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The foreign direct investments, carbon (CO_2) emissions, and economic growth nexus: an empirical analysis for Turkey and European Union countries

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Abstract

Purpose - This study aims to investigate the empirical relationship between foreign direct investment, carbon emissions, and economic growth. Our study attempts to contribute to the existing literature on sustainable economic development.
Methodology -The analysis was carried out using panel data analysis, covering Turkey and the 27 countries of the European Union from 2010 to 2020. Statistical data were obtained from the World Data Bank and the OECD Data Bank.
Results - Hausman test analysis indicated that a fixed effects model should be selected. The model results show that foreign direct investment significantly affects economic growth, but carbon (CO_2) emissions are also in a positive relationship. Foreign investment should be developed due to its impact on economic growth. However, the effects of CO2 emissions should be limited, as it causes negative social and environmental externalities.
Practical implications - with the development of foreign investment, appropriate environmental policies should be implemented by all countries in global cooperation. The article proposes some development policy solutions. These include, among others, promoting foreign direct investments that lead to more effective implementation of sustainable development goals and introducing market-based financial instruments to support such investments.
Originality and value - the study covers not only EU countries but also Turkey; It uses statistical modeling based on ten years of data for 28 countries. Results can be used in sustainable development policies.

Keywords: Foreign Direct Investments, Carbon (CO_2) Emission, Economic Growth, Panel Data Analysis, EU Countries, Turkey

1 Introduction

As a result of the globalization of the economy, multinational companies have gained the ability to shift their investment and production activities across borders through foreign direct investment (FDI). With the increase in the cross-border mobility of capital, foreign direct investments have a significant effect on the economic, social, and environmental indicators of the countries they enter (Wang et al. 2023; Hao 2023; Liu et al. 2017). The globalization of production is an essential dimension of the globalization of the economy. Foreign direct investment is a phenomenon that reflects the globalization of production. Two other crucial dimensions of the globalization of the economy are financial globalization and globalization of trade. Above all, foreign direct

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investments bring along the increase in production and economic growth in the countries they are directed to. From this point of view, foreign direct investment can provide positive macroeconomic improvements by providing income and employment increases in the host country (Hao, 2023). However, foreign direct investments made by enterprises operating in energy-intensive and polluting sectors cause increased carbon emission releases in the host country they enter. FDI has been identified as a channel through which CO_2 emissions can be transferred to host countries due to the relocation of polluting industries (Demena, Afesorgbor, 2020). The carbon emissions of multinational enterprises through FDI can shift the emissions burden and threaten climate change mitigation targets (Ma et al. 2023). This situation triggers negative environmental consequences, not only at the local level but also on a global scale.

Foreign direct investment, one of the dynamics important for realizing economic growth targets, is seen as one of the most prominent areas of competition among developing countries, especially those with capital shortage problems (Benli, 2020). By intensifying market competition, FDI in services effectively improves the availability, quality, and efficiency of services, significantly reducing the cost of remote transactions and coordination for manufacturing companies (Wang & Liu, 2023).

When the savings level falls below the investment level in a country, financing of this savings gap is needed. Short-term capital inflows, made mainly by portfolio investors, may adversely affect financial stability when a liquidity crisis occurs in developing countries. In this context, foreign direct investment is seen as a more preferred and stable source of financing the domestic savings gap. For this reason, attracting foreign direct investments into the country has become an essential goal for developing countries. Foreign direct investments are assumed to increase labor productivity and bring new technologies (Cambazoğlu and Güneş, 2016). Studies and evidence show that technology transfer by foreign direct investment positively affects economic growth and productivity increase in host countries (Kurtishi-Kastrati, 2013; Osano & Koine, 2016; Gherbi &Voytovych, 2018).

On the other hand, foreign direct investments positively influenced human development in developing countries. FDI provides employment opportunities to the host country's people and brings technology and new skills to the countries they head towards (Djokoto & Wongnaa, 2023; Armeanu, Vintil_a, & Gherghina, 2018).

The effects of foreign direct investment on employment occur in two ways: direct and indirect. In countries where capital is scarce, and labor is abundant, creating employment opportunities directly or indirectly is seen as one of the most prominent effects of foreign direct investment. The immediate effects occur when foreign multinational companies employ nationals of the host country they enter. Indirect effects are the employment potential created by local suppliers. The increase in employment caused by the increase in local expenditures by the employees of the multinational company is another indirect employment effect (Kurtishi-Kastrati, 2013). It is stated that foreign direct investments are of importance for economies with less financial markets. Because of trade liberalization, foreign direct investment inflow positively impacts developing countries' growth (Khan et al., 2022). Besides these benefits, it is seen that foreign direct investments and economic growth affect the amount of carbon emissions, which is directly related to global environmental problems such as global warming and climate crisis.

