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Is the Relationship between FDI and Environmental Degradation Nonlinear? Evidence from Tunisia and Morocco

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Abstract

This study attempts to examine the effect of Foreign Direct Investment (FDI) on environmental degradation in Tunisia and Morocco for the period 1980- 2022. The study uses the Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) techniques to explore a possible non-linear relationship between FDI and environmental quality. The results of our empirical study show that FDI inflows increase environmental degradation in the long run in both of Tunisia and Morocco. This confirms the pollution heaven hypothesis. In addition, we find a non-linear relationship between FDI and environmental degradation and follows an inverted U-shape for the cases of Tunisia and Morocco. The causality results showed that there is an uni- directional causality runing from FDI to environmental degradation for the cases of Tunisia and Morocco. In terms of potential directions for the cases of Tunisia and Morocco. Future research, we strongly advise looking into government incentives and public policies related to environmental issues.

Keywords: *FDI, Environmental Degradation, FMOLS, DOLS, Tunisia, Morocco.*

Introduction

The degradation Foreign Direct Investment (FDI) stimulates economic growth through the diffusion and the transfer of technology, the increased of productivity and the introduction of new production methods (Bouchoucha, and Yahyaoui,2019).FDI also creates jobs. Developing countries and in particular Tunisia and Morocco have made considerable efforts over the past decades to attract more FDI without giving major importance for the environmental degradation. Despite the importance of positive externalities for host countries, FDI inflows negatively influence air quality and increase greenhouse gas emissions , (Bouchoucha,2019). As it is possible that the economic growth gains associated with increased FDI are outweighed by the potential environmental costs, FDI leads to increasing environmental degradation (Cole, Elliott, and, Zhang, J. 2019), Morocco and Tunisia are predicted to have produced 1.968 and 2.482 million metrics tons of carbon dioxide, respectively. Indeed, the adverse effects on the environmental degradation not only affect economic growth, but have also damaged living standards in all worlds (Shahbaz, M,2019).

The literature is divided into three strands: The first line of research emphasized that FDI leads to increasing the environmental degradation (Pollution Haven Hypothesis). The second line of research supposed that FDI leads to decreasing the environmental degradation (Pollution Halo Hypothesis). While, the third line of resaerch assumed that the relationship between FDI and environmental degradation is non-linear.

In this context, this relationship could be negative, as FDI inflows lead to increase energy consumption and environmental degradation in host countries, due to the absence of effective environmental rules and legislation (Salari, M ,2021) .This is consistent with the Pollution Haven Hypothesis (PHH) which assumes that polluting production could accompany the foreign capital that is invested in developing countries. Since, the intense competition between developing countries to attract FDI could lead to a relaxation of environmental standards for foreign firms and therefore encourages firms from developed countries to shift their pollution-intensive production to developing countries. Thus, these countries lower their environmental standards to attract more foreign direct investment.

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Several empirical arguments support this view. For instance (Liu, Y., Hao, Y., et al,2017). found that FDI inflows increase environmental degradation. (Liu, Y., Hao, Y., et al,2017) examined the relationship between FDI and the environment in African countries. The results show that FDI increases environmental degradation in African countries. Similarly, other authors find a positive relationship between FDI and environmental degradation (Bokpin, G. A,2017) , (Salehnia N et al ,2021).Using sub-panels "Europe and Central Asia, Latin America and the Caribbean, and the Middle East, North Africa, and sub-Saharan Africa"(Qamri, G, Sheng, B et al,2022) found a bidirectional causality between foreign direct investment and economic growth for all the panels and between foreign direct investment and CO2 emissions for all the panels, except Europe and North Asia.

