The Impact of Income and Education on Building Environmental Culture and Reducing Carbonisation "Econometric Study Using Panel Data Model on the Maghreb Countries from 1987-2018"

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Abstract

In this study, we examine the relationship between Carbon Dioxide Emissions (CO_2) and two Human Development Indicators (HDI): income and education. Applying Panel data analysis across three countries: Algeria, Tunisia and Morocco within 29 years. On a hand, the study was able to confirm the positive high effect of income and in the other hand; education had no effect on carbonization. Besides to that, we detected a unidirectional causality from education to income and another one from income to CO_2 emissions. Meanwhile, we discovered a long-run relationship between variables. To close, the hypothesis of the Environmental Kuznets Curve (EKC) is note verified in the study period for our sample.

Key words: CO_2 emissions, income, education, EKC, panel data.

Jel Codes Classification : C33, I21, O15, O44, O55, Q53

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تأثير الدخل والتعليم على بناء الثقافة البيئية وخفض الانبعاثات الكربونية "دراسة قياسية باستعمال نموذج بيانات البانل في عينة من الدول المغاربية للفترة 1987-2018"

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ملخص

قمنا في هذه الدراسة باختبار العلاقة بين انبعاثات غاز ثاني أكسيد الكربون ومؤشرين للتنمية البشرية هما: الدخل والتعليم. بتطبيق نموذج بيانات البانل على ثلاث دول هي الجزائر، تونس والمغرب خلال 29 سنة. من جهة فقد تمكنت الدراسة من تأكيد وجود تأثير إيجابي عالي للدخل ولكن من جهة أخرى، لم يتم رصد أي تأثير للتعليم على الانبعاثات. بجانب ذلك فقد قمنا بإيجاد سببية أحادية الاتجاه من التعليم نحو الدخل وأخرى من الدخل نحو انبعاثات CO_2. كذلك فقد كشفنا عن وجود علاقة طويلة المدى بين متغيرات النموذج. وختاما، فإن فرضية منحنى كوزنتس البيئي (EKC) ليست محققة كليا في عينة وزمن الدراسة.

الكلمات المفاتيح: انبعاثات غاز ثاني أكسيد الكربون، الدخل، التعليم، منحنى كوزنتس البيئي، بيانات بانل

التصنيف JEL: *C33, I21, O15, O44, O55, Q53*

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Introduction

The problem of both climate change and pollution are becoming big troubles for governments to create charters such as Kyoto and Paris. Due to devastating effects on the environment, on health, reducing rainfall, increasing temperature, and declining water quality (mahdi akbari, 2020). Greenhouse gases (GHG) were considered as the main factor of creating these previous problems, the global average of atmospheric CO_2 is 407.4 parts per million in 2018, the higher ever from 800000 years ago (Lindsey, 2020). Several pieces of research were done to find out variables that affect carbonization. From natural disasters to a long list of human causes, income has been the main factor that allows the improvement of energy consumption, overconsumption of production and other activities allowed by the rise of income. Contrarily to that, the proposal idea for education is that it helps people to be more careful about nature, more cultured about its importance, more receptive to change maximization life style and elastic to adopt new technology for the reason of saving it. Eventually, all these efforts will lead to establish the environmental culture.

Biased on the presented overview above about the topic, we had determined the main problematic:

Education, income: do they create environmental culture and help reduction of carbon dioxide emissions in the Maghreb countries?

We hypothesised several points to determine the extent of their validity.

- The first hypothesis suggests that income has a positive relationship with CO_2 emissions. While, education has a negative relationship.
- We posed that income has the most proportional effect on carbonization comparing to education effect. However, all our variables have a relation in the long-run.
- We propose that EKC is partial verified in the Maghreb countries.
- Finally, the crucial hypothesis assumed that income and education work on to enhance environmental culture in the Maghreb countries but it is steel weak and limited.

The purpose of this study is to analyze carbon dioxide emissions comparing with income and educations evolutions. As well, to study the impact of these two human development indicators on carbon dioxide emissions. We have also the aim of encouraging the use of renewable energy and the rational use of natural resources.

Despite the importance of air pollution, few studies discuss CO_2 emissions in the Maghreb countries and the Middle East and North African (MENA). Besides, very few papers attempt to reveal how human development indicators can affect emissions. In this paper, we try to publish consciousness and culture of saving the environment, especially education indicator where it is rare to find a paper examining the impact of education on CO_2 emissions but it is not the case for income indicator. Where, we found quite few papers talk about education and CO_2.

