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Article

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The Relationship between Inward Foreign Direct Investment, Economic Growth and Carbon Emissions: A Case of Italy from G7 Countries

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ABSTRACT

Recently, a significant amount of carbon dioxide emissions has grabbed the attention of global community. Thus, this study attempts to investigate the impact of inward foreign direct investment, and economic growth on carbon dioxide emissions in case of Italy. We took Italy as our sample country as it has committed to achieve carbon neutrality by 2050. We took annual time series data for the dependent variable (CO_2) and explanatory variables (GDP, FDI, Natural Resources) for the period ranging from 1990 to 2021. To examine the long run relationship between the variables we used autoregressive distributed lags bounds test of cointegration. The empirical findings revealed the existence of long-run relationships among the variables of the model. Furthermore, we also found that natural resources unidirectionally caused CO_2 and GDP.

Keywords: Foreign Direct Investment, Economic Growth, Carbon Neutrality, Italy, Autoregressive Distributed Lag
JEL Classifications: F21, F43, Q43, Q47

1. INTRODUCTION

Due to urban development and rapid economic growth the natural resources have been adversely affected around the globe. Obstacles like deforestation, water shortage, environmental pollution and biodiversity loss are the serious problems being faced by both developing and the developed countries. Human beings have got badly affected by the poor environment quality and have suffered the social losses such as discomfort, untimely deaths, economic and environmental losses like decreased recreational values (Farooq et al., 2020). The deterioration of environmental quality and its adverse impacts upon the societies have led the attention of researchers to focus upon the subject of environmental economics (Destek and Sinha, 2020). Various studies have been conducted to identify the primary determinants that impact the quality of the environment. This research also focuses on the features of Foreign Direct Investment (FDI) and globalization that affect the quality of the environment. First, let us understand the meaning and role of globalization. Globalization is the opening of the global economy through the trade of goods and services, technology, tourism, and FDI. It removes the trade barriers, increases the transfer of technology, and adds to the capital inflows by increasing foreign funds (Farooq et al., 2020). The KOF aggregate globalization index quantifies the economic, political, and social aspects of globalization (Cohen et al., 2018).

FDI can be considered as one of the major driving forces behind GDP growth, and it also acts as a means for transferring latest

technologies to the host countries (Kayani et al., 2024; Kayani and Sadiq, 2022). Evidence exists in the literature that FDI plays a crucial role in contributing towards productivity spillover (Demena and van Bergeijk, 2017). Consequently, different countries are concentrating on producing promotion-based strategies to attract FDI. Investment promotion agencies (IPAs), run by the government, implement these promotional strategies and are successful in bringing the foreign funds and technical knowledge to the host countries (Demena and Afesorgbor, 2020). Despite having several advantages for economic development, the FDI has certain harmful impacts on the environment as well. Due to the increased atmospheric emissions that occur because of an increase in FDI, the economic advancements have possibly been nullified. However, studies like Shahbaz et al. (2016), for example, suggest that environmental emissions because of FDI can be negated very easily due to the potential of FDI of promoting growth. Several countries are encouraging "Green FDI" which pivots around FDI's that have economic benefits but simultaneously incorporate the harsh environmental externalities caused by the industrial production (Demena and Afesorgbor, 2020).

The scenario that pollution-intensive production could be associated with foreign investments that are particularly invested in developing countries supports the Pollution Haven Hypothesis. The Pollution Haven Hypothesis is justified in two main ways. First, developing nations are competing with one another to attract FDI which results in the relaxation of environmental regulations for foreign organizations, consequently it encourages the firms in developed countries to relocate their pollution-intensive production technologies to developing countries (Demena and Afesorgbor, 2020). Other studies are also available in the literature that authenticates that transfer of capital from the developed to the developing world exhausts the environmental resources in these recipient countries thereby negatively affecting their agriculture-based productivity. The race-to-the-bottom hypothesis provides evidence to the claim that FDI has negative impacts on the environment, arguing that gains being achieved from globalization are at the expense of environmental degradation. For instance, in the case of the Chinese economy, research by Huang et al. (2020) discovered that foreign organizations that indicate the presence of FDI had notable involvement towards increasing environmental emissions in China. Similarly, Sapkota and Bastola (2017) showed proof of the adverse impact of FDI on environmental quality.

