


“The nexus between foreign direct investment and environmental sustainability in North Africa”

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ARTICLE INFO	Marwa Lazreg and Ezzeddine Zouari (2018). The nexus between foreign direct investment and environmental sustainability in North Africa. <i>Environmental Economics</i> , 9(1), 57-68. doi: 10.21511/ee.09(1).2018.05
DOI	http://dx.doi.org/10.21511/ee.09(1).2018.05
RELEASED ON	Wednesday, 25 April 2018
RECEIVED ON	Thursday, 15 March 2018
ACCEPTED ON	Monday, 16 April 2018
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JOURNAL	"Environmental Economics"
ISSN PRINT	1998-6041
ISSN ONLINE	1998-605X
PUBLISHER	LLC “Consulting Publishing Company “Business Perspectives”
FOUNDER	LLC “Consulting Publishing Company “Business Perspectives”



NUMBER OF REFERENCES

21



NUMBER OF FIGURES

0



NUMBER OF TABLES

9

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The nexus between foreign direct investment and environmental sustainability in North Africa

Abstract

This paper provides a study of the relationship between sustainable development and foreign direct investment (FDI) from an empirical point of view in the case of the North African countries during the period from 1985 to 2005. The researchers use the cointegration test, the FMOLS (Fully Modified Ordinary Least Squares) model and the Granger causality test to examine this relationship. According to the empirical results, we confirm the existence of a cointegration relationship between the different series studied in this paper. Based on the cointegration test we can use the error correction model. Also, to test the effect of FDI on sustainable development in the North African countries, we make an estimate by FMOLS method. We found that the foreign direct investment has a positive impact on CO₂ emissions. Also, the Granger causality test confirms the presence of a bidirectional relationship between FDI and CO₂ emissions (carbon dioxide). That is to say, the FDI can cause CO₂ emissions and CO₂ emissions can cause FDI based on the Granger causality.

Keywords: foreign direct investment, sustainable development, CO₂, poverty, panel data.

JEL Classification: Q56, Q43.

Received on: 15th of March, 2018.

Accepted on: 16th of April, 2018.

Introduction

Regarding the relationship between FDI and the environment, a lot of literature focuses on their potential link. For example, Hoffmann et al. (2005) use the Granger causality test based on data from 112 countries to make sure that the relationship between FDI and pollution depends on the development of the host countries.

Cole et al. (2006) develop a model of political economy and conclude that when the degree of corruptibility of the government is weak, FDI leads to a stricter and cleaner environmental policy.

Hitam and Borhan (2012) use a data for Malaysia from 1965 to 2010 to examine the impact of FDI on the quality of the environment and conclude that FDI can increase environmental pollution. Therefore, FDI should be incorporated as an independent variable in the regression model of the environmental Kuznets curve (EKC). The estimated coefficients from the regression of the EKC equation will be biased by omitted variable.

Grossman and Krueger (1995) establish a relationship between economic growth and environmental pollution. Their conclusion shows

that the relationship between environmental pollution and income per capita is an inverted U-shape, which is known as environmental Kuznets curve (EKC). The quality of the environment does not deteriorate with both economic growths beyond the turning point.

According to the study by Grossman and Krueger (1995), some studies (Selden & Song, 1995; Jones & Manuelli, 2001; Hartman & Kwon, 2005; Brock & Taylor, 2010) construct various theoretical models (e.g. model of overlapping generations) to find the possible reasons for the inverted U-shape between economic growth and pollution.

In these models, they assume that individual utility is a function of the normal quality of goods and the environment, resulting in a compromise between the normal property and environmental quality to maximize the utility level when resource constraints are imposed.

An important difference between these theoretical models is that they offer different mechanisms to explain the survival of an inverted U-shaped pattern. Then, Stocky (1998) concludes that the choice of optimal production technology in diverse periods of development resulted in the EKC.

Jones and Manuelli (2001) change the outlook from technology to political factors; they show that the pollution tax and/or regulations may interpret the formation of the EKC.

For most of the existing literature, they neglect one significant feature that the effect of FDI on environmental pollution depends on the level of economic development, in other words, the impact

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of FDI on environmental quality varies according to the development period. The pollution is based on gross domestic product (GDP) and should be considered as a function of GDP.

In addition, most empirical research using the quadratic term and the cubic term to capture the nonlinear effect of GDP and/or FDI on the environment, prior specification of the regression function may bias the results as mentioned by Harbaugh et al. (2002).

This paper provides a study on the impact of foreign direct investment (FDI) on sustainable development from an empirical point of view in the case of the North African countries during the period from 1985 to 2005.

Then, we use the estimation FMOLS and causality test. According to the empirical findings, we show the existence of a cointegration relationship between the different variables used in this paper. With the cointegration test, we can determine the use of an error correction model. Also, to test the effect of FDI on sustainable development in the countries of North Africa, we will make an estimate by FMOLS method. We conclude that the FDI has a positive impact on sustainable development. In addition, we notice that there is a bidirectional relationship between FDI Granger and CO₂ emissions ($0.0000 < 5\%$ and $0.0000 < 5\%$). That is to say, the FDI can cause Granger emissions of CO₂ and CO₂ emissions can cause Granger FDI.