This study aims to investigate the empirical relationship between foreign direct investment, carbon (CO_2) emissions, and economic growth of Turkey and 27 EU countries between 2010-2020 with panel data analysis. The paper is structured as follows: Section Two reviews the related literature in the field; Section Three presents the data and methodology applied to the intended research; Section Four presents the data and results obtained; and Section Five, the final part of the article, highlights the conclusions obtained from the paper and provides policy recommendations.

2 Literature review

Exploring the theoretical mechanism of the relationship between FDI and economic growth has been the focus of scholars' attention. Studies conducted in various world regions using multiple methods have confirmed that economic growth is linked to increased CO_2 emissions. Khobai and Sithole (2022) investigated the connection between carbon emissions and economic development in South Africa, including the period between 1984 and 2018. In the study, the ARDL bounds technique was employed to determine the long-run connection among the variables, and the VECM was used to determine the direction of causality among variables. The results established a long relationship between carbon emission, economic growth, energy consumption, foreign direct investment, and trade openness in South Africa. The Vector Error Correction Model (VECM) proposed that bidirectional causality flows between economic growth and carbon emissions. The findings also confirmed the Environmental Kuznets Curve (EKC) hypothesis both in the long and short run (Khobai & Sithole, 2022).

Cederborg and Snöbohm (2016) researched the connection between per capita GDP and per capita emissions of greenhouse gas carbon dioxide (CO_2) to observe the possible impact of economic growth on environmental

degradation for 69 industrial countries and 45 poor countries by using cross-sectional data. The empirical finding of the cross-sectional study implies a connection between per capita GDP and per capita carbon dioxide emissions. A positive correlation suggests that growing per capita GDP causes carbon dioxide emissions to increase (Cederborg &Snöbohm, 2016).

Alaganthiran and Anaba (2022) examined the impacts of economic growth on carbon dioxide emissions in 20 selected Sub-Saharan African (SSA) countries. The empirical research applied a panel linear regression model for the data obtained in 20 SSA countries for 2000 and 2020. The results indicated that a 1 % increase in economic growth increases the carbon dioxide emission level by roughly 0.02% (Alaganthiran & Anaba, 2022).

Lacheheb et al. (2015) investigated the existence of the Environmental Kuznets Curve (EKC) hypothesis between economic growth and carbon dioxide (CO_2) emission in Algeria for the period 1971-2009 by using an autoregressive distributed lag-co integration framework. Findings obtained from the study indicated that the environmental Kuznets Curve hypothesis doesn't exist. (Lacheheb et.al., 2015).

Rahaman et. al. (2022) examined the effect of foreign direct investment (FDI), tourism, electricity consumption, and economic development on CO_2 emissions in Bangladesh from 1990-2019. Empirical findings from the study indicated that FDI, electricity consumption, and economic development variables have essential and positive long-term impacts on CO_2 emissions. The study results showed that the Environmental Kuznets Curve exists between economic development and carbon emissions in Bangladesh. Carbon emissions increase due to electricity consumption. As policy recommendations in the study, it was suggested that renewable energy production should be raised with a long-term energy plan to reduce CO_2 emissions. Clean energy investments should be given importance. On the other hand, environmental regulations for polluting businesses should be enacted (Rahaman et al., 2022).

Njoke et. al. (2019) investigated the connection between electricity consumption, carbon emissions, and economic growth in Cameroon between 1971-2014. Findings from the autoregressive distributed lag bounds test validate a positive and vital short-run and long-run connection between CO_2 emissions and economic growth (Njoke et. al., 2019).

Kim and Seok (2023) examined the connection between foreign direct investment (FDI) inflows and CO_2 emissions in Korea, applying the autoregressive distributed lag model. Specifically, the effect of FDI on CO_2 emissions based on Korea's economic growth level was tested using yearly data from 1971 to 2015. The results obtained from the study indicated that, in the long run, FDI inflows positively affect CO_2 emissions (Kim & Seok, 2023).

