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Evaluation of the Relationship between CO2 Emissions and Economic Growth in Morocco*

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Abstract: *This study aimed to evaluate the effects of CO2 emissions on economic growth and foreign direct investment in Morocco. The article uses a multivariable regression model to evaluate the impact of CO2 on economic growth and development as well as foreign direct investment in Morocco from 1986 to 2021. The results show that the research results show the impact of CO2 on economic growth and foreign direct investment. This result indicates that countries' economic growth is affected not only by the level of FDI investment in the current year but also by FDI and CO2 emissions in the previous year. This result has many implications for policymaking related to the use of low-CO2 energy technologies for the economic development of countries.*

Keywords: FDI, economic growth, CO2 emissions, regression

1. INTRODUCTION

Foreign direct investment (FDI) often positively impacts economic growth in the host country. FDI will help countries increase job creation, capital accumulation, and technology transfer between the investing and beneficiary countries (Gui-Diby, 2014). The level of FDI invested in Asian countries in the past decade averaged 14.94% of GDP (http://data.imf.org/). Assessing the level of influence for Asian countries, FDI impacts economic growth by 17% in Malaysia et al., 2007) ([1]; or 16% in Vietnam (Nguyen Van Duy et al., 2014) [2]. The statistics show that the degree of influence of FDI on economic growth is very different in each country. In recent years, most countries have paid the most incredible attention to the issue of sustainable development in general and green economic growth in particular. In a green economy or a low-carbon economy, reducing CO2 emissions is a central task of the development scenarios in each country.

The relationship between CO2 and economic growth has been studied and evaluated in many previous scientific works. However, these studies show significant differences in the relationship between total CO2 emissions and national economic development. Several studies have found a linear relationship between CO2 and economic growth (Shafik, 1994; Azomahou et al., 2006); Other studies have found an inverted U-shaped relationship (Lean & Smyth, 2010b; Saboori et al., 2012) . Recently, there have also been studies to evaluate the impact of both FDI and CO2 emissions on economic growth: Omri et al. (2015)[3] survey examined the relationship between CO2, increased economic growth, financial development, and commercial factors. The results show a connection between these factors in 12 MENA (Middle East and North Africa) countries from 1990 to 2011. In which CO2 has a negative effect on economic growth. Another study by Tang & Tan (2014) also found that CO2 and FDI both have a short-term and long-term impact on economic growth. In addition, the author considers the effect of FDI on economic development with a time lag (Nguyen Van Duy et al., 2014). The results also show a positive impact of immediate and lagged FDI on economic growth. Although there have been studies evaluating FDI and CO2 on economic growth, the issue of concurrent and detailed consideration of the direction of impact on economic growth is still limited. Studies have not explored the lagged effects of FDI and CO2 emissions on economic growth (an increase or decrease in FDI or CO2 emissions this year may affect economic growth in the following years). Therefore, the author conducts a study on the impact of FDI and CO2 emissions on economic development, considering Morocco's time lag factor.

2. LITERATURE REVIEW

The amount of CO2 and methane emissions in the atmosphere reached a record high in 2021 - one of the hottest years on record and this fact once again highlights the urgent need to take action to avoid this situation's re-occurrence.

According to a report by the European Union's Climate Change Monitor (E.U. - C3S) published on January 10, 2021, the year with the 5th highest temperature on record, with the average temperature higher than the average temperature in the period of 1850 to 1900, about 1.1 to 1.2 degrees Celsius. The report also confirmed that the last seven years were the hottest years on record. CO2 emissions in 2021 have risen to a record 414.3 ppm, an increase of about 2.4 ppm from the previous year. Meanwhile, methane emissions have also continuously increased in the past two years. Methane is usually emitted from natural sources such as wetlands during oil extraction, gas production, and farming. The report affirms that increased greenhouse gas emissions have changed the Earth's climate. According to which the world continues to experience long-term hot weather worldwide experiencing extreme weather, from floods in Europe, China, and South Sudan to wildfires in Siberia and the United States.