Conversely, Pollution Halo Hypothesis emphasizes the assumption that multinational organizations have better energy efficiency and are utilizing a clean production process in comparison to domestically owned organizations. Even though FDI might not be using the cleanest technology, it is still probable that it would be using a cleaner technology in comparison to the current technology being used by domestic firms of the developing nations (Casella et al., 2019). Furthermore, the multinational firms would likely be transferring their clean technologies to the domestic firms, resulting in carbon emissions reduction. Therefore, FDI is considered as a driving force for the transfer of the clean technologies to the developing nations. A wide range of empirical evidence is present in the literature to support this hypothesis (Demena and Afesorgbor, 2020).

Italy is ranked among top ten economies of the World. Italian government has made several promising efforts to attract FDI such as the implementation of investment promotion policies. However, all these efforts of Italy are sort of fruitless mainly because of the slower economic growth rate, unpredictable tax management, along with legal challenges (Damgaard and Elkjaer, 2017). In 2019, Italian government signed a memorandum with the Chinese government endorsing the collaboration with the Belt and Road Initiative (BRI) with the purpose to attract FDI from Chinese investors (Cicatiello et al., 2020). Some of the most important sectors that have been attracting a major amount of FDI in Italy are telecommunication, transport, energy, and pharmaceutical industry. Therefore, this research aims at understanding the nexus between inward FDI, economic growth, and CO_2 emissions in the context of an emerging European economy of Italy.

As per Figure 1, GDP per capita has remained consistent over the years from 1991 to 2021; being highest during the years of 2006 and 2007. Interestingly, the carbon emissions were also highest during the years of 2006 and 2007 (8.025 and 7.860 metric tons per capita).

From Figure 2, a very interesting pattern of relationship between Inward FDI and CO_2 Emissions has been observed. In ward FDI was highest during the years 2006 and 2007 (2.92 and 2.98 respectively). Whereas carbon emissions during 2006 and 2007 were also highest (8.025 and 7.860 metric tons/capita). After 2007, Italy experienced a drastic decrease in inward FDI; with decrease in FDI the carbon emissions also decreased. The remainder of the article is organized as follows. Section 2 comprises of extensive literature review. Section 3 is explaining the data and methodology. Section 4 discusses the results and finally the article is concluded in the section 5.

2. LITERATURE REVIEW

Understanding the impact of economic stability on inward FDI and the cumulative influence of these two economic variables on environmental pollution is a topic of interest considering the

Figure 1: GDP growth and CO_2 emissions

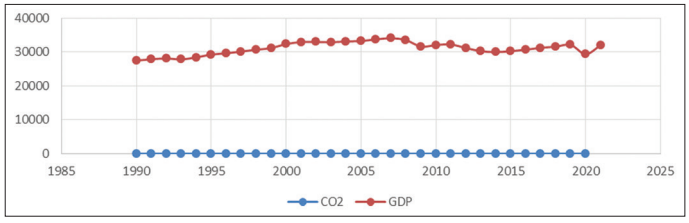
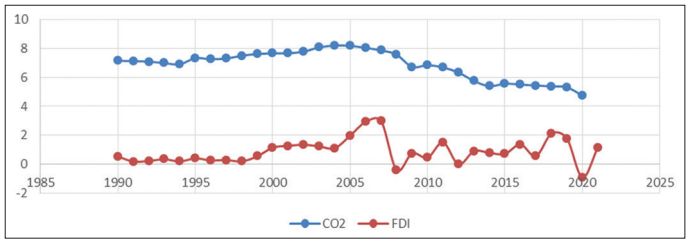