- **Literature Review**

In our review, we detected many studies that concentrate on CO_2 factors such as income, energy consumption, foreign direct investment (FDI)…In different regions: G7, MENA, a sample of countries from all over the world…Therefore, (Rojas-Vallejos & Lastuka, 2020) report the influence of CO_2 in a sample of 68 countries upon 50 years. They found that the relation between income and CO_2 emissions is not homogeneous and depends on the level of development. Hence, this relationship is negative for low to moderate per-capita level of income and becomes slightly positive after the threshold of 15000 dollars. (Uddin, Mishra, & Smyth, 2020) and (Ajmi, Hammoudeh, Nguyen, & Sato, 2015) examine the relation of CO_2 and income in G7, the first study had found that relationship between income inequality and CO_2 is highly nonlinear, while the second was running a causality from Gross Domestic Product (GDP) to CO_2 emissions over time. Both (Uzar & Eyuboglu, 2019) and (Halicioglu, 2009) had tried to verify the EKC model in Turkey, and both validated the EKC in Turkey. (Jayanthakumaran, Verma, & Liu, 2012) report that CO_2 emissions are influenced by energy consumption in India, and by per-capita income in China is reported by (C. Zhang & Zhao, 2014). However, (Dong & Zhao, 2017) reveal that it differs rural from urban. Where, (J. Zhang, Yu, Cai, & Wei, 2017) found that urbanists are the most emitters. Despite this fact, they have the most relative redaction of emissions by (-13.8% in 2012). (Kohler, 2013) examines a positive bidirectional causality between trade, income per-capita and between trade and per-capita energy use in South Africa. (Azlina, Law, & Nik Mustapha, 2014) and (Begum, Sohag, Abdullah, & Jaafar, 2015) confirm that the EKC hypothesis is not valid in Malaysia, and there is a long-run relationship from emissions to income.

From papers that discuss MENA counties. (Muhammad, 2019) and (Shahbaz, Balsalobre-Lorente, & Sinha, 2019) reveal that economic growth increase with the increase of energy consumption in developed and emerging countries while a decline in MENA countries. In the same time, CO_2 emissions increase in all countries when energy consumption increase. (Gorus & Aslan, 2019) exhibit that the EKC hypothesis and Pollution Haven Hypothesis (PHH) are partial validate in the MENA region. For more specification, (Ozcan, 2013) found an EKC inverted-U shape relationship for Egypt, Lebanon and United Arab Emirates (UAE). While (Ben Jebli & Ben Youssef, 2015) examine that the shape is not verified for UAE, Morocco and Tunisia. The same result is presented by (Fodha & Zaghdoud, 2010) where the EKC hypothesis is not valid in the case of Tunisia. (Abdallh & Abugamos, 2017) present in the study that urbanization is not the main factor of CO_2 emissions in the region. Contrarily to that, energy use and economic growth in these counties are the main sources. As a petroleum country and a part of the MENA region, (Wasti & Zaidi, 2020) found that Kuwait has a unidirectional causality from GDP to CO_2.

Several researches have studied the relation between CO_2 emissions and different popular factors such as income, energy consumption, trade…while education, culture were discussed very rarely. In the case of CO_2 reduction, culture and its dimensions can make a difference in the environmental issue. (Disli, Ng, & Askari, 2016) reveal that three culture dimensions: masculinity, power distance and indulgence move the EKC upward and shift the income turning point to the left. While, individualism, uncertainty and long-term orientation move the EKC download and shift the income turning point to the right. (Komatsu, Rappleye, & Silova, 2019) found that individualistic countries have a higher ecological footprint overall countries. In Pakistan’s case, (Wang, Danish, Zhang, & Wang, 2018) report a bidirectional causality between CO_2 emissions and Human Development Indicator (HDI). For Algeria and Egypt as (Gürlük, 2009) presents human development is crucial. While Morocco and Tunisia do not hurt the Biological Oxygen Demand (BOD). (Lv, 2017) added another factor and clarify that after reaching a certain level of per-capita income democracy can be an effective factor for reducing CO_2.

I- Theoretical Approach

In this second section, we present the theoretical approach of carbon dioxide emissions and its relation with human development indices with referring to hypotheses.

I-1- How Income Affect Carbon Dioxide Emissions?

Given the world movements, CO_2 emissions have a very important part in the academic, organisational and for policymakers these last ten years. The common idea is that the most there is an improvement in GDP the most CO_2 emissions rise in the air. The environmental Kuznets curve (EKC) presented by Kuznets (Kuznets, 1955), considered later as the main model and basic to explain the effect of economic growth on green gases such CO_2 and Sulphurous Dioxide (SO_2) and explain the environmental degradation and economic growth nexus. As well, it explained the income inequality effect and its specifications. The EKC could explain this relationship similar to most cases in reality. Whereas, CO_2 emissions increase when economic growth or income increase, until it reaches the threshold where emissions become to decline. While economic growth or income are still in rise (Pontarollo & Serpieri, 2020) (Apergis & Payne, 2010). Hence, there are two stages in the EKC; in the early stage of development, there is a positive relationship between CO_2 emissions and income wherever the successive rise of CO_2 emissions leads to distort the environment. Then, a negative relationship in the last stage where there are different changes lead to assure this decrease e.g. focus on intensive industries, services, spread of awareness, enacting regulations and encourage green technology use. All that help to reduce degradation and save the environment. Moving to EKC hypothesis, if the EKC hypothesis is valid then economic growth leads to better environmental conditions and we should keep economic growth without limitation. Contradictory, if the hypothesis is not valid then economic growth is not helpful and we should enact policies to mitigate environmental degradation (Kusumawardani & Dewi, 2020). Moreover, there are empirical studies found conflicted results and that is back to the use of different econometric methods, different country samples and different study period. Generally, there are two main results. The first one is an inverted U-curve (EKC) and the second is monotonically rising impact of income on CO_2 emissions (Chiu, 2017).