C3S director Carlo Buontempo emphasized that this fact is a stark reminder of the need for a significant change in how climate change is prevented, from decision-making to effective action towards climate change, a strong society, and reduced net emissions.

According to the above report, Europe experienced the hottest summer in 2021. Specifically, during the heat wave in July and August last year, the Mediterranean region witnessed wildfire disasters in many countries, including Turkey and Greece.

Sicily region recorded temperatures up to 48.8 degrees Celsius. Also, in July, over 200 people died in flash floods in western Europe. According to scientists, climate change has increased the frequency of floods by at least 20% [3].

In July 2021, floods in Henan province, China, claimed the lives of more than 300 people. In California, a record heat wave following the second-largest wildfire in the state's history has scorched swathes of land and severely polluted the air.

Such arguments are mainly theoretical. Reducing growth is not an option pursued by rich or emerging countries. What matters is how to achieve green growth, which means a massive shift in technological capabilities and social organization in world economies.

The four must-haves to accelerate the decoupling process include green investment, disruptive innovation, behavioral change, and climate adaptation. Mass investment is a must to decarbonize energy systems. The International Energy Agency (IEA) estimates that annual investment in energy systems, which currently account for 2.5% of global GDP, will have to increase to 4.5% by 2030. Finally, climate change is already present; therefore, investment is needed in response to fires, floods, and other extreme weather events. At the same time, these measures will not always have the immediate effect of mitigating the impact of climate change. These urgent investments still need to be ramped up, as otherwise, it will become increasingly challenging to meet the targets to curb climate change, especially by limiting global warming to 1.5 degrees Celsius above pre-industrial levels [4].

The correct answer to whether climate change can be tackled without abandoning economic growth will depend heavily on the world's willingness to scale up its climate action or not.

Many studies have evaluated the relationship between CO2 emissions, economic growth, and foreign direct investment. The linkages between countries in terms of economic activity and trade have spurred studies investigating hypotheses about pollution, economic development, and trade integration. The first study on the impact of the Carbon Index on economic growth was that of Grossman and Krugger (1991). The two authors argued that reducing trade barriers and expanding economic activities will affect the environment. This study also provides empirical evidence to assess the relative extent of these three effects applied to the process of trade liberalization in Mexico. Naranpanawa (2011) used an autoregressive distributional delay (ARDL) model and the Johansen cointegration technique to investigate the long-run relationship between economic development and the trade environment. The results of this study suggest that there is only a short-term relationship between trade and carbon emissions. Keho (2015) also uses the ARDL model but with an array of data to analyze the long-term impact of international trade on the environment and concludes that international trade leads to environmental degradation in 11 ECOWAS countries from 1970 to 2010. Rahman & Kashem (2017)[5] used Toda and Yamamoto's Granger ARDL and causal model (1995) to examine the relationships between carbon emissions, energy use, and the development industry in Bangladesh between 1972 and 2011. Most studies show a long-term association and a causal relationship between the variables [2, p. 2].

In addition, studies also show a positive relationship between economic growth and the increase in CO2 during the study period. Esso and Keho [6] have shown a causal and long-term association between energy consumption, CO2 emissions, and economic growth in several African countries. Balsalobre-Lorente, Alvarez-Herranza, & Shahbaz (2019)[7] used the Kuznets curve to examine the link between economic development and carbon pollution in a group of 16 countries belonging to the Organization for Economic Development Cooperation. OECD (period 1995 – 2016) found that environmental sustainability is hindered in the energy development process as economies deal with institutional imbalances. The authors proved the hypothesis of the Kuznets curve and showed that widespread economic growth and the use of renewable electricity in 17 OECD countries reduced environmental pollution between 1990 and 2012. Michieka and Fletcher (2002)) used a sample of about 20 developing countries and showed a marked decline in energy intensity as foreign direct investment increased. The above decrease can be attributed to the use of modern technologies accompanied by foreign direct investment, i.e. a leap forward from the outdated traditional technologies being used in other countries. the country thereby reduces emissions that pollute the environment. Research by Tran et al [8] has shown a positive relationship between the research variables in Vietnam. Research results show an impact relationship between CO2 emissions, economic growth, and foreign direct investment. Assessing the impact of CO2 emissions on economic growth and foreign direct investment will help policymakers make reasonable policies to balance the increase in foreign investment capital and economic growth while reducing CO2 emissions.[9]