In addition, (Bokpin, G. A,2017). studied the effect of FDI inflows and environmental quality on economic growth for 17 MENA countries with similar economic structures over the period 1990-2012. The empirical results show that FDI inflows stimulate the economic growth process in MENA region. On the other hand, the results show that economic growth in MENA countries negatively affects environmental degradation. Moreover, (Kocak, E et al,2018) investigated the effect of FDI on the environmental degradation in Turkey during 1974-2013. The results confirm the existence of the Pollution Haven hypothesis(PHH). Also, they confirm the Environmental Kuznet Curve hypothesis. Furthermore, they find a bidirectional causality between FDI and Carbon emissions.

On the other hand, the effect of FDI on the environmental degradation could also be positive, in the sense that an increase in FDI leads to a decrease in environmental emissions. In theory, this is called pollution halo hypothesis . The pollution halo effect assumes that foreign firms utilize less energy and use cleaner production processes than domestic firms. For instance (Zhu, H et al 2016) found that there is an inverse relationship between FDI inflows and CO2 emissions, which confirms the Pollution Halo hypothesis. Additionally, (Liu, Yet al ,2017) showed that FDI is beneficial for reducing CO2 concentrations in China. Similarly, other studies such as (Zhu, H et al ,2016) (Wang H et al,2017),showed that FDI could be reduce CO2 emissions through improved management practices and technologies. For (Zheng, J et al,2017), FDI reduces pollution intensity. (Jiang, L et al, 2018) showed that FDI improved air quality in China.

In the same vein of research (Hitam, M et al,2012) (Mahmood ,H et al ,2019) found a negative relationship between FDI and environmental degradation. Furthermore, (Shahbaz, M et al,2015), found that in high-income countries, FDI improves environmental quality, confirming the Pollution Halo Hypothesis, while, FDI contributes to increase of CO2 emissions in low-income countries, confirming the Pollution Haven Hypothesis (PHH). However, in middle-income countries, the study showed the existence of the environmental Kuznets curve between FDI and environmental degradation. (Shahbaz, M et al,2019). showed the existence of N Shaped between FDI and carbone emissions in MENA countries. Recently, (Christoforidis,T and Katrakilidis, C,2021) examined the effect of FDI on environmental degradation in Central and Eastern European (CEE). The results showed that FDI inflows have a non-linear effect on the environmental quality in CEE countries which follows the formation of an inverted U-shaped curve. So, there is inconclusive impact between FDI and Carbon emissions.

This paper contributes to the existing empirical literature in the following three ways: First, the empirical literature on the relationship between FDI and environmental degradation is very limited and presents mixed results. This study presents fresh evidence for the impact of FDI on environmental degradation both in Tunisia and Morocco. Second, in our knowledge, this study is the first one that analyses the non-linearity between FDI and environmental degradation in the long run for a comparative study between Tunisia and Morocco. Third, we will test the direction of causality between FDI and environmental degradation.

The paper is structured as follows: First, we present the data and methodology. Then, we discuss the main empirical results and the discussion. Finally, we conclude with a conclusion and some research perspectives.

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Materials and Methods

Bibliometric Data

This study aims to test for possible nonlinear relationship between Foreign Direct Investment and environmental degradation for the case of Tunisia and Morocco over the period 1990 - 2021. To do this framework, we will test the long-term relationship between these two variables using the FMOLS and DOLS approaches. The explanatory variables used in our study are carbone missions, Foreign direct investment, energy consumption, GDP per capita and trade openness. Based on explanatory variables, the environment function is written as:

$$Ln(CO2)_i = \beta_0 + \beta_1(LnFDI)_i + \beta_2(LnFDI^2)_i + \beta_3(Lnenerg)_i + \beta_4(LnGDP)_i + \beta_5(Lnopen)_i + \varepsilon_i$$

Where CO2 represents Carbon dioxide emissions per capita; FDI denotes Foreign Direct Investment; FDI^2 refers to FDI squared, this variable was introduced to take into account the possibility of non-linearity in the nexus between FDI and CO2 emissions, theoretically based on the Environmental Kuznet Curve (EKC); Open measures the trade openness; GDP denotes GDP per capita and energ denotes energy consumption. All variables are transformed into logarithm.

