Effects Of CO2 Emissions On Economic Growth, Urbanization And Welfare: Application To Mena Countries

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Abstract

This paper has investigated the impact of CO_2 emissions on per capita growth, energy consumption, life expectancy and urbanization in MENA countries (Algeria, Bahrain, Egypt, Emirates Arabs, Jordan, Saudi Arabs, Morocco, Qatar, Tunisia and Yemen) from 1990 to 2010. The empirical results have covered two time horizons: the short and long term. Indeed, in the short term we noticed for all countries of our sample, that the CO_2 emission is explained by energy consumption and economic growth per capita which exert positive and significant effects. However, we noticed that the CO_2 emission is always positively influenced by energy consumption and negatively influenced by life expectancy. Also, the effect of income per capita is negative and significant which means that the long-term economic strategy of these countries is based on activities and non-polluting sectors. In other words, growth-generating economic potential are located in non-polluting sectors and not generators of greenhouse gas.

Keywords: Environmental Kuznets Curve, CO_2, energy consumption, growth

JEL Classification: Q43, Q53, Q56

1. Introduction

Since the seventies, economic and environmental issues seem increasingly inseparable so that it has become difficult now to talk about the environment without talking about the economy and vice versa.

Indeed, the importance addressed to the environmental issues (global warming, pollution, deforestation, overexploitation of natural resources, etc.) continues more and more to attract the interest of researchers and academicians. The fundamental reason underlying such interest lies in the fact that CO2 was, until then, doubly valued and subjected to two distinct approaches: economic approach and an environmental approach.

The economic approach considers the CO2 emission as the logical consequence of industrial activities which, although they are polluting, they are creating added values, and therefore they are a guarantee of strong economic growth. The environmental approach often differs from the first by considering that sustainable development can not in any case be based on polluting industries as long as the realized growth was offset by a loss of social welfare. According to Stern (2006) "global warming due to the accumulation of Greenhouse Gas (GHG), whose the main one being carbon dioxide (CO2) is the main threat to humanity»[1].

However, it should be noted that an alternative approach was submerged in recent years, and has tried to criticize the positive relationship which between CO2 and economic growth. For example, Nordhaus et al (2000) suggested that a warming of 2° C could lead to a 5% decrease in the average annual per capita consumption in Africa and Asia[2].

As long as the growth models based on polluting energy are generalized, the MENA countries are facing the same problem baskets of problems, and trade-offs (growth versus environment) as those known by the developed countries. Indeed, CO2 emissions in MENA countries are becoming increasingly important since the Rio Summit in 1992 and threatens the well-being of their populations. This reality is confirmed by the World Bank (2010) which estimated that the cost of pollution makes up 7% of GDP in MENA[3].

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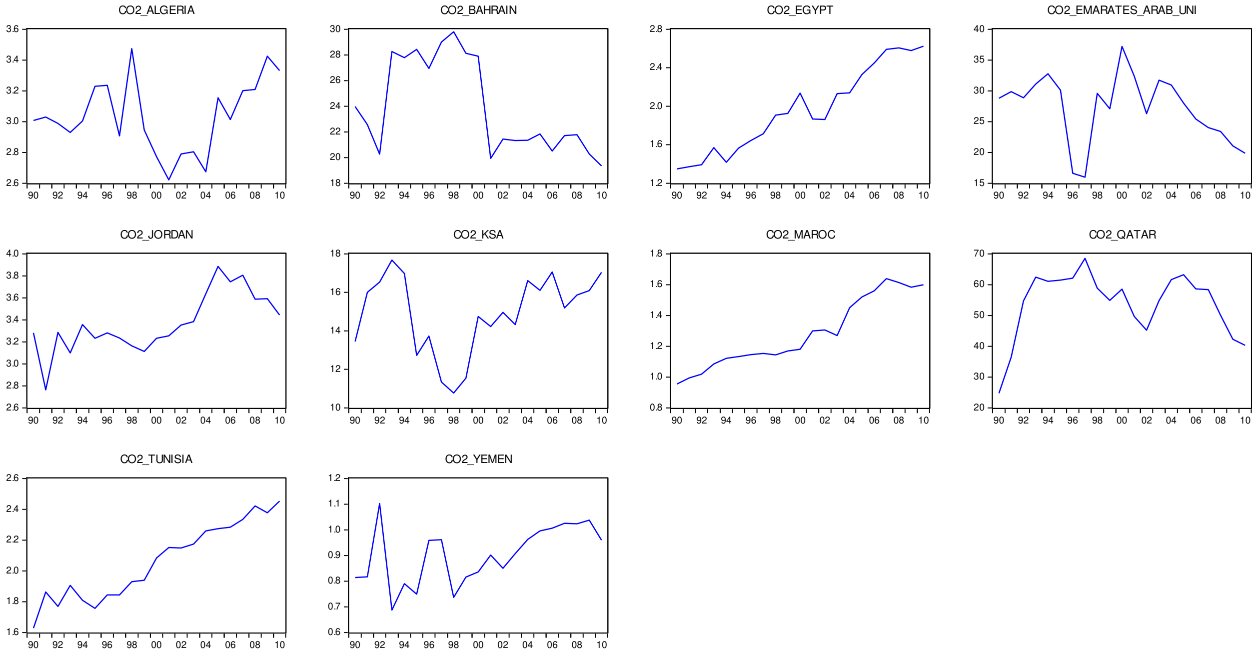
[1] Stern, N. (2006). "Stern Review on the Economics of Climate Change.