The rest of the paper is organized as follows. In section 1, we present a literature review. Second section summarizes the econometric methodology. Data are presented in section 3. Section 4 was dedicated to the interpretation of results. The conclusion is made in the last section.

1. Literature review

Moreover, Borenszteina et al. (1998) study the impact of foreign direct investment (FDI) on economic growth in developing countries through panel data for 69 countries for two decades from 1970 to 1989. Their results show that FDI is an important vehicle for technology transfer, contributing to growth relatively more than domestic investment. However, the greater productivity of FDI holds only when the host country has a minimum threshold stock of human capital. Thus, FDI contributes to economic growth only if sufficient capacity to absorb advanced technologies is available in the host economy.

Similarly, Nair-Reichert and Weinhold (2001) analyze the effect of FDI on growth with a panel of 24 developing countries over 25 years using a mixed approach of fixed and random coefficient (mixed fixed and random coefficient approach). This study explored that the FDI has averaged a significant positive impact on growth, but the relationship is heterogeneous across countries.

Besides, Manuchehr and Ericsson (2001) work on the causality between foreign direct investment and production based on a sample of four countries, namely Denmark, Finland, Sweden and Norway, for the period 1970-1997. They use Lag-augmented vector autoregression method. They show that FDI has a positive effect on economic growth in the country of Norway.

The study of Choe (2003) tried to show the causal relationship between economic growth and FDI in 80 countries during the period 1971-1995. The Granger causality test results show that FDI causes economic growth and vice versa.

In addition, Chowdhury and Mavrotas (2006) examine the causal relationship between FDI and economic growth using innovative econometric methodology to study the direction of causality between the two variables. They apply their methodology, based on Lag-augmented vector autoregression with time series data covering the period 1969-2000 for three developing countries, namely Chile, Malaysia and Thailand. Their empirical results show that there is strong evidence of bidirectional causality between the two variables for Malaysia and Thailand.

In addition, Chakraborty and Nunnenkamp (2006) analyze the effect of FDI on India's economy. The authors took a period from 1987 to 2000 by applying the model of Granger causality test. They find bidirectional causality in the industry of manufacturing sector. While FDI has a positive effect on economic growth.

The study of Al-Iriani (2007) also examines the association between foreign direct investment and economic growth. The sample consists of six countries including the Gulf Cooperation Council (GCC) for the period 1970-2004. The model used is Granger causality test of Holtz-Eakin. The results of a panel analysis indicate bidirectional causality

between FDI and GDP in this group of GCC countries. Hence, the FDI has a positive effect on economic growth.

Regarding the research of Shaikh (2010) who has studied the causal link between FDI and economic growth in Pakistan using time series of quarterly data from 1998 to 2009, the model OLS (Ordinary Least Squares) shows bidirectional causality between foreign direct investment and economic growth, and foreign direct investment has a positive impact on the economic growth in Pakistan, especially in the manufacturing sector. Moreover, Shaikh applies the same methodology in Malaysia for a further period from 1970 to 2005 to confirm the significant positive relationship between these two variables.

Davletshin et al. (2015) analyze the relationship between the flow of foreign investment in the country and economic growth by taking two groups: group of developed countries and group of developing countries. Their analysis is based on the correlation test for the period 1995–2012. Their results show that GDP depends directly on FDI and the FDI effect on GDP is strong and important in developing countries.

Moreover, Iamsiraroj (2016) studies the relationship between FDI and economic growth through panel data from 124 countries

covering the period from 1971 to 2010. The author uses the method of OLS. The estimation results indicate that the overall effects of FDI are positively associated with growth and vice versa. So, there is a bidirectional relationship between FDI and economic growth.

Still, the study of Pegkas (2015) including its goal is twofold: first, analyzes the relationship between foreign direct investment and economic growth, and, second, estimates the effect of FDI on economic growth using panel data for the euro area countries over the period from 2002 to 2012 and applying the method of OLS completely changed FMOLS and Dynamic Ordinary Least Squares (DOLS). The empirical analysis reveals that there is a lasting positive co-integration relationship between the stock of FDI and economic growth, and the results show that the stock of foreign direct investment is a significant factor that positively affects economic growth.

2. Empirical methodology

This paper provides a study of the effect of foreign direct investment (FDI) on sustainable development from an empirical point of view in the case of the North African countries during the period from 1985 to 2005.

First of all, the model is:

$$\begin{aligned} LCO2_{it} = & \beta_0 + \beta_1 LFDI_{it} + \beta_2 LGINI_{it} + \beta_3 LINF_{it} + \beta_4 LGDP_{it} + \beta_5 LUP_{it} + \beta_6 LLR_{it} + \\ & + \beta_7 LEU_{it} + \beta_8 LPE_{it} + \beta_9 LFD_{it} + \beta_{10} LGCF_{it} + \beta_{11} LU_{it} + \beta_{12} LRE_{it} + \beta_{13} LMC_{it} + \\ & + \beta_{14} LPOV1.91\$_{it} + \beta_{15} LPOV3.1\$_{it} + \varepsilon_{it} \end{aligned}$$

where β_0 is a constant, β_i are coefficients of the explanatory variables $i = 1, \dots, 16$, $t = 1, \dots, 31$ and

ε_{it} is the term of error. Table 1 summarizes the different variables used in our paper.