All the data used for the estimation of equation (1) are annual time is sourced from the World Bank (See Table 1). Thus, we will detail the definition of the variables of our study in the following.

Definitions and Measures of Variables.

CO2 emissions indicate CO2 emissions per capita in metric tons and used as a variable that measures environmental degradation; FDI measures Foreign direct investment inflows expressed as a percentage of GDP; GDP represents GDP per capita in constant 2010 US dollars. This indicator reflects the extent of a country's economic activity or the magnitude of its wealth generation; Open is measured by the sum of imports and exports relative to GDP; energy denotes the consumption of primary energy (any form of energy extracted directly from a natural deposit: before transformation into fuels). Energy consumption is measured in kilo tons of oil equivalent. The description of the variables used in our study and their sources are presented in Table 1.

Table 1. Data Description and Sources

	Variables	Sources
CO2	Carbon dioxide emissions per capita	WDI
Open	Trade openness is measured by the sum of exports and imports as share of percentage of GDP	WDI
FDI	Foreign direct investment expressed as a percentage of GDP	WDI
GDP	GDP per capita in constant 2010 US dollars	WDI
Energ	Consumption of energy (in kilo tonnes of oil equivalent)	WDI

Empirical Methodology

The objective of this study is to examine the nexus between Foreign Direct Investment and environmental degradation for the case of Tunisia and Morocco. In order to do this framework, we will apply an empirical methodology in four stages :

The first stage consists to test the properties of the individual time series. More precisely, we will test the unit root test using the ADF (Augmented Dickey and Fuller 1979) and PP (Phillips and Perron 1988) tests.

In the second stage we will test the presence of cointegration by applying the Trace test. In the third

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stage of our analysis, we will apply the FMOLS and DOLS approaches in order to examine long run relationship between these variables. In the four stage of our analysis, we test the causality link between FDI and environmental degradation.

Results and Discussion

Descriptive Statistics

Before proceeding to the estimation, it is interesting to propose the descriptive statistics of all the variables of our study. Thus, the descriptive statistics of the endogenous variable and the explanatory variables are presented in Table 2.

Table 2. Summary Statistics

Tunisia					
	CO2	FDI	Energ	GDP	Open
Mean	2.123	2.777	6.623	7.989	4.510
Median	2.150	2.208	6.651	7.977	4.502
Maximum	2.620	9.424	6.849	8.285	4.739
Minimum	1.722	0.629	6.342	7.642	4.355
Std. Dev.	0.274	1.818	0.163	0.219	0.092
Skewness	0.096	2.059	-0.273	-0.112	0.416
Kurtosis	1.748	8.333	1.709	1.585	2.786
Jarque-Bera	1.670	47.312	2.047	2.137	0.771
Probability	0.433	0.000	0.359	0.343	0.679
Sum	53.088	69.430	165.5780	199.728	112.761
Sum Sq. Dev.	1.804	79.342	0.638	1.153	0.206
Observations	25	25	25	25	25
Morocco					
	CO2	FDI	Energ	GDP	Open
Mean	1.299	2.233	6.051	7.550	4.122
Median	1.255	1.986	6.000	7.500	4.084
Maximum	1.741	7.158	6.327	8.021	4.450
Minimum	0.875	0.547	5.736	7.283	3.852
Std. Dev.	0.272	1.466	0.195	0.211	0.199
Skewness	0.200	1.5637	0.059	0.4795	0.284
Kurtosis	1.737	6.088	1.570	2.138	1.703
Jarque-Bera	1.826	20.124	2.142	1.731	2.088
Probability	0.401	0.000	0.342	0.420	0.352
Sum	32.494	55.827	151.294	188.763	103.057
Sum Sq. Dev.	1.781	51.601	0.916	1.069	0.952
Observations	25	25	25	25	25