I-2- How Education And Human Capital Affect Carbon Dioxide Emissions?

Higher education institutions (HEIs) are very crucial to adopt and mitigate CO_2 emissions (Bekaroo, Bokhoree, Ramsamy, & Moedeen, 2019). Hence, in the production sector human capital (HC) can reduce emissions by innovating, adopting and using new technologies that face carbonization. Firms with sufficient human capital helps to decrease environmental costs and fights environmental degradations. We can improve the quality of HC by investing and educating citizens. This improvement helps to create consciousness about the necessity of eco-friendly use. In addition, HC helps to enforce and accelerate mitigations activities in order to reduce carbonization which create a significant and negative relationship between HC and CO_2 emissions (Hao, Umar, Khan, & Ali, 2021).

The number of tertiary schooling considered as HC indicator where they assume that increase in tertiary schooling with one year will decrease emissions by 50.1%-65.8%. In a sample of OECD countries from 1965 to 2014, they found that higher HC decrease fossil fuels energy consumption and rise clean energy. Further, in Chinese states with higher HC, industrial emissions were lower. Furthermore, educated population makes environmental conditions better (Yao, Ivanovski, Inekwe, & Smyth, 2020).

I-2-1- The Conceptual Channels Through Which Is Related To CO_2 Emissions

Human Capital is related to CO_2 emissions through channels in the macro and micro level.

- **Micro Level Channels**

In this level, they suggest a negative relationship between HC and carbon dioxide emissions. Better-educated professionals enhance innovation and adaptation of technologies. As a result, in the production firms with large quantity of HC, they have better control on pollution and have the ability to apply the environmental regulations.

At the household level, educated classes concentrate more on the environmental issues in a way that change the behaviour of people to save the environment e.g. a survey in British households found that 25% of qualified tertiary are more likely to live friendly with the environment. Hence, higher HC communities with larger stock of HC were successful in Chinese cities in reducing pollution in the environment.

- **Macro Level Channels**

The first channel appears that income effect suggests that economic growth mediates the relationship between HC and carbonization, where HC helps to increase productivity of labours and economic growth. The second channel was suggested by endogenous growth theory, in which HC improves both technological and R&D (research and development) process. As implication, new technologies reduce renewables energy costs. The third channel in which HC affects emissions is through investment in the physical capital for technology to achieve technology-intensive capital; it needs to combine between HC and physical capital investment (PCI) in which PCI shifts energy consumption patterns and enforce renewable energy consumption.(Yao et al., 2020)

Moreover, the culture aspect can have a prominent role that makes societies differ one from another in saving the environment (Disli et al., 2016). Besides the cultural aspect, education may give surprising results. The more expenditure on education is high, the environmental choices of population become better, and that is guide to help mitigation of carbonisation (Dutt, 2008).

After presenting and analysing literature review and theoretical appraoch, we hypothesised several points to determine the extent of their validity.

II- Methodology

In this section, we will present model specification (section 3.1). Clarify econometric strategy (section 3.2) and discuss our data (3.3).

II-1- Model Specification

Panel data gather both time series and cross-sections, it has three options; the Pooled regression model (PRM), the Fixed Effect Model (FEM) and the Random Effect Model (REM). Therefore, there are several benefits of using the Panel data: (i) Controlling for individuals heterogeneity, (ii) Panel data gives more information, more variability, less multicollinearity among variables, more degree of freedom and more efficiency because in time-series studies are plagued with multicollinearity. (iii) Panel data are better able to study dynamics of adjustment while cross-sectional distributions that look relatively stable hide a multitude of changes. (iv) Panel data are better able to identify and measure effects that are simply not detectable in pure-section or pure time-series data. (v) Micro panel data gathered on individuals, firms and household may be more specified than similar variables measured at the macro level, in the other hand, macro panel data have a long time series and unlike the problem of non-standard distributions typical of unit roots tests in time-series analysis (B. H. Baltagi, 2008).

The equation form of the panel is the following:

$$Y_{it} = X'_{it}\beta + Z'_{i}\alpha + \varepsilon_{it}$$

For FEM, if Z'_i is unobserved but correlated with X'_{it} then the least square estimator of β is biased and inconsistent as a consequence of an omitted variable for this model:

$$Y_{it} = X'_{it}\beta + \alpha_i + \varepsilon_{it} \qquad \text{Where: } \alpha_i = Z'_{i}\alpha.$$

The FEM approach takes α_i to be a group-specific constant term in the regression model (Greene, 2003). The term fixed is used to refer that the term is fixed over time, and does not vary. It means that differences across unites can be captured in differences in the constant term (Greene, 2002).