Figure 2: Inward FDI and CO_2 emissions



current wave of industrial development and globalization. Over the past few decades, the world has experienced a technological transition, as the developing countries are aiming to become technologically advanced countries and to achieve the swift and speedy industrialization (Aysan et al., 2020; Kayani and Gan, 2022). With the increased awareness about environmental protection and controlling carbon emissions, countries are developing modern economic and industrial growth models aimed at reducing pollution-causing activities and shifting to sustainable resource use. Developing countries are facing two-faceted challenge in the ongoing 21st century; on one side the needs of billions of people regarding the basic energy services are to be met and on the other side they have to participate in the global transition towards clean and low carbon energy systems or models (Kayani, 2021). Researchers have presented a set of contrasting empirical results on the correlation between inward FDI and the carbon footprint of countries (Shahbaz et al., 2016). Hongxing et al. (2021) studied the correlation between foreign investment and CO_2 levels by employing the autoregressive distributed lags (ARDL) model. The findings suggested a positive correlation between inward FDI, and carbon burden in the case of Thai, Malaysian, and Philippines' economy while for Indonesia, a negative correlation has been observed. Whereas in the case of Singapore, the authors found no influence between these two variables.

In another study, the relation between FDI inflows and GHG emissions has been explored in 18 countries from Latin America by using the Granger Causality Model. As per the results, FDI contributes to the increase in pollution-causing industries leading to higher GHG emissions. In Kuwait, Salahuddin et al. (2019) utilized the ARDL method for analyzing the impact of increased foreign investments in the country on its environmental quality from 1980 to 2013. According to the findings, FDI inflows led to an increase in CO_2 emissions. Jiang et al. (2018), in another study explored the correlation between FDI inflows on CO_2 pollution and environmental adversities in 150 cities of China by using the economic and environmental statistics from 2014. A significant negative correlation has been reported between FDI and carbon footprint implying those higher foreign investments in the country lead to improved environmental quality. Thus, the study validated the Pollution Halo hypothesis. Another study from China conducted by Liu et al. (2017) reported similar findings. The study used the panel data from more than 100 Chinese cities and observed that FDI and environmental quality share a positive correlation suggesting the increased inward FDI contributes to improved emission index and lower carbon footprint. The findings support the conclusions drawn by Liu et al. (2018) which also emphasized the absence of any negative impacts of FDI on eco-sustainability.

In research by Abid (2022) FMLOS estimation approach has been deployed to investigate the correlation between foreign investments and environmental sustainability in G-8 economies including Italy. As per the findings of the study, there exists a statistically significant negative correlation between carbon footprint and inward FDI, economic growth, and industrial modernization in the country. In another study by Caglar (2020), the causality shared by FDI, renewable and non-renewable energy usage, fiscal development, and CO_2 levels have been examined in nine countries including Italy by employing the ARDL method. The results reported a negative correlation between carbon emissions and sustainable energy usage. Zambrano-Monserrate et al. (2016) deployed the ARDL method in combination with the VECM model for exploring the linkage between GDP development and polluting emissions in case of Brazil over a period of 40 years. The findings confirmed the presence of a complex lasting correlation between carbon footprint and economic development. The findings of the study support the conclusions drawn by the systematic review conducted by Mardani et al. (2019).

According to Aye and Edoja (2017), the correlation among CO_2 levels, environmental emissions, inward FDI and GDP growth rate is positive for high-income countries. In Turkey, the linkage between carbon footprint, GDP development, FDI, and energy demand has been evaluated by Kizilkaya (2017) using the ARDL testing approach from 1970 to 2014. As per the findings, financial development and power usage share a positive correlation with the CO_2 emissions. While the research did not report any considerable correlation between inward FDI and carbon emissions. Erdoğan et al. (2019) found that fiscal development without considerable technological intervention increases CO_2 levels. The findings are in accordance with the Endogenous growth theory which emphasizes that technological growth significantly impacts the state of economic stability and eco-sustainability.