Source: estimated by author

According to Table 2, the mean value of FDI inflows is 2,777 and 2,333 for the cases of Tunisia and Morocco, respectively. Indeed, the minimum value of FDI inflows is 0.629 and 0.547; while, the maximum value of FDI inflows is 9.424 and 7.158 for the cases of Tunisia and Morocco, respectively. Moreover, the

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mean level of carbon emissions is 2,123 and 1,299 for the cases of Tunisia and Morocco, respectively. In fact, the lowest means value of carbon emissions are 1.722 and 0.875, while, the highest means value of CO2 emissions are 2.620 and 1.741 for Tunisia and Morocco, respectively.

Unit Root Test

The first step in our empirical analysis is to test the stationarity of our variables. To do this framework, we will use the ADF (Augmented Dickey and Fuller 1979) and FP (Phillips and Perron 1988) tests. These ADF and FP tests have the null hypothesis of the presence of unit root (non-stationarity) against the alternative hypothesis of the absence of unit root (stationarity).

Table 3. Unit Root Test Results

		Tunisia		Morocco	
		ADF	PP	ADF	PP
CO2	Level	0.575	0.576	0.967	0.980
	First difference	0.0000*	0.000*	0.000*	0.000*
FDI	Level	0.263	0.086	0.360	0.060
	First difference	0.000*	0.000*	0.000*	0.000*
Energ	Level	0.385	0.750	0.771	0.759
	First difference	0.000*	0.000*	0.000*	0.000*
GDP	Level	0.186	0.181	0.187	0.231
	First difference	0.000*	0.000*	0.000*	0.000*
Open	Level	0.104	0.101	0.421	0.426
	First difference	0.0000*	0.0000*	0.000*	0.000*

Source: estimated by author ***, **Indicate significance level at 1% and 5% respectively

According to the results in Table 3, all variables are stationary in first difference, so it concluded that all the variables are integrated at order one difference I (1).

Results of Cointegration Test

After ensured the stationarity of our series, the next step, we apply the cointegration test in order to examine the long-term relationship between the variables studied. The Trace test is the most commonly used test for cointegration analysis in time series. According to Table 4, the trace statistic indicates that cointegration exists among the study variable, both in Tunisia and Morocco.

Table 4. Cointegration Test Results

Unrestricted Cointegration Rank Test (Trace)				
Tunisia				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.939705	147.6085	95.75366	0.0000
At most 1 *	0.807737	83.01286	69.81889	0.0031
At most 2	0.583630	45.08839	5613	0.0889
At most 3	0.474919	24.93625	29.79707	0.1637
At most 4	0.245216	10.11958	15.49471	0.2717
At most 5	0.146711	3.649124	3.841466	0.0561

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Morocco				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.984938	221.8549	125.6154	0.0000
At most 1 *	0.916174	125.3559	95.75366	0.0001
At most 2	0.744352	68.33847	69.81889	0.0652
At most 3	0.487867	36.96753	47.85613	0.3491
At most 4	0.416075	21.57660	29.79707	0.3226
At most 5	0.329758	9.202996	15.49471	0.3469
At most 6	1.35E-05	0.000312	3.841466	0.9880

Source: estimated by author

FMOLS and DOLS Results

To examine the relationship between foreign direct investment and emission of carbon in long run, we will apply the FMOLS (Fully Modified Ordinary Least Squares) and DOLS (Dynamic Ordinary Least Squares) techniques. The signs of the FMOLS and DOLS coefficients produce identical results. The estimation of the FMOLS and DOLS models both in Tunisia and Morocco are presented in Table 5.