We can mention some limitation of Fixed Effect Model (FEM): (i) the more you add dummy variables the more it costs an additional degree of freedom. Thus, if you have a small sample you will lose observation by introducing dummy variables and you will not obtain a meaningful statistical analysis. (ii) Too many additive and multiplicative dummies may lead to multicollinearity, and that will lead to losing the estimation precision of one or more parameters. (iii) We need to be careful that the error term follows the classical assumption of normality, to obtain the best results (gujarati, 2011).

II-2- Econometric Strategy

The econometric strategy is organized on five steps. First, we run the three-panel models in order to verify the general validity of the panel model. Secondly, Lagrange Multiplier test was done to verify either pooled regression model (PRM) or Fixed Effect (FEM)/Random Effect (REM) is the required model. If the last one is the case, we should apply Hausman Test to choose between Fixed and Random effect models. In this stage, we estimate the chosen model using Least Square Dummy Variable estimator (LSDV) if the chosen model is FEM or Generalized Least Square estimator (GLS) if the chosen one is REM. After that, we apply the unite root test to ensure that our variable have the same integration order. After verifying that variables have the same order, in this stage, we apply cointegration tests to validate or not the existence of long-run relationship equilibrium between the study variables (Alvarado et al., 2019). Finally, we fetch the existence of uni-or bidirectional running causality using the Granger test.

II-3- The Data

In this analysis, we studied the effect of some human development indicator (income and education) on the environmental, measured by per-capita carbon dioxide. In order to detect how much these indicators build the environment culture of citizens in a sample of three Maghreb countries: Algeria, Tunisia and Morocco during the period 1990 to 2018. We made use two independent variables to determine human development, which are: education index (EDU) and income index (INCM) retrieving from United Nations Development Program ("Human Development Data (1990-2018)," 2020), and a dependent variable: carbon dioxide emission per capita (CO_2) to present environmental culture retrieving from Knoema web site ("CO2 emissions per capita," 2020)

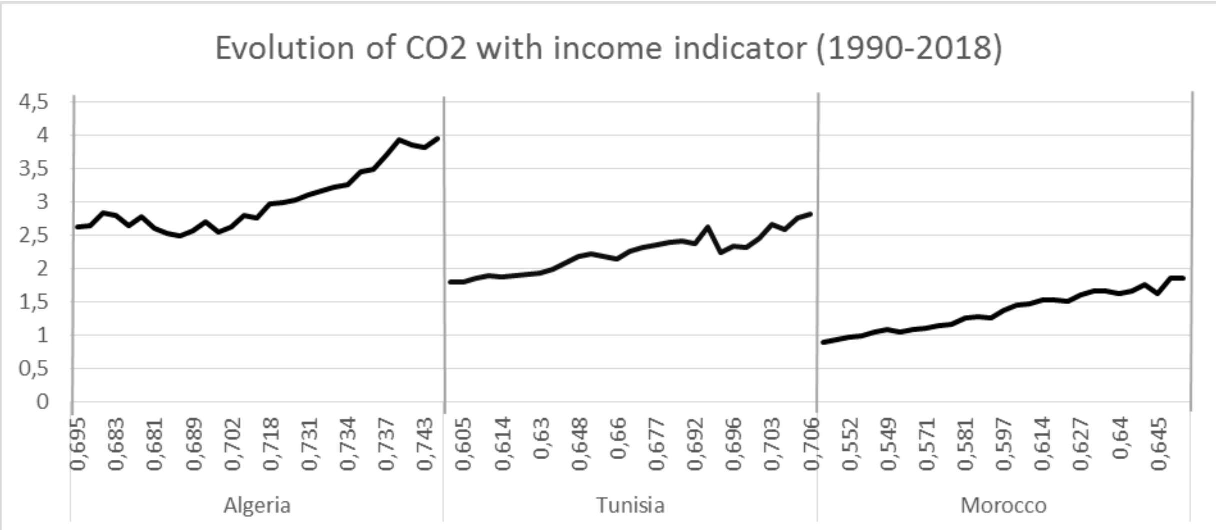
III- Empirical Finding and Discussion

In this section, a descriptive analysis of CO_2 emissions evolution with income and then with education movements was done in (section 4.1). Then, we present the results and discussions of our Panel model in (section 4.2).

III-1- Descriptive Analysis

Firstly, in order to analyse the influence of income evolution on CO_2 emissions, we tried to apply the Kuznets model for Algeria, Tunisia and Morocco. However, the difference between the original EKC and our case is that income indicator has values between [0-1] while the original EKC has income values per-capita. Then, the same analysis was done for education indicator evolution [0-1], where we tried to reveal the CO_2 emissions with education movements. From these two analysis, we can extract relations between CO_2 emissions and both income and education and in the other hand, it appears if there is other relation between income and education.