In China, Wang et al. (2019) investigated FDI's influence on financial development and how both these variables influence the quality of the environment in the country taking CO_2 emissions as a reference measure. In the light of the empirical findings, it can be established that FDI and economic growth share a positive correlation. While when environmental sustainability is included in this relationship, it is found that higher FDI and stronger economies lead to higher pollution levels. Moreover, the authors reported that when there are limited environmental laws and standards in a country, the volume of inward FDI increases. According to Jiang et al. (2017), economic development and export volume share a negative correlation. This implies that as the economic condition of the country improves, its export volumes tend to reduce. Focusing on the literature from Italy, strong evidence for Pollution Halo Hypothesis can be found. For instance, Paramati et al. (2021) explored the influence of financial stability and higher FDI inflows on environmental protection. According to the results, economic development leads to higher investments in greener technologies which ultimately contribute towards environmental sustainability and reduced CO_2 levels. Thus, the study validates the Pollution Halo Hypothesis.

Similarly, Essandoh et al. (2020) explored the correlation among carbon footprint, foreign trade volumes, and inward FDI in a set of 52 low and high-income nations from 1991 to 2014. As per the findings, CO_2 levels, inward FDI, and economic stability share a long-term positive relationship in economically struggling developing countries. On the other hand, for developed economies like Italy, a negative long-term correlation has been observed. A wide range of literature is available regarding energy demand,

financial development, and CO_2 levels long run and causal relationship in case of different regions. It was reported by Sharif et al. (2020) that energy demand and economic development in Turkey have a positive correlation. However, it is also reported that when economic development reaches a certain threshold, it starts damaging the environment of that country since carbon emissions tend to increase because of economic development. Therefore, a policy framework is needed so that carbon-based emissions can be reduced using clean and sustainable technologies for production in a country.

3. RESEARCH METHODOLOGY

3.1. Data

This study aims to investigate the effect of inward foreign direct investment, and economic growth on carbon emissions of Italy using ARDL approach over the period of 1990-2021. Moreover, we analysed annual data of inward foreign direct investment, economic growth, natural resources and carbon emissions downloaded from World Development Indicator (WDI). Foreign direct investment, economic growth and natural resources are considered as independent variables whereas, carbon emission is taken as the dependent variable. Natural resources rents are the total revenue that can be generated from the extraction of the natural resources minus the cost of extracting the resources. The details about the dependent and independent variables are shared below in Table 1.

3.2. Methods

To examine the impact of inward foreign direct investment, and economic growth on carbon emissions. We used the ARDL Stationarity model for analysis. Prior to this, we descriptively analysed the data (mean, standard deviation, skewness, etc.,) to provide the summary statistics for the selected variables. Also, before applying the ARDL technique, time series data must be stationary. For that purpose, we used unit root tests as suggested by (Dickey and Fuller, 1979), to check for stationarity in the data used. As a result, we found that time series data used for all the variables possess the characteristics of stationarity and were integrated.

Furthermore, we utilized equation 1, to check the relationship among the variables.

$$CO_2\ emissions = f(FDI,\ GDP,\ NTR) \quad (1)$$

Representation in regression form,

$$Y(CO_2\ emissions) = \alpha + \beta_1(FDI) + \beta_2(GDP) + \beta_3(NTR) + e \quad (2)$$

Where, β_1, β_2 and β_3 refer to the coefficients of the respective independent variables, α is the intercept of the regression model, FDI represents the foreign direct investment, GDP is the gross domestic product per capita, NTR is natural resources and e reflects the residuals. Furthermore, it is necessary to check every time series data for stationarity before employing co-integration tests, because without stationarity the regression technique generates inaccurate results. Additionally, one of the prerequisites of the ARDL bounds test is that none of the variables must be integrated into order two. As a result, we employ the ADF test initially. Moreover, the mathematical illustration of the ADF test is given in the equation 3 below:

$$\Delta x_t = \varphi x_{t-1} + \sum_{i=1}^{m} \delta \Delta x_{t-i} + e_t \quad (3)$$

Where Δ is the difference operator, t refers to time, φ is the symbol of the coefficient showing the process root, δ refers to the time trend coefficient, m shows the number of lags autoregressive model, and e_t is the random error term.