Table 1. The different variables

Nature of factor	The variable	Variable code	Source
Dependent variable	CO2 emissions (kt)	CO2	World Bank
Control variable	GINI Index	GINI	World Bank
Control variable	Poverty to \$ 1.90 a day (2011 PPP) (%)	\$ POV1.91	World Bank
Control variable	Poverty to \$ 3.10 a day (2011 PPP) (%)	\$ POV3.1	World Bank
Control variable	Foreign direct investment, net inflows (% of GDP)	FDI	World Bank
Control variable	Youth literacy rate (% of youth aged 15 to 24)	LR	World Bank
Control variable	GDP per capita (annual%)	GDP	World Bank
Control variable	Public expenditure (% of GDP)	PE	World Bank
Control variable	Use of renewable energy (% of total energy consumed)	RE	World Bank
Control variable	Inflation, consumer prices (annual%)	INF	World Bank

Table 1 (cont.). The different variables

Nature of factor	The variable	Variable code	Source
Control variable	Urban population (% of total)	UP	World Bank
Control variable	Market capitalization of listed companies (% of GDP)	MC	World Bank
Control variable	Unemployment, total (% of population) (ILO modeled estimate)	U	World Bank
Control variable	Gross capital formation (% of GDP)	GCF	World Bank
Control variable	Domestic credit to private sector (% of GDP)	FD	World Bank
Control variable	Energy use (kg oil equivalent) per \$ 1,000 GDP (PPP constant 2011)	EU	World Bank

The data used in this paper are of annual frequency for all variables. These data come from the World Bank database and the International Monetary Fund for the period from 1985 to 2015. We will estimate the models chosen by referring to an analysis of panel data.

The choice of panel data is based on the two dimensions of the used data: the first dimension is time (a period of 31 years) and the second is individual (employee sample consists of 6 countries of North Africa).

3. Data

In this section, we present the sample and the model used in our paper.

Our objective in this paper is to study of the impact of FDI on sustainable development in the case of the North African countries during the period from 1985 to 2015.

In Table 2, we expose the different countries employed in our paper.

Table 2. The countries of North Africa

Name of the country	Area (km ²)	Population (2016 estimate)	Population density (per km ²)
Algeria	2,3817,41	37,100,000	14.5
Egypt	1,001,450	81,249,302	80.4
Libya	1,759,540	646,1450	3.7
Morocco	710,850	32,245,000	70.8
Sudan	1,886,068	31,957,965	16.9
Tunisia	163,610	10.67,3000	64.7

In this section, we will try to make a descriptive analysis of the different results for the study of the impact of FDI on sustainable development in the North African countries.

First, let's define the type of assessment which is a regression on panel data. Our choice is justified by the presence of two dimensions in the data used: the first is time (a period of 31 years) and the second is individual (our sample is made up of 6 North African countries).

This section is dedicated to the interpretation of results for the descriptive statistics and Pearson correlation matrix for the variables used in our study.

All descriptive statistics of the variables used in our paper are summarized in Table 3.

According to the results of Table 3, we find that the LCO2 variable, which expresses logarithm of CO2 emissions, can reach a maximum value of 12.30497. As its minimum value is 7.975197, its risk is measured by the standard deviation which is 1.022934.

The LGINI variable, which measures the logarithm of the GINI Index, can reach a maximum value of 4.146937. While its minimum value is 3.425890, its risk is measured by the standard deviation which is 0.192268.

Using both statistics of asymmetry (skewness) and kurtosis, we can conclude that all variables used in this paper are characterized by non-normal distribution. Then, the asymmetry coefficients indicate that all variables are shifted to the left (negative sign of asymmetry coefficients) and are far from symmetrical except for LGINI, LFDI, LINF, LGDP, LUP, LEU, LGCF and LU variables, which are oriented to the right (positive sign of asymmetry coefficients).

Also, the kurtosis coefficient shows that leptokurtic for all variables used in this paper indicate the presence of a high peak or a large tail in their volatilities (leptokurtic the coefficients are more than 1).

In addition, the positive sign of estimation coefficients of Jarque-Bera statistics indicates that we can reject the null hypothesis of the normal distribution of the variables used in our paper. In fact, the high value of the coefficients of the Jarque-Bera statistic shows that the series are not normally distributed at a level of 1 percent.

The results shown by the three statistics, namely skewness, kurtosis and Jarque-Bera, suggest that all variables used in our paper are not normally distributed for the case of the countries of North Africa and during the study period from 1985 to 2015.

Thus, we conduct a test of the correlation between the different variables used in the case of the North African countries during the study period from 1985 to 2015.

Table 4 summarizes the results for Pearson correlation test. In addition, the results show that all coefficients between the explanatory variables do not exceed the tolerance limit (0.7), which does not cause problems in the estimation of the model. That is to say, we can integrate the different variables used in the same model.

A study of the causal relationship between FDI and sustainable development in the North African countries requires performing prior stationary tests to determine the order of integration of each series. The results of the Levin-Lin-Chu test (LLC), Im-Pesaran-Shin (IPS), Fisher-Augmented Dickey Fuller (ADF) and Fisher-Phillips-Perron (PP) applied to the series are shown in Table 5 for the North African countries.

The acceptance or rejection of the null hypothesis of the different tests is based on the value of probability and the indicated statistics test. These probabilities are compared with a 10% threshold. If these probabilities are less than 10%, then we reject the null hypothesis and if these probabilities are more than 10%, then we accept the null hypothesis.