Thus, many empirical studies evaluate the link between foreign direct investment, economic growth, economic integration, and CO2 emissions. However, the research results have differences between countries regarding short-term and long-term effects, cointegration relationship and adverse effects, and positive impact of the relationship between factors. Because of the different results across countries, the author wanted to conduct an empirical study to evaluate the relationship between economic growth, CO2 emissions, and foreign direct investment in Morocco. The empirical results can help policymakers make policies to balance reducing CO2 emissions while increasing FDI attraction and improving economic growth in the future.[10]

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3. DATA AND METHODOLOGY

This analysis is based on statistical data from Morocco's General Statistics Office and the World Bank (Worldbank) from 1991 to 2019. The extracted figures include the GDP economic growth rate, foreign direct investment in Morocco, and CO2 emissions for 1986-2021.

This study will structure three variables, including economic growth (GDP), foreign direct investment (FDI), and CO2 (CO2) emissions, to clarify the relationship between CO2 emissions, economic development, and foreign direct investment. The values in each of the three variables were converted to Logarithmic to compensate for the skewed variance in the data and the substantial data variability,

The multivariable regression model has the following form:

$y= \alpha + \beta 1x1i+ \beta 2x2i +\beta 3x3i + ...+.....+ \beta kxki + \varepsilon i$

4. RESEARCH RESULT AND DISCUSSION

4.1 Units root test

When studying time series data, it is necessary to check the stationarity of the data series. The stationarity test will avoid the situation of the pseudo-regression series. However, if a linear combination between nonstationary series is stationary, then the regression is an actual regression, and those nonstationary time series are said to be cointegrated. In other words, if the residual in the model between nonstationary time series is a stationary series, then the regression result is accurate and represents the long-run equilibrium relationship between the variables in the model.

Table 1: Stationarity test of data series

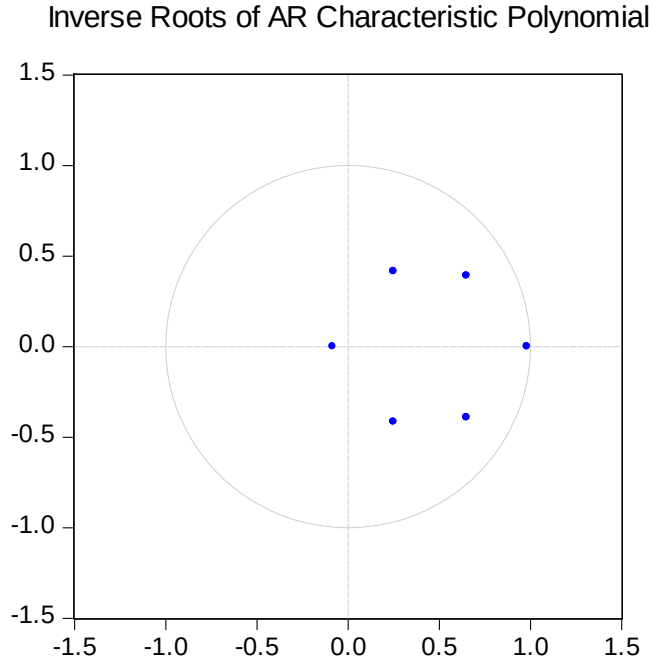
Variable name	ADF test	t-Statistic	P value	Degree of difference
LNCO2	-4.808585	-3.699871 -2.976263 -2.627420	0.0004	1
LNFDI	-3.997124	-3.689194 -2.971853 -2.625121	0.0004	1
LNGDP	-4.828096	-3.689194 -2.971853 -2.625121	0.0006	1

However, when taking the first difference, all the above variables are stationary. The variables in the model all stop at the first difference, which is a necessary condition for the model.