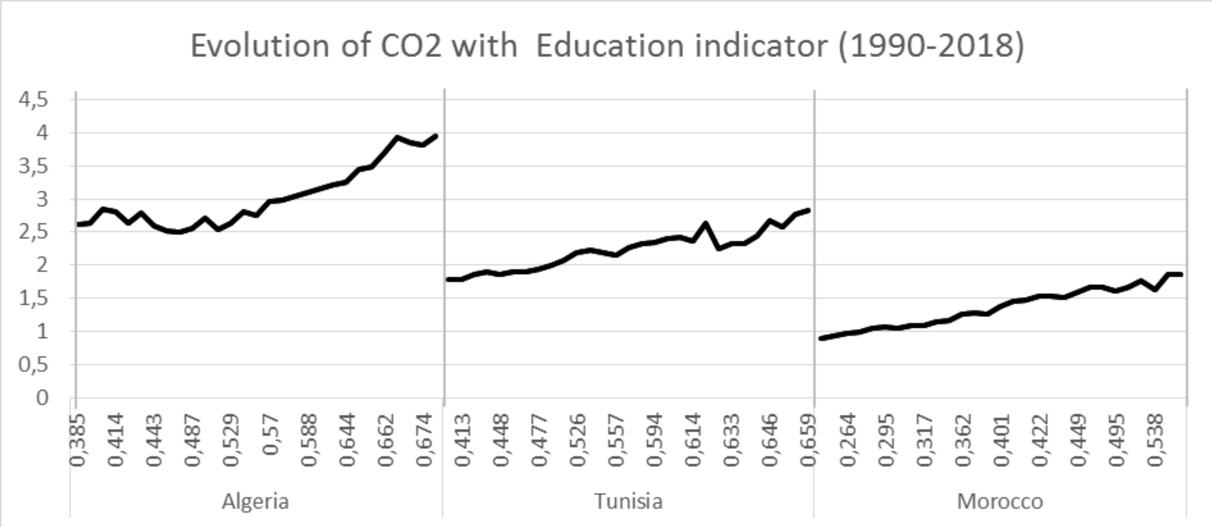
Graphic 01: Evolution of CO_2 with income indicator (1990-2018)



Source: made by the author using Excel 2013.

In Graph 01, the horizontal axis corresponds to the income indicator of Algeria, Tunisia and Morocco, and not economic growth/income as in the EKC but it still significant to explain the effect of economic growth. In the other hand, the vertical axis corresponds to the measurement of per-capita carbon dioxide emissions (Ton CO_2 / capita) for each country. From the first view, graphs appear a disproportion of carbon dioxide emissions between countries; successively Algeria, Tunisia then Morocco from the top consumption to the weakest. Even fluctuation there is general increase in both income and carbon dioxide emissions for all countries. However, CO_2 in the case of Algeria is the most fluctuated, especially in the first period, which presents the security instability and the early 2000s period. Contrary to Algeria, emissions has almost sustainable evolution for Morocco. Finally, Tunisia has slight fluctuations in carbon dioxide emissions. Generally, according to EKC our countries steel in the stage of CO_2 increase, where they do not reach the turning point yet. We can conclude that the EKC hypothesis is partial verified in the three Maghreb countries.

Graphic 02: Evolution of CO_2 with education indicator (1990-2018)



Source: made by the author using Excel 2013.

In graph 02, the vertical axis measures per-capita carbon dioxide emissions (Ton CO_2 / capita). While the horizontal axis measures the education indicators for the three countries. Generally, Carbon dioxide emission goes up with education indicator increase. We can note also that both education and income indicators practically have the same effects on CO_2 emissions, which guide us to confirm also the relative relation between education and income in these three countries. Hence, education is correlated with income and countries with a high level of income are the highest level of education (Dutt, 2009).

Table 01: Descriptive Statistics and Normality Test

Variables	Obs	Mean	Median	Std.Dev	Max	Min	Prob (Jaque-Bera)
CO2	87	2.207586	2.25	0.771	3.94	0.9	0.36093
INCM	87	0.657092	0.668	0.056525	0.745	0.547	0.091489
EDU	87	0.497724	0.5	0.117136	0.675	0.254	0.145524

Source: made by the author using Eviews 9.

From table 01, we can extract that the mean and median values are slightly different which means that there is a weak dispersion, where standard deviation confirmed that result. The mean of education indicator has a weak value, it is lower than 0.5. It reflects the situation of institutions in the maghrebain countries. While income is higher than 0.5. Regarding the education indicator, income has a better process. Lastly, there is a big jump between the max and min of per-capita carbon dioxide emission, and it considered as big changing in the consumption behaviour. In addition, it reflects that CO_2 emissions in these countries are heterogeneous, and there is a gap in many factors for getting this difference.

The Jaque-Bera test confirms a normal distribution for our three variables, where the p-values are higher than 0.05 (acceptance of the null hypothesis of error normality). Therefore, errors are normally distributed.

III-2- DISCUSSION OF PANEL FINDINGS

To establish this study, we used Panel data analysis in order to take account the time series and cross-section effects in the same time. For that, we added the Napierian logarithm to all our variables for unification of units, CO_2, INCM, EDU will be respectively LCO_2, LINCM, LEDU.