[2] Nordhaus, William; Boyer, Joseph (August 21, 2000). *Warming the World: Economic Models of Global Warming (hardcover)*. MIT Press. Retrieved February 19, 2014.

[3] http://siteresources.worldbank.org/EXTANNREP2010FRE/Resources/Banquemondiale Rapportannuel2010.pdf

The graph (1) allows us to follow the evolution of the average carbon dioxide emissions in some countries of the MENA region.

Figure. 1. Evolution of the average CO2 emissions in the ten MENA countries from 1990 to 2010.



Source: World Bank

It is important to note, at this stage of analysis, that the relationship between growth and CO2 emission is relatively ancient. Most studies have focused on the trade-off between economic growth and CO2 emissions. However, studies that have examined the impact of CO2 emissions on welfare are relatively rare and recent.

Therefore, to cope for this deficiency we will try, in our article, to deal within a single model the two approaches mentioned above. Indeed, we try to explain the relationship that is established between the emission of CO2 on one side and a vector of variables involving economic growth, energy consumption (first approach), urbanization and life expectancy (second approach).

To carry out our work we will subdivided the article into five separate sections. In the second section we present the literature review which examined the study of the effects of CO2 emissions on growth and welfare. The third section will present the methodological approach. The fourth section will present the econometric estimation approach. The fifth section will analyse the results. The last and final section concludes the paper.

2. Literature review

2.1 Literature review of the CO2 effect on growth

The review of the literature can be divided into four research components. The first one has tried to test the existence of the Kuznets curve. The second has tried to test if exists a causality between energy consumption and economic growth. The third component has attempted to establish a dynamic relationship between carbon emissions, energy consumption and economic growth. The fourth component has focused by the dynamic relationship between carbon emissions, energy consumption, economic growth, trade liberalization and urbanization.

Regarding the first research component we can refer to the work of Grossman and Krueger (1995) who have concluded the absence of evidence showing the existence of causality relation between the gradual environmental degradation with the growth of the country, contrary to the results of Shafik (1994) saying that CO2 emissions are increasing in parallel with economic growth.

Stern et al (1996) showed that CO2 emissions began to decrease when the economy reach a well-defined income threshold while the results of Akbostanci et al (2006) do not comply with the principles of the hypothesis (CEK). Martinez-Zarzo and Bengochea-Morancho (2004) showed that CO2 emissions and income level are negatively related in low-income countries, but they are positively related in high-income countries.

We find that the results of the first category of works are divergent and often contradictory. Also, in the majority of cases, researchers have failed, to confirm the existence of a typical Kuznets curve (inverted U-shaped curve).