4.2. Check model stability

All the root values are in the unit circle, which shows that the estimated model is stable.

Figure 1: A.R. unit graph



Source: Data processing results on Eviews

4.3. Regression estimation results

Cointegrating Eq:	CointEq1		
LNGDP(-1)	1.000000		
LNFDI(-1)	-0.085749 (0.04744) [-1.80755]		
LNCO2(-1)	0.220420 (0.07657) [2.87863]		
C	-1.204893		
Error Correction:	**D(LNGDP)**	**D(LNFDI)**	**D(LNCO2)**
CointEq1	-0.587998 (0.22357) [-2.63007]	1.193888 (0.36235) [3.29482]	-0.008704 (0.11633) [-0.07482]
D(LNGDP(-1))	0.327752 (0.18704) [1.75227]	0.017433 (0.30316) [0.05751]	0.034934 (0.09733) [0.35893]
D(LNFDI(-1))	0.040200 (0.09017) [0.44581]	0.065615 (0.14615) [0.44895]	0.014383 (0.04692) [0.30654]
D(LNCO2(-1))	-0.297987	-2.960779	0.259997

	(0.46422)	(0.75240)	(0.24155)
	[-0.64190]	[-3.93510]	[1.07636]
C	0.018460	0.350787	0.054843
	(0.04954)	(0.08030)	(0.02578)
	[0.37262]	[4.36868]	[2.12750]
R-squared	0.366006	0.518727	0.072547
Adj. R-squared	0.255746	0.435028	-0.088749
Sum sq. resids	0.405934	1.066354	0.109907
S.E. equation	0.132851	0.215321	0.069127
F-statistic	3.319483	6.197489	0.449778
Log likelihood	19.54250	6.021154	37.83428
Akaike AIC	-1.038750	-0.072940	-2.345306
Schwarz SC	-0.800857	0.164954	-2.107412
Mean dependent	0.005828	0.134298	0.077486
S.D. dependent	0.153994	0.286466	0.066250
Determinant resid covariance (dof adj.)		3.26E-06	
Determinant resid covariance		1.80E-06	
Log likelihood		65.96460	
Akaike information criterion		-3.426043	
Schwarz criterion		-2.569626	

The OLS model that evaluates the long-run effects between variables will have the following form:

$$ETCt\text{-}1 = [1.000\ln GDP_{t-1} - 0.085\ln FDI_{t-1} + 0.22\ln CO2_{t-1} - 1.204\ ]$$

And the OLS model evaluates the short-term impact between variables in the form of a regression equation as follows:

$$\Delta\ln GDP_t = -0.587ETC_{t-1} + 0.328\Delta\ln GDP_{t-1} + 0.40\Delta\ln FDI_{t-1} - 0.298\Delta\ln CO2_{t-1} + 0.018$$

5. Conclusion

The debate about the impact of FDI and economic growth on carbon emissions is still ongoing in many developed and developing economies, especially developing countries like Morocco. This paper uses a linear regression model to evaluate the relationship between CO2 emissions, FDI, and GDP in Morocco. The regression model shows that CO2 emissions impact total FDI invested in Morocco and economic growth and vice versa. The impact of foreign direct investment on CO2 emissions is negative, meaning that an increase in FDI and economic growth by 1 unit will increase CO2 emissions by 4.2 and 4.8%, respectively. In addition, the amount of CO2 also impacts the amount of FDI investment and GDP economic growth with an impact ratio of 27.3% and 17.4%, respectively.

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