Joint research on this relationship shows a significant positive impact on carbon emissions when GDP is low, consistent with a wide range of today's low-income economies. However, when GDP per capita exceeds a certain level, this positive impact almost disappears (Wang et al., 2023).

3 Methodology

When we look at econometric studies, we can see that many studies were examined using a panel data set. The most significant advantage of using a panel data set is that it is possible to explore the relationship between variables using horizontal and time section data. In panel data models, the number of observations increases due to the coexistence of time series and cross-section data. It should also be noted that it causes an increase in the degree of freedom and decreases the probability of finding a highly linear relationship between the explanatory variables.

3.1 Panel Data Models

It should be emphasized that the panel data model has advantages, unlike regression models such as cross-section and time series. While studies with cross-sectional data reveal only differences between units, studies using panel data reveal both differences between teams and examine changes in a unit over time (Baltagi, 2001). Panel data analysis also allows for building and testing more complex models than cross-sections or time series. Thanks to this superiority of panel data analysis, excluded variables that cause significant deviations in the estimation results obtained from studies using only time series or cross-section data are no longer a problem. Thus, each result obtained by panel data analysis provides more realistic, precise, and comprehensive estimates. The other essential and most significant benefit of this analysis method is that it also enables the effects of factors that cannot be observed, clearly measured, or expressed numerically (Hsiao, 2003).

The panel data model has two basic approaches: the fixed and random effects models. In general, the panel data model with 'K' variables is generally shown as follows:

$$y_{it} = \beta_{1it} + \beta_{2it} X_{2it} + ... + \beta_{Kit} X_{Kit} + \varepsilon_{it} \quad (1)$$

Here, the mean of the non-probabilistic error term ε is assumed to be zero, and with constant variance, $t=1,...,T$ time and $i= 1,..., N$ show cross-section units.

In this situation:

y_{it} : The value of the dependent variable at time t of the ith cross-section unit,

X_{Kit} : Kth explanatory variable value at time t of the ith cross section unit,

β_{Kit} : Shows the estimated coefficient of the Kth explanatory variable for the ith unit and tth period (Baltagi, 2001: 11).

In panel data analysis, the coefficients between β_{2it} and β_{Kit} in a model in (1) take different values for different units at different periods. For this reason, while estimating the model, various assumptions are made about the model's constant term, error term, and slope coefficients, and different models can be calculated depending on these.

3.2 Fixed Effects Model

While one of the models estimated in panel data analysis is the fixed effects model, the other is the random effects model.

The fixed effects model, one of the panel data models, is one in which the slope coefficients are the same for cross-section and time units, but the fixed coefficient changes according to the cross-section unit (Green, 1993: 466). In the fixed effects model, the differences between the cross-section units are explained by the differences in the fixed term. In the fixed effects model, the panel data model is estimated with the help of a dummy variable. For this reason, the fixed effects model is also called the dummy variable model. While equation (1) is in question in the panel data model, it is assumed that $\beta_{2it} = \beta_2$, $\beta_{3it} = \beta_3$ in the fixed effects model. In this case, the equation can be made as follows:

$$y_{it} = \beta_{1it} + \beta_{2it} X_{2it} + \beta_{3it} X_{3it} + \ldots + \beta_{kit} X_{Kit} + u_{it} \quad (2)$$

In studies with panel data, it is seen that the fixed effects model and the random effects model are used.

3.3 Random Effects Model

In the random effects model, unlike the fixed effects model, the differences in the cross-section units are assumed to be lucky, like the error term (Greene, 1993). These models include changes in cross-section units or concerning time and teams as a component of the error term. The most important reason for this is to prevent the loss of degrees of freedom encountered in the fixed effects model because the important thing in the random effects model is not the unit or unit and time specific coefficients, but the unit or unit and time specific error components. The general representation of random effects models is as follows since the error term used in random effects models includes the value of "μ_i" unlike those in fixed effects models:

$$Y_{it} = \alpha + \beta_{1it} X_{1it} + \beta_{2it} X_{2it} + \ldots . + \beta_{kit} X_{kit} + (v_{it} + \mu_i) \quad (3)$$

4 Application

This study aims to investigate the relationship between foreign direct investments, carbon (CO2) emissions, and economic growth variables. The scope of the survey is Turkey and European Union (EU) countries such as Germany, Austria, Belgium, Bulgaria, Czech Republic, Denmark, Estonia, Finland, France, Croatia, Netherlands, Ireland, Spain, Sweden, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Malta, Poland, Portugal, Romania, Slovakia, Slovenia and Greece. The period of the study is between 2010-2020. There are 308 data for each variable, 28 countries in the horizontal section of the prepared panel data set and 11 years in the time section. To use reliable and up-to-date data in the study, the time frame was limited to 2020.