Regarding the second category, a series of studies was interested by analyzing the relationship of causality between growth and energy of consumption. Indeed, according to the works of Akarca and Long (1980), Yu and Hwang (1984), Yu and Choi (1985), Erol and Yu (1987), Stern (1993) and Cheng (1995), there is no causality relation, between energy consumption and GDP . Nevertheless, the works of Asafu Adjaye (2000), Yang (2000), Soytas and Sari (2003), Morimoto and Hope (2004), and Altinay Karagol (2005), Narayan and Smyth (2008), have converged to the existence of a causal relation between the two variables (energy consumption and growth). Other research has found a unidirectional causal relation as shown by the works, of Glaze and Lee (1998), Cheng and Lai (1995), Cheng (1999), Chang and

Wong (2001), Soytas and Sari (2003), Narayan and Smyth (2008) or a two-way direction found by Masih and Masih (1997), and Asafu Adjaye (2000) Glaze (2002) and Oh and Lee (2004).

As for the third category we can refer to the work of Soytas et al (2007) have showed the absence of causality relation between growth and carbon emissions, in the one hand, and income and energy consumption and that their use. Unlike the works of Cole and Neumayer (2004) Shahbaz et al. (2010), Halicioglu (2009) and Akpan et al. (2012), who have found a causality relation between all those variables. The work of Soyats and Sari (2007), Boujelbene and Chebbi (2008), Ang (2008), Soytas and Sari (2009) and Zhang and Chang (2009), have led to varied results.

Concerning the final component of our literature review which focuses on dynamic relationship between carbon emissions, energy consumption and the economic growth we can refer to the study of Sharif Hossain (2011) who has shown the absence of a long-term causality relation between those variables. However, in the short term, the author confirms the existence of a set of unidirectional causality relations (from economic growth, trade openness and CO_2 emissions; from economic growth to the consumption of energy; from trade openness to economic growth; from urbanization to economic growth and from trade openness to urbanization).

2.2: Literature review of the CO2 effect on well-being

As noted above, the majority of works have focused on the trade-off which can occur between economic growth and the CO_2 emissions. Although the studies that have examined the impact of CO_2 emissions on the well-being are relatively rare, we can refer to those of Georgescu-Roegen (1971) and Meadows et al (1972) showing that the economic activity generates necessarily the accumulation of the CO_2 emissions. As consequence, this will cause environmental degradation and decreased the social-welfare.

Eric Lambin (2009) had studied the interactions between welfare and environmental degradation and concluded that environmental problems can threaten the social well-being. Christophe Declerc et al (2011) showed that life expectancy would increase up to 22 months if the major European cities can reduce air pollution. Also, Yuyu Chenaet et al (2013) have showed the existence of negative correlation between longevity and the environmental degradation. According to the authors, since 1950 and due to pollution, the life expectancy decreases by 5 ½ years in northern China[4].

UNEP's report on the future of the global environment "environment for development" (GEO-4) showed that air pollution adversely affects the well-being in almost all regions of the world. WHO estimates that over one billion people in Asian countries are exposed to air pollutants[5].

3. Methodology and data

To study the effects of economic growth on emissions of carbon dioxide (CO2) and well-being, we have selected a sample of ten MENA countries (Algeria, Bahrain, Egypt, UAE, Jordan, Saudi Arabia, Morocco, Qatar, Tunisia, Yemen) covering the period 1990 to 2010.

This research is based on the following equation, in which the explanatory variables were selected from a varied literature:

$$CO2 = f\,(GDPC, EC, URB, LEXP)$$

The variables used in our study are:

- **CO2**: Carbon dioxide emissions, measured on metric tons per capita, are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.
- **GDPC**: the GDP per capita measured in US dollars which evaluates the impact of the level of development on the environment. Theoretically, the assumption of the EKC (Environmental Kuznets Curve) postulates that environmental degradation has accelerated in Developing countries, while the opposite effect is observed when these countries reach a certain level of income. Given the poor economic performance associated with low technological development of the study countries, we can assume that any unit increase in GDP per capita is associated with an increase in total carbon dioxide emissions.
- **EC**: Energy consumption, measured in kilograms of oil equivalent per capita, refers to the use of coal, oil, rock oil and natural gas as energy sources. At the global level, energy consumption is the second source of greenhouse gas (GHG) emissions.