4. RESULTS AND DISCUSSION

4.1. Descriptive Statistics

Before applying the ARDL method, we analysed the summary statistics of the data used for variables namely CO_2 emissions, GDP, FDI and NTR as illustrated in Table 2 below. The average CO_2 emissions (metric tons/capita) is 6.86, with having maximum emissions up to 8.18 and minimum emissions up to 4.73, along with the standard deviation of 1.00. Furthermore, the average GDP of Italy is 0.30 with a maximum and minimum value of 3.73, and −8.52. As shown, the average FDI in Italy between the years 1991 to 2021 is 0.86, ranging from the maximum value of 2.98 to a minimum value of −0.89, and a standard deviation of 0.86, respectively. Moreover, the number of observations used for the variables are 31.

4.2. Augmented Dickey-Fuller (ADF) Unit Root Testing

After examining the descriptive of the variables, we used ADF test to check the stationarity and integration in the data used for the FDI, GDP, NTR and CO_2 emissions. As depicted in Table 3, all of our variables (dependent and independent) are integrated at I(0) and I(1). Thus, it can be concluded that the results extracted from ADF test confirm that all the variables are integrated and stationary, therefore, we can employ the ARDL model to detect the long-run relationships among the set of our variables.

4.3. ARDL Bounds Test

To investigate the long-run relationships between variables, we used ARDL bounds test. The Table 4 below represents the results regarding the ARDL bounds test, it can be noted that the

Table 1: List of variables

Variable	Type	Proxy	Data source
Carbon emissions	DV	Metric tons per capita	WDI
Foreign direct investment	IV	Foreign direct investment, net inflows (% of GDP)	WDI
Economic growth	IV	GDP per capita growth (annual %)	WDI
Natural resources	IV	Total natural resources rents (% of GDP)	WDI

DV: Dependent variable, IV: Independent variable, WDI: World development indicator

Table 2: Summary Statistics for the Selected Variables

Variables	Mean	Median	Maximum Value	Minimum Value	Standard Deviation
CO_2	6.864809	7.119180	8.189341	4.732373	1.001247
GDP	0.306517	1.117817	3.739947	-8.529728	2.514903
FDI	0.869655	0.724337	2.981233	-0.898590	0.865800
NTR	0.089255	0.082493	0.169646	0.023753	0.037413

Table 3: Results of augmented Dickey-Fuller test

Variable	Symbol	ADF (level)	ADF (1st difference)
Carbon emissions	CO_2	Nonstationary	Stationary
GDP per capita	GDP	Stationary	Nonstationary
Inward foreign direct investment	FDI	Nonstationary	Stationary
Natural resources	NTR	Nonstationary	Stationary

ADF: Augmented Dickey-Fuller, FDI: Foreign direct investment

Table 4: ARDL bounds test

Test statistics	Value	K
F-statistics	11.90	3
Critical value bounds		
Significance level	I (0)	I (1)
10%	2.37	3.2
5%	2.79	3.67
2.5%	3.15	4.08
1%	3.65	4.66

Table 5: ARDL long run results

Variable	Coefficient	Standard Error	T-statistics	P
GDP	−3.640782	5.632574	−0.646380	0.5239
FDI	1.631026	2.886629	0.565028	0.5771
NTR	59.12550	95.46715	0.619328	0.5413

Independent variables=FDI, GDP and natural resources; dependent variable=CO2 emissions. FDI: Foreign direct investment, ADRL: Auto regressive distributed lag

Table 6: Pairwise Granger Causality

Variables	F-statistics	P-value	Causality
GDP – $C0_2$	1.85480	0.1845	No
CO_2 - GDP	0.62257	0.4370	No
FDI- CO2	0.14507	0.7063	No
CO2- FDI	1.10359	0.3028	No
NTR – CO_2	11.6074	0.0021	Yes
CO_2-NTR	1.31862	0.2609	No
FDI -GDP	1.53252	0.2260	No
GDP -FDI	0.23368	0.6326	No
NTR – GDP	13.6709	0.0009	Yes
GDP -NTR	1.27408	0.2886	No
NTR – FDI	0.05059	0.8237	No
FDI - NTR	0.60259	0.4441	No

F-statistics value is greater than the lower bound as well as the upper bound value at 10%, 5%, 2.5%, and 1% significance levels, so co-integration is existing in our model.