For the North African countries, we observe that only three variables, namely LFDI, LGDP and LEU, are non-stationary in level according to the test of Levin-Lin-Chu, but all variables are stationary in first difference according to this test.

According to statistics of the Im-Pesaran-Shin (IPS) test, Fisher-ADF test and the test Fisher-PP, we can conclude that only four variables, LFDI, LGDP, LINF and LEU are stationary in level. But in first difference, all variables are stationary according to these three tests. Thereafter, all the variables are integrated of order 1. Thus, we can use the cointegration test.

Table 3. Descriptive statistics

	LGINI	\$ LPOV1_91	\$ LPOV3_1	LCO2	LFDI	LINF	LGDP	LUP
Average	3.659430	1.711339	2.819903	10.52246	1.740903	12.13125	1.966823	3.953845
Median	3.572328	1.751173	2.913658	10.57184	1.226897	5.737290	1.894978	4.005441
Maximum	4.146937	3.801985	4.074482	12.30497	9.424248	132.8238	104.6576	4.361301
Minimum	3.425890	-0.916291	0.741937	7.975197	-0.469340	-9.797647	-62.21435	3.132751
Standard deviation	0.192268	1.537783	1.007091	1.022934	1.875266	21.34465	9.915128	0.299145
Skewness	1.017615	-0.314673	-0.407684	-0.437984	1.658814	3.792586	4.340137	-0.572764
Kurtosis	3.330697	1.869836	1.860567	2.615518	6.371119	18.51450	72.66292	2.511294
Jarque-Bera	32.94928 *	12.96843 *	15.21429 *	7.092390 *	173.3760 *	2311.317 *	38194.09 *	12.02076 *
Probability	0.000000	0.001527	0.000497	0.028834	0.000000	0.000000	0.000000	0.002453
Sum	680.6540	318.3091	524.5020	1957.178	323.8080	2256.413	365.8290	735.4151
Sum Sq. Dev.	6.838913	437.4836	187.6328	193.5830	650.5753	84284.89	18187.31	16.55519
Observations	186	186	186	186	186	186	186	186
	LLR	LEU	LPE	LFD	LGCF	LU	LRE	LMC
Average	4.397266	4.647219	2.760326	3.117432	24.17608	2.671726	1.880000	3.329833
Median	4.400727	4.538225	3.187676	3.306042	24.53558	2.694627	2.356580	3.180049
Maximum	4.604464	5.460651	3.566570	4.336893	46.87646	3.394508	4.450014	5.622575
Minimum	4.067913	4.276705	1.401579	0.479664	4.329239	2.091864	-1.730354	0.716136
Standard Deviation	0.148325	0.288363	0.742070	0.959663	7.523842	0.292898	1.737291	1.399367
Skewness	-0.428835	1.298344	-0.776126	-0.727663	0.207327	0.045106	-0.529717	-0.324575
Kurtosis	2.526260	3.880495	1.924430	2.732941	3.446433	2.417982	2.494614	2.045393
Jarque-Bera	7.440210 **	58.26498 *	27.63912 *	16.96701 *	200.877117	232.688345	10.67806 *	10.32820 *
Probability	0.024231	0.000000	0.000001	0.000207	0.000000	0.000000	0.004801	0.005718
Sum	817.8915	864.3827	513.4206	579.8423	4496.752	496.9410	349.6800	619.3490
Sum Sq. Dev.	4.070076	15.38337	101.8735	170.3764	10472.52	15.87098	558.3630	362.2723
Observations	186	186	186	186	186	186	186	186