[4] http://www.pnas.org/content/110/32/12936.full.pdf
[5] http://www.unep.org/geo/GEO2000/pdfs/ov-fr.pdf

- **URB**: the percentage of urban population relatively to the overall population. This variable is also an important determinant of the quality of the environment. Indeed, it is assumed that the increase of population and in particular that of urban area, induces the increase in food needs, which results in over-exploitation and depletion of natural resources and the CO2 emission increase ((Malthus (1894); Azomahou et al (2007)).,
- **LEXP:** Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life. This variable is so important, to determine the quality environmental. The UN has published in its GEO-4 report that "environemental degradation undermines development and threatens all aspects of human well-being". It has been demonstrated that environmental degradation is linked to human health problems, including certain types of cancers, vector-borne diseases, more and more zoonosis, nutritional deficiencies and respiratory assignments»[6].

The database that we will use covers the period 1990 to 2010 and includes ten countries belonging to the MENA region. To find the relationship between CO2 emissions, energy consumption (EC), GDP per capita, urbanization (URB) and life expectancy (LEXP), the following model is proposed:

$$\mathbf{CO2_{it} = A_o EC_{it}^{\alpha 1i} GDPC_{it}^{\alpha 2i} URB_{it}^{\alpha 3i} LEXP_{it}^{\alpha 4i} (1)}$$

The logarithmic transformation of the equation (1)

$$\mathbf{\ln(CO2_{it}) = \alpha_o + \alpha_{1i}\ln(EC_{it}) + \alpha_{2i}\ln(GDPC_{it}) + \alpha_{3i}\ln(URB_{it}) + \alpha_{4i}\ln(LEXP_{it}) + \varepsilon_{it}(2)}$$

Notes: $\alpha_o =$ A_o , the index (i) and (t) represent respectively the country and the time period; α_1, α_2, α_3 and α_4 represent the long-term elasticities.

The table (1) will give us the overall descriptive statistics of all variables including in the model for the ten MENA countries which are selected in our sample.

[6] Rapport GEO-4, PNUE, 2007, voir page 38/574 de la version française

Table (1): individual and global Descriptive Statistics

		CO2	LEXP	GDPC	EC	URB
PANEL	**Mean**	13.23336	70.70593	10433.68	4703.922	66.96800
	Median	3.230908	71.40626	2796.769	998.1973	70.40850
	Std. Dev.	16.92878	4.651866	14866.52	5871.391	20.91096
	Probability	0.000000	0.000001	0.000000	0.000000	0.001358
ALGERIE	**Mean**	3.035276	68.83138	2367.963	905.0349	59.89095
	Median	3.006722	68.93020	1743.346	872.6684	59.91900
	Std. Dev.	0.235222	1.211948	1054.008	100.7633	4.823877
	Probability	0.759202	0.499202	0.136683	0.272108	0.519009
BAHRAIN	**Mean**	23.92757	74.50603	13801.28	8593.231	88.39048
	Median	21.83855	74.58924	12846.45	8691.604	88.38600
	Std. Dev.	3.656382	1.185637	4649.082	422.5012	0.074447
	Probability	0.270055	0.500524	0.309012	0.337434	0.000001
EGYPTE	**Mean**	1.960237	68.05932	1346.084	712.3024	42.97171
	Median	1.907532	68.59124	1249.493	654.3698	42.98100
	Std. Dev.	0.443456	1.813750	562.2748	149.8815	0.210760
	Probability	0.462222	0.398067	0.080536	0.258101	0.573631
EAU	**Mean**	27.19258	74.32040	33589.40	10887.17	80.62481
	Median	28.78999	74.40568	32984.74	11305.89	80.23600
	Std. Dev.	5.445985	1.520804	6780.037	1521.597	1.957001
	Probability	0.571414	0.515521	0.296033	0.150005	0.362358
JORDANIE	**Mean**	3.368071	71.76074	2143.286	1076.560	79.29895
	Median	3.285860	71.77976	1763.000	1018.519	79.80800
	Std. Dev.	0.265895	1.074106	920.9909	111.5092	2.550532
	Probability	0.977590	0.543127	0.044370	0.212672	0.245827
ARABIE SAOUDITE	**Mean**	14.90136	72.43208	10689.97	5232.876	79.74862
	Median	15.18525	72.61476	8656.165	5029.878	79.84800

