Resources Policy,* 78, 1-8. https://doi.org/10.1016/j.resourpol.2022.102814

Yang, B., Ali, M., Nazir, M. R., Ullah, W., & Qayyum, M. (2020). Financial instability and CO_2 emissions: Cross-country evidence. *Air Quality, Atmosphere & Health,* 13, 459-468. https://doi.org/10.1007/s11869-020-00809-7