Table 4. The correlation matrix

	LGINI	\$ LPOV1_91	\$ LPOV3_1	LCO2	LFDI	LINF	LGDP	LUP
LGINI	1.000000	0.216744	0.154968	-0.165647	-0.220977	-0.227902	-0.017152	0.653434
\$ LPOV1_91	0.216744	1.000000	0.089412	0.399300	-0.211419	0.025710	-0.059185	0.176666
\$ LPOV3_1	0.154968	0.089412	1.000000	0.457670	-0.226173	0.013915	-0.057560	0.144844
LCO2	-0.165647	0.399300	0.457670	1.000000	0.000554	-0.472189	-0.028778	0.416057
LFDI	-0.220977	-0.211419	-0.226173	0.000554	1.000000	-0.175203	0.107440	-0.116444
LINF	-0.227902	0.025710	0.013915	-0.472189	-0.175203	1.000000	-0.034212	-0.550643
LGDP	-0.017152	-0.059185	-0.057560	-0.028778	0.107440	-0.034212	1.000000	-0.022537
LUP	0.653434	0.176666	0.144844	0.416057	-0.116444	-0.550643	-0.022537	1.000000
LLR	0.526538	0.287783	0.208722	0.066702	0.093524	-0.139248	-0.014518	0.535036
LEU	0.274596	0.255015	0.194614	-0.655195	-0.074166	0.565342	-0.090298	-0.340264
LPE	-0.622753	-0.437272	-0.386163	0.404099	0.115025	-0.256776	-0.007249	0.011678
LFD	0.057127	-0.258985	-0.274410	0.330278	0.061514	-0.508943	-0.049271	0.390001
LGCF	-0.167209	-0.192547	-0.163840	0.278071	0.174104	-0.297027	-0.008009	0.278378
LU	0.478501	0.349806	0.310655	-0.192702	-0.311803	0.043348	-0.046815	0.281923
LRE	-0.160403	-0.551713	-0.579122	-0.017235	0.273491	0.341804	0.070820	-0.627556
LMC	-0.467603	-0.061890	0.025036	0.622213	-0.079906	-0.251845	-0.017867	0.102219
	LLR	LEU	LPE	LFD	LGCF	LU	LRE	LMC
LGINI	0.526538	0.274596	-0.622753	0.057127	-0.167209	0.478501	-0.160403	-0.467603
\$ LPOV1_91	0.287783	0.255015	-0.437272	-0.258985	-0.192547	0.349806	-0.551713	-0.061890
\$ LPOV3_1	0.208722	0.194614	-0.386163	-0.274410	-0.163840	0.310655	-0.579122	0.025036
LCO2	0.066702	-0.655195	0.404099	0.330278	0.278071	-0.192702	-0.017235	0.622213
LFDI	0.093524	-0.074166	0.115025	0.061514	0.174104	-0.311803	0.273491	-0.079906
LINF	-0.139248	0.565342	-0.256776	-0.508943	-0.297027	0.043348	0.341804	-0.251845
LGDP	-0.014518	-0.090298	-0.007249	-0.049271	-0.008009	-0.046815	0.070820	-0.017867
LUP	0.535036	-0.340264	0.011678	0.390001	0.278378	0.281923	-0.627556	0.102219
LLR	1.000000	0.287557	-0.393472	0.034387	-0.101385	0.309117	-0.278047	-0.444202
LEU	0.287557	1.000000	-0.038724	-0.542902	-0.515000	0.271294	0.379276	-0.029952
LPE	-0.393472	-0.038724	1.000000	0.538695	0.485806	-0.438228	-0.139890	0.011836
LFD	0.034387	-0.542902	0.538695	1.000000	0.167907	-0.338843	-0.085541	0.181762
LGCF	-0.101385	-0.515000	0.485806	0.167907	1.000000	-0.180540	-0.400536	0.556466
LU	0.309117	0.271294	-0.438228	-0.338843	-0.180540	1.000000	-0.331089	-0.283439
LRE	-0.278047	0.379276	-0.139890	-0.085541	-0.400536	-0.331089	1.000000	-0.489024
LMC	-0.444202	-0.029952	0.011836	0.181762	0.556466	-0.283439	-0.489024	1.000000

Table 5. The unit root test

	<i>Levin, Lin and Chu test</i>		<i>Im Pesaran and Shin test</i>		<i>Fisher-ADF test</i>		<i>Fisher-PP test</i>	
	In level	In the first difference	In level	In the first difference	In level	In the first difference	In level	In the first difference
LGINI	0.04843	-8.49929 *	0.89018	-8.20229 *	2.29937	* 60.0539	2.40167	* 55.2620
\$ LPOV1_91	-0.14884	-5.74166 *	1.42407	-4.50321 *	3.24554	* 30.8073	3.11444	* 62.9879
\$ LPOV3_1	0.16586	-6.66453 *	1.83580	-5.19057 *	2.70321	* 40.9005	2.59457	* 75.6234
LCO2	-2.31532 **	-4.30995 *	0.69587	-7.07982 *	8.56954	* 69.5309	9.67859	154 030 *
LFDI	-1.34558 ***	-7.74929 *	-1.45050 ***	-7.72450 *	17.4511	* 77.2053	21.3662 **	110 975 *
LINF	-0.95540	-4.66477 *	-1.15735	-8.10519 *	15.8569	* 80.9894	19.9673 ***	169 770 *
LGDP	-1.51908 ***	-8.99655 *	-6.75610 *	-15.2398 *	* 69.8560	143 243 *	114 075 *	147 112 *
LUP	0.27789	-3.04947 *	1.41163	-2.65498 *	8.52763	* 38.9532	5.71631	* 96.0690
LLR	0.92601	-6.17024 *	2.71270	-5.34750 *	1.70601	* 42.3096	1.56592	* 82.1910
LEU	0.94164	-6.57636 *	0.52071	-7.52213 *	11.7411	* 74.3314	20.9092 ***	166 572 *
LPE	0.10824	-4.94802 *	0.78000	-4.79169 *	6.71074	* 37.6871	6.01183	* 74.3079
LFD	-0.45709	-2.94146 *	0.07851	-4.68708 *	8.62522	* 47.3625	8.09243	* 87.9162
LGCF	-0.55114	-8.91245 *	-0.27310	-8.55507 *	12.4720	* 86.1683	12.9794	109 564 *
LU	1.16977	-8.14926 *	0.72209	-3.48922 *	6.58552	* 36.7939	9.46106	104 902 *

Table 5 (cont.). The unit root test

	<i>Levin, Lin and Chu test</i>		<i>Im Pesaran and Shin test</i>		<i>Fisher-ADF test</i>		<i>Fisher-PP test</i>	
	In level	In the first difference	In level	In the first difference	In level	In the first difference	In level	In the first difference
LRE	0.35985	-6.81112 *	1.81424	-7.27592 *	4.81480	* 73.3678	4.84895	145 911 *
LMC	1.40710	-4.90207 *	0.84712	-6.38119 *	8.13605	* 62.8924	12.1554	118 134 *

Note: In this test, the p-value is compared to 10%. If the probabilities <10%, then, we reject the null hypothesis and if the probabilities >10%, then, we accept the null hypothesis. With the null hypothesis all series are non-stationary. (*), (**) and (***) are significant values for the 1% and 5%, respectively.