Table 5. The Contribution of FDI On Environmental Degradation in the Long Run

	Tunisia		Morocco	
	FMOLS	DOLS	FMOLS	DOLS
FDI	0.046 (0.001)***	0.114 (0.000)***	0.239 (0.011)**	0.204 (0.067)*
FDI2	-0.003 (0.006)***	-0.007 (0.030)**	-0.028 (0.020)**	-0.024 (0.004)***
Energ	3.887 (0.002)***	2.611 (0.002)***	0.475 (0.032)**	0.418 (0.054)*
GDP	4.263 (0.0001)***	3.406 (0.09)*	0.827 (0.004)***	0.700 (0.050)*
Open	1.388 (0.001)***	1.744 (0.006)*	1.048 (0.029)**	0.916 (0.090)*

Notes: * significance at the 1% level. **significance at the 5% level. ***significance at the 10% level

The coefficients of FDI variable are positive in FMOLS and DOLS models both in Tunisia and Morocco. This implies that an increase in FDI of 1% leads to an increase in CO2 emissions by 0.04 and 0.11, for the case of Tunisia, in FMOLS and DOLS models, respectively. On the other hand, for Morocco, an increase in FDI of 1% leads to an increase in CO2 by 0.239 and 0.204, in FMOLS and DOLS models, respectively. These results can be explained by the fact that foreign direct investments in Tunisia and Morocco are becoming less and less respectful for the environment in the long term. These results confirm the conclusion of Salehnia N, Karimi Alavijeh N, (2020). Regarding the control variables, the consumption of energy is positive and statistically significant at 1% level both in Tunisia and Morocco. It means that, an increase in energy consumption of 1% will lead to increase more environmental degradation in Tunisia, with a coefficient that range from 3,887 to 2,611, in FMOLS and DOLS models, respectively. On the other hand, for Morocco, an increase in energy consumption of 1% leads to an increase in emission of carbon by 0.475 to 0.418, in FMOLS and DOLS models, respectively. These results are consistent with the findings of Salari et al. (2021).

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The coefficients of FDI variable are positive in the FMOLS and DOLS models both in Tunisia and Morocco. This implies that an increase in FDI of 1% leads to an increase in CO2 emissions by 0.04 and 0.11, for the case of Tunisia, in FMOLS and DOLS models, respectively. On the other hand, for Morocco, an increase in FDI of 1% leads to increase CO2 by 0.239 and 0.204, in FMOLS and DOLS models, respectively. These results can be explained by the fact that foreign direct investments in Tunisia and Morocco are becoming less and less respectful of the environment in the long term. These results confirm the conclusion of (Kivyiro, P,2014) , (Shahbaz, M et al,2014).

Regarding the economic growth variable, it is positive both in Tunisia and Morocco. Indeed, the coefficients of the GDP variable are positive and significant. A one increase in economic growth will intensify carbon dioxide emission by 4.263 and 3.406 for the case of Tunisia, in FMOLS and DOLS models, respectively. However, for Morocco, an increase in economic growth of 1% will lead to increase Carbon CO2 emissions in the range of 0.827 to 0.700, in FMOLS and DOLS models, respectively. Hence, this positive relationship can be explained by the fact that when economic growth improves, then the industrial sector improves and fuel consumption increases, hence CO2 emissions will increase.

Moreover, Trade openness has a positive and significant effect on CO2 emissions in the case of Tunisia and Morocco. Indeed, the icrease of degree of trade openness by 1% generates an increase of pollution by 1.388 and 1.744, respectively, for the case of Tunisia, in FMOLS and DOLS models, respectively. However, for Morocco, an increase in trade openness of 1% leads to an increase in carbon emissions by 1.048 and 0.916, in FMOLS and DOLS models, respectively. The negative effect of trade openness on the environmental degradation can be explained by the fact that trade openness favors polluting export industries with a high level of pollution [18].

The relationship between FDI and CO2 emissions turns out to be non-linear and statistically significant. Indeed, the negative sign of FDI2 coefficients shows the existence of an inverted U-shaped curve in the relationship between FDI and CO2 emissions, which indicates a functional specification close to the environmental Kuznets curve (EKC). This result implies that, in the first stage, the increase in FDI inflows both in Tunisia and Morocco leads to environmental degradation, thus making these countries polluting. However, above a certain threshold, FDI inflows have the opposite impact on environment degradation of these countries, leading to a reduction in CO2 emissions.