First, we started by running pooled regression model, fixed effect model and random effect model. They are shown in table 02; where we found probabilities less than 0.05 except for (EDU), which is not significant in pooled regression and random effect models. Generally, models are accepted according to high values of R-square and probabilities of fisher statistics.

Table 02: Panel estimation regression results for PRM, FEM and REM

		Estimated models		
		PRM	FEM	REM
C	coeff	2,528204	1,685304	2,528204
	prob	0,00000	0,00000	0,00000
LINCM	coeff	4,410566	1,50457	4,410566
	prob	0,00000	0,00040	0,00000
LEDU	coeff	-0,09117	0,442011	-0,09117
	prob	0,2565	0,00000	0,0784
R	/	0,944619	0,977772	0,944619
Prob(F-stat)	/	0,00000	0,00000	0,000

Source: made by the author using Eviews 9.

Moving to select the according model for our analysis in (table 03), we started with Lagrange multiplier test to choose either pooled model or fixed and random effect models is/are associate to our study. Table 03 clarified that Breusch-Pagan and Honda probabilities are less than 0.05 and the null hypothesis is rejected. Hence, either the fixed or random effect model is the right model to goes with this estimation.

Table 03: Lagrange Multiplier Test for Random Effect

	Test Hypothesis		
	Cross-section	Time	Both
Breusch-Pagan	39.05877 (0.0000)	0.064637 (0.7993)	39.12341 (0.0000)
Honda	6.249702 (0.0000)	0.254238 (0.3997)	4.598979 (0.0000)

Source: made by the author using Eviews 9.

Hausman test is used to choose between fixed effect and random effect models. In Table (04), we had presented the Hausman test results. It showed a very high value of Ch-square (122.305) comparing this value with critical value (5.99). Besides, the p-value (0.000) was lower than 0.05, which guide us to reject the null hypothesis and impose the existence of correlation between the effects of countries. Therefore, the Fixed Effect Model is the suitable model.

Table 04: Hausman Test Results

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	122.305293	2	0.0000

Source: made by the author using Eviews 9.

After finding out the relative model, which is the Fixed Effect Model (FEM), table 05 shows the estimation of FEM.

Table 05: Fixed Effect Estimation Results

Dependent Variable: LCO2
Method: Panel Least Squares
Date: 04/03/20 Time: 23:01
Sample: 1990 2018
Periods included: 29
Cross-sections included: 3
Total panel (balanced) observations: 87

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.685304	0.103134	16.34091	0.0000
LINCM	1.504570	0.404576	3.718883	0.0004
LEDU	0.442011	0.102495	4.312526	0.0000

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.977772	Mean dependent var	0.725921
Adjusted R-squared	0.976688	S.D. dependent var	0.376966
S.E. of regression	0.057556	Akaike info criterion	-2.816349
Sum squared resid	0.271645	Schwarz criterion	-2.674630
Log likelihood	127.5112	Hannan-Quinn criter.	-2.759283
F-statistic	901.7640	Durbin-Watson stat	0.597678
Prob(F-statistic)	0.000000		

Source: made by the author using Eviews 9.

The first view appears that all our variables are significant (probability less than 0.05). R-square is 0.9777. It means that variation of income and education indices explain the variation of carbon dioxide emission with 97.77 %. From Fisher –stat probability we can extract that our model has a global significance. Thus, our model is globally accepted, except for the Durbin-Watson test (DW=0.597678) where it poses the problem of positive serial correlation in the model which is a common issue in panel data model, the problem of autocorrelation can influence the reliability of coefficients significance. Hence, we will try to remove this problem in order to valid the most appropriate model.

In table (06), we tried to remove the problem of serial correlation by including one period lag of the dependent variable as independent variable and results are presented below.

Table 06: Fixed Effect Estimation Results after adding one lag period

Dependent Variable: LCO2
Method: Panel Least Squares
Date: 02/01/21 Time: 23:04
Sample (adjusted): 1991 2018
Periods included: 28
Cross-sections included: 3
Total panel (balanced) observations: 84

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.403488	0.128929	3.129526	0.0024
LCO2(-1)	0.841303	0.049614	16.95693	0.0000
LINCM	0.660435	0.254644	2.593565	0.0113
LEDU	-0.010197	0.040218	-0.253544	0.8005

R-squared	0.988222	Mean dependent var	0.734704
Adjusted R-squared	0.987781	S.D. dependent var	0.371361
S.E. of regression	0.041051	Akaike info criterion	-3.501575
Sum squared resid	0.134812	Schwarz criterion	-3.385822
Log likelihood	151.0662	Hannan-Quinn criter.	-3.455043
F-statistic	2237.511	Durbin-Watson stat	2.613063
Prob(F-statistic)	0.000000		

Source: made by the author using Eviews 9.

From table 06, the R-square value (0.98822) shows that the variation of the selected independent variables can explain 98.82 % of the dependent variable variation, with a significant probability of F-statistic. This model shows a significance of parameters except for LEDUC, which is not significant. In addition to that, DW value (2.613063) is situated in the doubt zone, for that we will test for serial correlation using the below tests.

Moreover and for testing the serial correlation between cross-sections, we have presented the following table.