4. Empirical analysis

4.1. The cointegration test. We expose in this part the results of cointegration test. Kao, Pedroni and Johansen Fisher cointegration tests are used to verify the long-term relationship between the variables used in this paper to examine the impact of FDI on sustainable development in the case of the North African countries.

The Kao test is based on the statistical t-test and ADF Pedroni is based on two statistical PP-Statistic Panel and ADF-Statistic Panel individual and grouped. But Fisher's test is based on the Fisher statistical test track and Fisher Statistic of max-eigen test. The results of cointegration test for the countries of North Africa are presented in Table 6.

Indeed, the Pedroni test demonstrates the long-term relationship between the FDI and sustainable development.

Thus, Kao test confirms the long-term relationship between the different variables used in this paper, mainly between FDI and sustainable development.

In addition, Fisher's test results confirm the presence of a long-term relationship between FDI and sustainable development in the North African countries for the period from 1985 to 2015.

According to the results in Table 6, we confirm the existence of a cointegration relationship between the different series studied in this paper. The results of the null hypothesis test of no cointegration were rejected at the 5% threshold, which explains the presence of a cointegration relationship.

The results of these tests can determine the use of an error correction model. Also, to test the effect of FDI on sustainable development in the North African countries, we will perform a FMOLS estimate.

Table 6. The cointegration test of the impact of FDI on sustainable development for countries of North Africa

Pedroni Residual Cointegration Test				Kao Residual Cointegration Test	Fisher Johansen Cointegration Test Panel			
Common AR coeffs. (Within-dimension)		Individual AR coeffs. (Between-dimension)		Statistics (Probability)	Fisher Stat. * (From test track)	Prob.	Fisher Stat. * (From max-eigen test)	Prob.
PP-Statistic Panel	-2.817652 (0.0024) *	PP-Statistic Panel	-2.677227 (0.0037) *	-4.010569 (0.0000) *	199.5	(0.0000) *	112.6	(0.0000) *
ADF-Statistic Panel	-4.053302 (0.0000) *	ADF-Statistic Panel	-4.637353 (0.0000) *					

Note: (*) are significant values at a threshold of 1%.

4.2. The error correction model (ECM). After testing the cointegration between FDI and sustainable development in our paper, we'll estimate the error correction model. The ECM allows to model together for short-term dynamics (represented by the variables in first differences) and long-term dynamics (represented by the variables in level).

Table 7 summarizes the estimated error correction model for sustainable development and for the North African countries during the period from 1985 to 2015.

For LFDI variable and studying the short-term dynamics, we notice that the FDI (t-2) have a positive and significant impact on a threshold of

1% of foreign direct investment at time t for the case North African countries. That is to say, if the IDE at the time $(t-2)$ increases by one unit, then, foreign direct investment at time t increases by 0.265404 units.

Poverty measured by the GINI Index has a negative and significant impact on foreign direct investment at a 10% threshold. That is to say, if the GINI Index increases by 10 units, then, foreign direct investment fell by 3.518615 units.

The LINF variable that measures the consumer price index also has a negative and significant impact on foreign direct investment with a threshold of 5%. That is to say, if the level of the inflation rate increases by five units, then, foreign direct investment falls by 0.016970 units.

The LEU variable that measures the level of energy consumption is statistically significant and has a positive impact on foreign direct investment at a level of 5%. So, if energy consumption increases by five units, then, foreign direct investment increases by 1.659182 units.

The LGCF variable that measures the gross formation of capital stock also has a positive and significant impact on foreign direct investment with a threshold of 1%. That is to say, if the level of gross fixed capital stock increases by one unit, foreign direct investment increases by 0.059556 units.

LRE variable that measures the consumption of renewable energy has a positive and significant impact on foreign direct investment with a threshold of 1%. That is to say, if the level of consumption of renewable energy increases by one unit, foreign direct investment increases by 0.619481 units.

For sustainable development, we note that emissions of CO₂ at the time $(t-1)$ have a negative and significant effect on CO₂ emissions at 1% threshold. This means that if emissions of CO₂ at the time $(t-1)$ increase by one unit, they decrease fell by 0.401891 units at time t .

The LINF variable that measures the consumer price index also has a negative and significant impact on emissions of CO₂ at a threshold of 5%. That is to say, if the level of the inflation rate increases by one unit, then the CO₂ emissions decrease to 0.001444 units.

The LMC variable that measures the market capitalization of listed companies has statistically significant and positive impact on CO₂ emissions at a 10% threshold. So, if the market capitalization of listed companies increases by ten units, then, the CO₂ emissions increase by 0.026446 units.

FDI has no effect on CO₂ emissions, which measures sustainable development at short time.