4.4. ARDL Long-Run Results

After employing unit root tests (ADF), we applied the ARDL model to investigate the long-run relationships between the dependent and independent variables (CO_2, GDP, FDI, NTR). Table 5 represents the results generated from applying the ARDL approach. As illustrated, GDP has insignificant negative impact on carbon emissions whereas FDI and NTR have insignificant positive impact on CO_2.

Figure 3: Cumulative SUM residual test

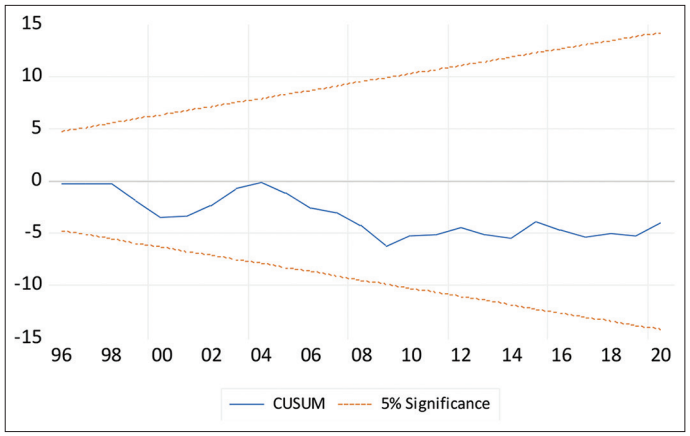
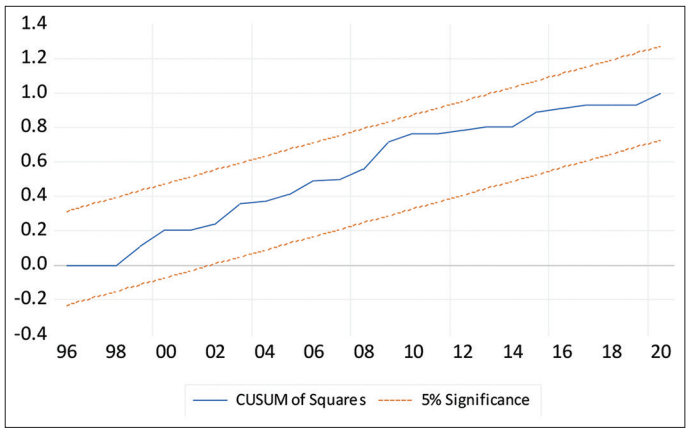


Figure 4: Cumulative SUM squared residual test



4.5. Stability Diagnostics

Figures 3 and 4 show the results of cumulative sum and cumulative sum of square tests respectively. Results show that the statistics of both cumulative sum and cumulative sum of square test are lying within the interval bands at 5 per cent confidence interval.

4.6. Granger Causality Test

In the Table 6 below, we can see a unidirectional relationship between natural resources and CO_2; natural resources are granger causing CO_2, but CO_2 is not granger causing natural resources. Similarly, a unidirectional relationship between natural resources and GDP also exists; natural resources are granger causing GDP, but GDP is not granger causing natural resources.

5. CONCLUSION

This empirical study investigated the long-run relationship of inward foreign direct investment and economic growth with CO_2 emissions in the Italian context. For this purpose, we employed the ARDL bound test method on the annual time series data over the period of 1990-2021. The statistical results of this study revealed that there exists a significant long-term relationship among the set of the selected variables. These findings are congruent with the prior empirical studies. Furthermore, we also found that natural resources unidirectionally caused CO_2 and GDP. To discuss the limitations of the study, this time series empirical research is restricted to Italian economy, future studies can apply the panel methodology on the other emerging and developed economies from Europe.

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