Table 07: Residual cross-section dependence test

Residual Cross-Section Dependence Test
Null hypothesis: No cross-section dependence (correlation) in residuals
Equation: EQ03
Periods included: 28
Cross-sections included: 3
Total panel observations: 84
Cross-section effects were removed during estimation

Test	Statistic	d.f.	Prob.
Breusch-Pagan LM	4.892302	3	0.1799
Pesaran scaled LM	-0.452216		0.6511
Bias-corrected scaled LM	-0.507771		0.6116
Pesaran CD	1.604084		0.1087

Source: made by the author using Eviews 9.

Table 07 presents four different tests for residual cross-section dependence: The Breusch-Pagan LM test (Breusch & Pagan, 1980) Both Pesaran scaled LM test and Pesaran CD test (Pesaran, 2004) and finally Bias-corrected scaled LM test(B. Baltagi, Feng, & Kao, 2012).

The table above appears that the probability of Breusch-Pagan LM test is higher than 0.05, then we accept the null hypothesis of no serial correlation. Meanwhile, the bias-corrected scaled LM statistic is more than 0.05, which guide us to accept the null hypothesis of no autocorrelation between cross-sections in the fixed effect model.

Generally, from the above analysis and after removing the serial correlation problem and confirming that there is no serial correlation between cross-sections, the model is becoming globally accepted. Whereas, when income index (trapped between 0 and 1) moves with 1% point carbon dioxide will move also with 0.660435% and the same will happen if carbon dioxide of (T-1) period grows up with 1% then carbon dioxide of (T) period will grow up with 0.841303%. From all these results, we resume that income affects carbon dioxide emission, and according to the environmental Kuznets curve (EKC: shows how income affects emission) the Maghreb countries are situated in the first phase of the EKC where the improvement in income enhance carbonization. In this phase, the Maghreb societies still search to rise there consumption without using green and clean industries or renewable energy. In the other hand, the non-significance of education indicator appears the absence of education impact on carbonization in our sample which guide us to judge that the Maghreb society do not yet reach the environmental culture where we are in the phase of rising consumption without tanking in count any responsibly for the environment around us.

The panel equation of our model is given as follow:

$$LCO2_{it} = C_{1i} + \beta_1 LINCM_{it} + \beta_2 LEDU_{it} + \mu_{it}$$

Where: LCO_2 is the logarithm of carbon dioxide emissions, LINCM is the logarithm of income indicator, LEDU is the logarithm of education indicator, β_1 β_2 present coefficients, C_{1i} is the intercept, μ_{it} error term, I presents the cross-section unit, t presents the time.

From table 06, after adding one lag period of the dependent variable and had found that LEDU was not significant we formulated the following equation as next:

$$LCO2_{it} = 0.403488 + 0.841303 LCO2_{it(-1)} + 0.660435\, LINCM_{it}$$

In this step, we analysed the unit root test with automatic integration order, after looking into our data and making graphs of our variables, they showed a trend and constant over time. Thus, we chose to run the unit root test with individual intercept and trend in order the get the best results, the finding is shown in table 08.

Table 08: Probabilities Results of Unit Root Tests

		Summary					Hadri
		LLC	Breistung	Im, Pesaran	ADF	PP	/
Carbon Dioxide Emission	LCO2	0,307	0,0755	0,0895	0,086	0,0872	0,0002
	DLCO2	0,000	0,000	0,000	0,000	0,000	0,4308
Income Indicator	LINCM	0,9617	0,7155	0,948	0,6068	0,1458	0,0065
	DLINCM	0,009	0,158	0,000	0,000	0,000	0,0003
Education Indicator	LEDU	0,993	1,00	1,00	0,9993	1,00	0,000
	DLEDU	0,000	0,0752	0,000	0,000	0,000	0,0797

Source: made by the author using Eviews 9.

The result of summary tests and Hadri test confirm that both of LCO_2, LINCM and LEDU are stationary after converting to the first difference. Whereas, all summary probabilities are more than 0.05 at the level for all variable and less than 0.05 for Hadri probability. While, the majority of summary tests probabilities are less than 0.05 and more than 0.05 for Hadri test probability. Therefore, all variables have the same integration order I (1).

Table 09: Pedroni Test Probabilities Results

Null Hypothesis: No cointegration
Trend assumption: Deterministic intercept and trend
Automatic lag length selection based on SIC with a max lag of 5
Newey-West automatic bandwidth selection and Bartlett kernel

Alternative hypothesis: common AR coefs. (within-dimension)

	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	0.742465	0.2289	0.570719	0.2841
Panel rho-Statistic	-1.213772	0.1124	-1.308264	0.0954
Panel PP-Statistic	-2.356643	0.0092	-2.445334	0.0072
Panel ADF-Statistic	-2.361835	0.0091	-2.450667	0.0071

Alternative hypothesis: individual AR coefs. (between-dimension)

	Statistic	Prob.
Group rho-Statistic	-0.556003	0.2891
Group PP-Statistic	-2.228935	0.0129
Group ADF-Statistic	-2.231477	0.0128

Source: made by the author using Eviews 9.