4.1 Dataset and Descriptive Statistics

The foreign direct investment (FDI) variable used in the study was obtained from the World Data Bank database as the foreign direct investment variable (a share in GDP), the economic growth variable as gross domestic product (GDP) data in dollars per capita, and the carbon (CO_2) emission data in million tons were obtained from the OECD Data Bank database. Explanations about the variables used in the analysis are shown in Table 1.

Table 1. Explanations Regarding the Variables Used in the Analysis

Variables	Explanation	Source
FDI (Foreign Direct Investment)	Foreign Direct Investment Flow (Its Share in the Gross Domestic Product)	World Data Bank
Economic Growth (Gross Domestic Product)	Economic Growth (Gross Domestic Product)	OECD Data Bank

	(Per capita Dollar)	
CO2 Carbon Emission	Carbon Emission (Million ton)	OECD Data Bank

The descriptive statistics of the data used in the study, the horizontal section of which consists of 27 EU countries and Turkey, and the 11-year time dimension is summarized in Table 2.

Table 2. Descriptive Statistics Regarding the Variables

Statistics	FDI	CO_2	GDP
Average	1.84e+10	112.917	39088.48
Standard deviation	5.52e+10	156.5852	18053.2
Maximum	3.32e+11	763.65	119128
Minimum	-3.45e+11	1.35	14692
Horizontal section	28	28	28
Time Section	11	11	11
Total Data	308	308	308

As can be seen in Table 2, analyses were carried out with 308 observations of each variable. The lowest observation for the foreign direct investment variable belongs to Italy, the lowest value for the economic growth variable belongs to Bulgaria, and the lowest value for the CO_2 variable belongs to Malta. In addition, the most significant observation for the foreign direct investment variable belongs to the Netherlands, the most critical value for the economic growth variable belongs to Luxembourg, and the most effective value for the CO_2 variable belongs to Germany.

4.2 Research results

The study examined foreign direct investment, CO2, and economic growth variables for 28 countries, including 27 EU countries and Turkey. The study was limited to 2010-2020 due to data constraints, and the data from 2010-2020 were used in the research. The dependent variable is economic growth, and the independent variables are foreign direct investment and CO_2 emissions, which are included in the analysis.

Analyzes were conducted with the Hausman test to decide on the model for panel data analysis. To determine whether fixed effects or random effects, the results of the fixed effects model calculated with the fixed effects model estimation resistant standard errors (robust) obtained from the Hausman test analysis are given in Table 3. It shows that the Hausman test findings should be accepted as one of the models used in panel data analysis. In addition, Table 3 includes the results of the Modified Wald Test, which shows whether there is time-varying variance in the fixed effects model, the Baltagi-Wu LBI test, which tests autocorrelation, and the Pesaran test, which pushes the correlation between units.

Table 3. Fixed Effects Estimation Results

Variables	Coefficient	Z Score	Possibility
FDI	-1.51e-08	-1.96	0.005**
CO_2	-77.67558	-2.17	0.030**
Number of observation	308		
Period	11		
Wald $\chi 2$ (28)	4092.91		0.000*
F(2,278) test	8.25		0.000*
Hausman test statistic	5.98		0.703
Different variance test			
Changed Wald test- $\chi 2(28)$	4092.91		0.000*
Autocorrelation test			
Baltagi-Wu LBI	0.50953567		
Bhargava et al. Durbin-Watson	0.17082087		
Interdivisional correlation			
Pesaran test	54.047		0.000*

, ** and *, show respectively statistical significance at 1%, 5%, and 10% significance levels*

When Table 3 is examined, the probability value was found to be less than 5% in the Modified Wald test, and it is understood that the variance varies according to the units. According to Bhargava et al., the Durbin-Watson and Baltagi-Wu LBI test result is less than two, indicating that autocorrelation is significant (Born & Breitung, 2010). In addition, when the inter-unit correlation Pesaran test results in Table 3 are examined, it can be said that there is an inter-unit correlation since the probability value is less than 5%. It is seen in Table 3 that there are different variances, autocorrelation, and inter-unit correlation in the fixed effects model obtained in this study.