Table 7. The ECM for variable LCO2

Cointegrating Eq:	CointEq1	
LFDI (-1)	1.000000	
LCO2 (-1)	-1.389206	
	(0.52364)	
	[-2.65299] **	
C	12.83399	
Error correction:	D (LFDI)	D (LCO2)
CointEq1	-0.573241	0.010564
	(0.08189)	(0.00654)
	[-7.00033] *	[1.61631]
D (LFDI (-1))	0.138686	-0.001438
	(0.08452)	(0.00675)
	[1.64088]	[-0.21316]
D (LFDI (-2))	0.265404	0.002442
	(0.07799)	(0.00622)
	[3.40303] *	[0.39234]
D (LCO2 (-1))	1.654061	-0.401891
	(1.00477)	(0.08019)
	[1.64620]	[-5.01151] *
D (LCO2 (-2))	2.396795	-0.067375
	(0.96360)	(0.07691)
	[2.48733]	[-0.87605]
C	-7.842108	0.307039
	(9.47774)	(0.75644)
	[-0.82742]	[0.40590]
LGINI	-3.518615	0.017769
	(1.90225)	(0.15182)
	[-1.84971] ***	[0.11703]
\$ LPOV1_91	0.488675	-0.013726

Table 7 (cont.). The ECM for variable LCO2

Cointegrating Eq:	CointEq1	
	(0.64651)	(0.05160)
	[0.75587]	[-0.26600]
\$ LPOV3_1	-0.935288	0.007996
	(1.02202)	(0.08157)
LINF	-0.016970	-0.001444
	(0.00655)	(0.00052)
	[-2.59077] **	[-2.76299] *
LGDP	0.012013	0.000539
	(0.00970)	(0.00077)
	[1.23820]	[0.69627]
LUP	1.234348	-0.110114
	(1.26188)	(0.10071)
	[0.97818]	[-1.09333]
LLR	1.478636	-0.027672
	(1.23857)	(0.09885)
	[1.19383]	[-0.27993]
LEU	1.659182	0.066109
	(0.81033)	(0.06467)
	[2.04755] **	[1.02218]
LPE	-0.357099	-0.025279
	(0.48293)	(0.03854)
	[-0.73944]	[-0.65584]
LFD	-0.102722	0.007644
	(0.22079)	(0.01762)
	[-0.46525]	[0.43379]
LGCF	0.059556	-0.002622
	(0.02136)	(0.00170)
	[2.78848] *	[-1.53825]
LU	0.828491	-0.009341
	(0.53879)	(0.04300)
	[1.53769]	[-0.21721]
LRE	0.619481	-0.007170
	(0.21316)	(0.01701)
	[2.90615] *	[-0.42146]
LMC	-0.011525	0.026446
	(0.17641)	(0.01408)
	[-0.06533]	[1.87827] ***
R-squared	0.713195	0.759906
Adj. R-squared	0.725025	0.764894

Note: (*), (**) and (***) are significant values for the 1%, 5% and 10% , respectively.

4.3. The FMOLS estimation results. The panel FMOLS method proposed by Pedroni (1996, 2000) solves problems of heterogeneity in the sense that it allows to use heterogeneous cointegrating vectors. For Maeso-Fernandez et al. (2004), FMOLS estimator takes into account the presence of the constant term and the possible existence of correlation between the error term and differences estimators.

Adjustments are made to this effect on the dependent variable and long-term parameters obtained by estimating the fitted equation. In the case of panel data, the long-term coefficients from the FMOLS are obtained by the average group of estimators with respect to the sample size (N).

According to Table 8, the coefficient of determination is more than 0.7, therefore, the estimated model is characterized by a good linear fit. The first is the variable for FMOLS estimate, we notice that there

are five significant variables, but with different signs.

We find that the LFDI variable measuring foreign direct investment has a positive impact on sustainable development at a threshold of 5%. That is to say, if the level of foreign direct investment increases by 5 units, then, CO2 emissions increase by 10.61978 units.

Then, LGDP which measures the GDP growth rate has a positive and significant impact on sustainable development at a threshold of 1%. This means that if the GDP growth rate increases by one unit, then, the CO2 emissions increase by 0.018659 units at time t in the case of the North African countries.

The LEU variable which measures the level of energy consumption is statistically significant and positive at a 1% level. So, if energy consumption increases by one unit, then, the CO2 emissions increase by 4.452260 units.

The LGCF variable that measures the gross formation of capital stock also has a positive and significant impact on sustainable development with a threshold of 5%. That is to say, if the level of gross fixed capital stock increases by five units, then the CO₂ emissions increase by 0.244468 units.

The LRE variable that measures the consumption of renewable energy has a positive and significant impact on sustainable development with a threshold of 5%. That is to say, if the level of consumption of renewable energy increases by five units, then, the CO₂ emissions increase by 10.17242 units.

Table 8. FMOLS estimation for variable LCO₂

Variable	Coefficient	Std. error	t-Statistic	Prob.
LFDI	10.61978	4.308183	2.465026 **	0.0162
LGINI	-3.011224	10.42049	-0.288971	0.7735
\$ LPOV1 91	-1.161451	4.228998	-0.274640	0.7844
\$ LPOV3 1	2.217986	6.760589	0.328076	0.7438
LINF	-0.090040	0.106092	-0.848699	0.3990
LGDP	0.018659	0.023422	5.796654 *	0.0000
LUP	-25.62075	20.10734	-1.274199	0.2069
LLR	1.729992	8.980003	0.192649	0.8478
LEU	4.452260	5.405615	5.823636 *	0.0000
LPE	0.615290	3.503239	0.175634	0.8611
LFD	-0.855632	1.758813	-0.486483	0.6282
LGCF	0.244468	0.095770	2.552650 **	0.0129
LU	-2.385291	4.091739	-0.582953	0.5618
LRE	10.17242	4.478871	2.271201 **	0.0263
LMC	0.460040	0.853206	0.539190	0.5915
R-squared	0.740912	Mean dependent var		1.694030
Adjusted R-squared	0.749871	SD dependent var		1.716853
SE of regression	1.582980	Sum squared resid		172.9020
Long-run variance	5.086191			

Note: (*), (**) and (***) are significant values for the 1%, 5% and 10%, respectively.