In this context, by deriving the quantity of CO2 emissions by FDI, in equation (1), we obtain:

In optimum: $\frac{d \ln CO2_t}{d \ln FDI_t} = 0$ $\ln FDI* = (-\frac{\beta_1}{2\beta_2})$

$FDI* = e^{-\frac{\beta_1}{2\beta_2}}$ $\frac{d^2 \ln CO2_t}{d^2 \ln FDI_t} = 0$

$\ln(FDI)** = (2\beta_2)$

It means $FDI** = e^{2\beta_2}$

The values of 0.986 and 0.953 correspond to the foreign direct investments in Tunisia and Morocco, respectively, necessary for CO2 emissions to begin their downward trajectory. Beyond this level, any increase in FDI inflows results in a reduction in carbon emissions.

Causality between FDI and environment degradation

Table 6 presents the causality test results between FDI and environment. These results indicate that there is an uni-directional causality running from FDI to environmental degradation in the case of Tunisia and

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Morroco. In fact, we find that the null hypothesis of no causality from FDI to environmental degradation is rejected (P-value<5%). This implies that the higher level of FDI inflows will increase the environmental degradation in the case of Tunisia and Morocco.

Table 6. Causality Test Results

Countries	Null hypothesis	P-value
Tunisia	FDI does not cause CO2	0.025
	CO2 does not cause FDI	0.113
Morocco	FDI does not cause CO2	0.039
	CO2 does not cause FDI	0.265

Source: estimated by author

Conclusion

The objective of this study is to investigate the nonlinear relationship between foreign direct investment (FDI) and environmental degradation in Tunisia and Morocco from 1980 to 2021. Our econometric study is based on the FMOLS and DOLS approaches to test the long-term relationship between these two variables. These two approaches make it possible to control for autocorrelation and endogeneity bias.

We followed the following empirical approach: First, we started our analysis with the stationarity properties of selected variables through ADF and PP unit root tests. Second, we examined the presence of cointegration. Then, we estimated our model using FMOLS and DOLS approaches. Finally, we test the causality from FDI to environmental degradation.

The results of the ADF (Augmented Dickey and Fuller (1979)) and PP (Phillips and Perron (1988)) tests indicate that the variables in our study are stationary in first difference. This implies that our variables are integrated of order 1. Then, the Trace test results show us the existence of at least a cointegrating relationship between FDI and environmental degradation. Our empirical analysis also suggests that FDI inflows increase the environmental degradation in the long run in the cases of Tunisia and Morocco. This confirms the Pollution Haven hypothesis. Furthermore, we demonstrated that the relationship is non-linear between FDI and the environmental degradation. In this sense, this relationship presents an inverted U-shaped curve for the case of Tunisia and Morocco. This implies that during the first stage, the increase in FDI inflows in Tunisia and Morocco lead to a deterioration of the environment, but after a certain in FDI threshold, the FDI inflows have the opposite impact on the environmental pollution of these countries, which leads to a reduction in CO2 emissions. We find also that there is an uni-directional causality from FDI to environmental degradation in the case of Tunisia and Morroco.

The implications of these findings are as follows: The governments should further improve the attraction of FDI while taking into account the protection of the environment. Second, countries should establish an appropriate regulatory framework including trade and carbon taxes, fiscal incentives for green investments. Furthermore, additional efforts are also required in the Maghreb countries to update companies with advanced and environmentally friendly technologies. Also, countries should apply taxes on polluting industries and try to turn to clean and alternative energy sources. As a limitation of this work, we can introduce other indicators of environment to ensure the robustness results. In future research, we will introduce some transmissions channels between FDI and the environment, such as institutional quality and financial development.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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