Therefore, a fixed effects model with resistant standard errors was obtained. According to the fixed effects model findings, the effects of foreign direct investment and CO_2 emission variables on the economic growth variable are positive. Increasing foreign direct investment and CO_2 emissions will boost economic growth.

The findings obtained from the study show that all the variables obtained from Azam et al.'s studies covering the years 1971-2013 for selected high CO_2 emissions economies such as China, America, India, and Japan, and examining the effect of per capita CO_2 emissions on economic growth, have an essential role in influencing the part of economic growth among countries and are in line with the findings that CO_2 emissions and energy use have a significant positive effect on economic growth.

5 Conclusions

Foreign direct investments (FDI) are integral to an open, efficient international economic system and significant catalysts for change. The main objective of this research is to examine the relationship between foreign direct investment and carbon (CO_2) emissions and economic growth of Turkey and 27 EU countries between 2010-2020 with panel data analysis. The findings from the study show that foreign direct investment and carbon (CO2) emissions significantly affect economic growth, which is also positively related. In many developing countries, attracting foreign direct investment and reaping their full development benefits is shaped by national policies and the international investment structure. Challenges are faced primarily by the countries where the assets are to be made, as they must create, based on the policies in place, a transparent, broad, efficient, and favorable investment environment and build the human and institutional capacity to implement them. The benefits of foreign direct investment by developing country economies have been widely documented. Most studies prove, assuming the existence of appropriate national policies and a basic level of development, that foreign direct investment results in technology transfer, contributes to the creation of human capital and the integration of international trade, helps create a more competitive business environment, and accelerates the development of enterprises. All of the effects mentioned above translate into higher economic growth.

However, one important and frequently raised issue regarding FDI is its potentially harmful environmental consequences. Awareness of the potential ecological costs from FDI means that most countries are selective about the type of FDI that comes into their countries. Many countries are now promoting green FDI, which can promote economic growth and internalize the adverse environmental externalities associated with industrial production (Demena & Afesorgbor, 2020; Ahmad & Satrovic, 2023). It should be emphasized that GDP, FDI, and carbon emissions are essential drivers of eco-innovation (Ben Amara et al., 2023). Therefore, taking care of GDP growth and consciously implementing foreign investments is critical.

Environmental innovations and investments have been implemented in the countries analyzed for many years. However, they may not be financed by foreign investment, or their effect on reducing CO_2 still needs to be longer. Indeed, in the long term, environmental innovations reduce CO_2 emissions. At the same time, in a short time, the observed effect is the opposite, suggesting a rebound effect (Mongo et al., 2021).

The impact of foreign direct investments and economic growth on the amount of carbon emissions verifies the significance of making sustainable economic development real in solving the problem of global warming and climate change. Because carbon emissions are among the most significant reasons for the global warming problem, from this viewpoint, it is essential that the appropriate environmental policies, which a green growth strategy exists at its core, should be implemented by all countries in global cooperation. Moreover, in addition to the strictly economic benefits, foreign direct investment can prove helpful in improving environmental and social conditions in target countries, for example, through the transfer of "cleaner" technologies and the emergence of corporate policies with a greater social focus. Some guidelines are recommended to abate carbon emissions in this context, as indicated below.

Depending on economic growth, the increase in the use of fossil fuels such as coal, oil, and natural gas, which cause carbon emissions into the air when burned, causes the problem of human-induced global warming and climate crisis. Carbon emissions generate social costs by causing negative externalities, which should be priced with public measures. In this context, it can be said that the results obtained from the study point out the necessity of implementing market-based financial instruments as a significant component of a comprehensive climate crisis response package, on an international scale and in cooperation, and as a policy proposal to reduce carbon emissions. Cap and trade systems, limiting the amount of carbon emissions companies can release, and emissions taxes are nowadays regarded as market-based tools with the field of application on a large scale, unlike command - and - -control tools such as bans, standards, and restrictions, market-based tools price emissions by leaving the determination of emissions to market forces. Implementing these policy tools successfully is essential in terms of sustainable economic growth.

As a result, this paper aims to contribute to the existing literature by investigating the relationship between foreign direct investment, economic growth, and carbon emissions for Turkey and 27 European Union Countries from 2010-2020. This research is an essential step towards a better understanding the need to support the transition to sustainable development. Confirmation that sustainability efforts to date are insufficient prompts consideration of other solutions to promote more environmentally efficient foreign direct investment.

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