4.4. The causality test. We need to check if the foreign direct investment affect CO₂ emissions or the CO₂ emissions affect FDI in the North African countries.

The acceptance or rejection of the null hypothesis of Granger causality test is based on a threshold of 5%. If the probability of the test is less than 5% in this case, we reject the null hypothesis and if the probability is more than 5%, then, we accept the null hypothesis of no causality.

Table 9 summarizes the overall results of causality test between FDI and emissions of CO₂ for countries of North Africa during the study period from 1985 to 2015.

According to Table 9, we notice that there is a bidirectional relationship between FDI and CO₂ emissions with the Granger causality (0.0000 < 5% and 0.0000 < 5%). That is to say, the FDI can affect CO₂ emissions and CO₂ emissions can affect FDI.

Thus, we notice that there is a unidirectional relationship between sustainable development and economic growth Granger. Only CO₂ emissions can affect economic growth.

In addition, we remark that there is a bidirectional relationship among the urban population and CO₂ emissions. That is to say, the urban population can affect CO₂ emissions and CO₂ emissions can affect urban population.

Table 9. The causality test for variable LCO₂

Null hypothesis:	Obs	F-statistic	Prob.
CO ₂ does not Granger Cause FDI	174	6.97621	0.0000
FDI does not Granger Cause CO ₂		7.69724	0.0000
GINI does not Granger Cause CO ₂	174	2.05242	0.1316
CO ₂ does not Granger Cause GINI		0.02150	0.9787
\$ POV1_91 does not Granger Cause CO ₂	174	0.41057	0.6639
CO ₂ does not Granger Cause \$ POV1_91		0.29971	0.7414

Table 9 (cont.). The causality test for variable LCO2

Null hypothesis:	Obs	F-statistic	Prob.
\$ POV3_1 does not Granger Cause CO2	174	0.25712	0.7736
CO2 does not Granger Cause \$ POV3_1		0.27003	0.7637
INF does not Granger Cause CO2	174	2.77630	0.0651
CO2 does not Granger Cause INF		1.02793	0.3600
GDP does not Granger Cause CO2	174	1.06934	0.3455
CO2 does not Granger Cause GDP		3.92708	0.0215
PU does not Granger Cause CO2	174	5.41834	0.0052
CO2 does not Granger Cause PU		14.4620	2.E-06
LR does not Granger Cause CO2	174	2.27006	0.1064
CO2 does not Granger Cause LR		0.95201	0.3880
EU does not Granger Cause CO2	174	1.13016	0.3254
CO2 does not Granger Cause EU		0.19505	0.8230
PE does not Granger Cause CO2	174	1.31492	0.2712
CO2 does not Granger Cause PE		0.34891	0.7060
FD does not Granger Cause CO2	174	0.89644	0.4100
CO2 does not Granger Cause FD		2.14380	0.1204
GCF does not Granger Cause CO2	174	0.08322	0.9202
CO2 does not Granger Cause GCF		0.34931	0.7057
U does not cause CO2 Granger	174	2.11836	0.1234
CO2 does not Granger Cause U		0.93460	0.3948
RE does not Granger Cause CO2	174	1.51098	0.2237
CO2 does not Granger Cause RE		1.36169	0.2590
MC does not Granger Cause CO2	174	1.96667	0.1431
CO2 does not Granger Cause MC		2.61227	0.0763

Conclusion

Currently, much of the debate on foreign direct investment and the environment revolves around the assumption of “pollution havens” This essentially means that companies move their activities to less developed countries to benefit from less stringent environmental regulations. Thus, this paper provides a study on sustainable development and foreign direct point (FDI) from an empirical investigation of view in the case of the North African countries during the period from 1985 to 2005.

According to the empirical findings, we confirm the existence of a cointegration relationship between the different series studied in this paper. So, we notice that there is a bidirectional relationship between FDI and CO2 emissions with the Granger causality.

The cointegration test can confirm the use of a error correction model. Also, to test the effect of foreign direct investment on sustainable

development in the North African countries, we make an estimate by FMOLS method. We find that the foreign direct investment has a positive impact on sustainable development.

The study therefore suggests the following recommendations: The North African Governments should impose stringent laws to protect their environment and regulate the activities of international corporations and ensure that these laws are adhered to. Environmental by friendly equipments should be utilized by multinational corporations and resource extracting industries. Governments should prepare policies and programs that will lessen poverty and provide to the less privileged and poor citizens. This is to make sure that natural resources are not wasted or misused by the poor. Finally, adequate lands should be provided for housing, farm and resources productivities between the less privileged to achieve environmental sustainability.

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