After confirming that our variables have the same integration order. We assumed that there is a long-run cointegration. In view of that, we performed the Pedroni cointegration test using individual intercept and trend to affirm or reject the assumption. Results are presented in Table 09. From this table, we can estimate that there is a long-run cointegration according to tests probabilities where there are six probabilities over eleven have values less than 0.05, which guide us to reject the null hypothesis of no cointegration.

Table 10: Pairwise Granger Causality Test Results

Null Hypothesis:	Obs	F-Statistic	Prob.
LINCM does not Granger Cause LCO2	81	2.49638	0.0891
LCO2 does not Granger Cause LINCM		0.22492	0.7991
LEDU does not Granger Cause LCO2	81	1.11649	0.3327
LCO2 does not Granger Cause LEDU		0.43613	0.6481
LEDU does not Granger Cause LINCM	81	9.10971	0.0003
LINCM does not Granger Cause LEDU		2.12551	0.1264

Source: made by the author using Eviews 9.

Table 08 presented Pairwise Granger Causality test results. It shows probabilities higher than 0.05 except for the couple “LEDU and LINCM” (0.0003<0.05). Therefore, we reject the null hypothesis of causality absence. Then, education causes income at 5%. In the other hand, income causes carbon dioxide emission at 10%. For the other constraints: probabilities are higher than 0.05 and 0.1. Therefore, we reject the null hypothesis, which guide as to confirm that there is no causality. Thus, there is a unidirectional causality running from education to income at 1% and another unidirectional causality running from income to CO_2 emissions at 10%.

Conclusion

Forecasts tell that over 2030, all countries will get an increase of CO_2 emissions. For that, we have to save the environment over a policy plan to mitigate carbonization (Mohmmed et al., 2019). Indeed, policymakers in the Maghreb countries still very far away from developing strict laws and instructions either for consumers or for producers. In developing counties, society mentality does not help for saving the environment; this issue reflects the weak values of human development indicators (HDI). In the other hand, there are many reasons of increasing the carbonisation from human to natural. In addition to common factors of rise, fall and fluctuations of CO_2 are controlled by many factors as local regulations, legislations, multinational agreements, pollution-abating technologies, natural disasters, economic cycles and composition of the national economic sector (Ajmi et al., 2015).

This paper illustrates a list of results. First, emissions of CO_2 are heterogeneous over the sample; the Algerians citizens are the biggest emitters, Tunisians then finally Moroccans. For Algeria, especially after the 2[end] century after the oil price jump; consumption of energy and product, transportation have a surge, which guide to rise the emissions more than before. For both Tunisia and Morocco, they have different economic structure, where tourism, agriculture, and non-industrial sectors have the most contribution part in GDP of these countries, which explain the slight increase of CO_2 emissions compared with income increase. Meanwhile, the consumption mode of the Algerian society is slightly more welfare than the Moroccan and Tunisian societies.

Moving to panel results, the Fixed Effect Model (FEM) was the associate model to our study. Therefore, income and education averages move with fixed values and then the Maghreb countries have similar behaviour. Moreover, income is the crucial variable of rising emissions while education has no significant effect on carbon dioxide emissions, which means no influence on carbonisation in the study sample. In the other side, a unidirectional causality is running from education to income and from income to emissions. Therefore, the improvement of education level in any countries will lead to an increase in the level of income. Based on this, the increase of income will encourage consumption and for sure increase carbon emissions. Besides, Cointegration shows that there is a long-run relationship between HDI (income and education) and carbon dioxide emissions. For the three counties in the sample and over the study period, the EKC is not valid yet, where we do not reach the sufficient threshold of GDP/income to make emissions go down. Lastly, the environmental culture is still absent in our societies even the improvement in education rates especially increasing numbers of tertiary students. To valid the EKC, we need a high level of education and income indicators.

Our recommendations for the Maghreb countries are: (i) reinforce the service, agriculture, and non-polluted sectors. (ii) Stimulate minimisation consumption and reinforce the environment consciousness over awareness campaigns for children and adults. (iii) Work on developing the human resources especially education and the other indicators will improve parallel in either the long or short time. (iv) Policymakers should develop strict instructions and new strategies for mitigating carbonisation. (v) The imposition of taxes for every citizen of producers that contribute in carbonisation. (vi) Encourage developing, researching and using renewable energy. Regarding possibilities, which the Maghreb countries have, they can change the current situation, not only in carbonisation but even improve the standards of living. Literature talking about "reduction of carbon dioxide emissions" assume that having the basic understanding about environmental issues and accumulation process promote decisions makers to take the better policies to improve the environment quality.

Finally, we have a couple of limitation in which they can help future researcher. The first one, for applying panel data estimation try to regroup a big sample to generalize the results on a big scale e.g. choose a large number of countries such as the MENA countries. Moreover, try other variables that can effect carbon dioxide emissions in the Maghreb countries until we can find the most effective variable, which help policy makers to take the right decisions for limiting the environmental degradation.

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