	Std. Dev.	2.023712	1.825820	4079.434	811.2721	1.559060
	Probability	0.403146	0.514252	0.104500	0.731302	0.630005
MAROC	**Mean**	1.282715	67.89000	1638.974	378.0332	53.30267
	Median	1.180945	68.13859	1362.532	359.1470	53.33500
	Std. Dev.	0.225468	1.575827	624.2352	69.50769	2.613129
	Probability	0.389320	0.536076	0.177656	0.415786	0.731811
QATAR	**Mean**	53.70485	76.77919	35449.18	18220.45	96.13129
	Median	58.34635	76.82015	28666.61	18319.97	96.31100
	Std. Dev.	10.68711	0.856219	22747.73	2567.262	1.722734
	Probability	0.083646	0.569985	0.245240	0.618533	0.595536
TUNISIA	**Mean**	2.059278	72.12904	2641.421	756.4648	63.00338
	Median	2.083213	72.50000	2336.084	763.9368	63.43200
	Std. Dev.	0.249160	1.363362	898.2617	108.8773	2.421974
	Probability	0.477189	0.712544	0.357442	0.422842	0.417535
YEMEN	**Mean**	0.901669	60.35113	669.2846	277.0875	26.31710
	Median	0.906886	60.45785	546.5362	270.8959	26.26700
	Std. Dev.	0.114287	1.453051	359.1083	50.76310	3.302762
	Probability	0.606358	0.535815	0.156906	0.439023	0.555365

4. Estimation method

In this section we will present the results of estimation of equation (1) using different methods such as fully modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS). These methods allow us to exceeding the limits of other methods used in the context of panel data models such as fixed or random effects models which not take into account the presence of unit roots in the series. This can give and lead to biased estimates and statistical tests that do not follow the standard Student distribution.

4.1. Unit root test

There are a variety of unit root tests used in panel data. As illustration we can refer to the works of Breitung (2000), Hadri (2000), Choi (2001), Levin et al. (2002), Im et al. (2003) and Carrion-i-Silvestre et al. (2005). Consider the following autoregressive specification:

$$\mathbf{y_{it} = \rho_i y_{it-1} + \delta_i x_{it} + \varepsilon_{it}} \qquad (3)$$

With i = 1, ..., N for each country in the model panel ; t = 1, ..., T design the time period; Xit represent the exogenoues variables in the model; ρi represent the autoregression coefficeients; εit represent the stationary error terms. If ρi> 1, yit is considered as having stationary trend while if ρi = 1, than yit will have a unit root. Breitung (2000), et Levin et al (2002) assume an homogeneous autoregressive unit root under the alternative hypothesis, while Im et al (2003) assume the existence of an heterogeneous autoregressive unit root under the alternative hypothesis. According to Maddala and Wu (1999) and Choi (2001) that unit root tests can be determined using the nonparametric statistics of Fisher. Hadri (2000) and Carrion-i-Silvestre et al. (2005) assume that unit root tests in panel examine the null hypothesis of stationarity of the panel data.

In the case of dynamic models of panel data, the recognition of the heterogeneity of parameters is important, to avoid potential biases that may arise due to poor specification of the model. Im et al (2003) assume that the unit root test in dynamic models of panel data is used for heterogeneous autoregressive coefficients. Such heterogeneity may occur due to the heterogeneity of different economic conditions and stages of economic development of each country.

Thus, Im et al (2003) suggest the average of Augmented Dickey-Fuller (ADF) test, allowing serial correlations of error terms to the different orders, $\mathbf{\varepsilon_{it} = \sum_{j=1}^{pi} \rho_{ij} \varepsilon_{it-j} + u_{it}}$; by substituting this into equation (3), we obtain :

$$\mathbf{y_{it} = \rho_i y_{it-1} + \sum_{j=1}^{Pi} u_{ij} e_{it-j} + \delta_i x_{it} + u_{it}} \quad (4)$$

Where ρi is the number of lags in the ADF regression. The null hypothesis is that each series in the panel data, contains a unit root (H0: ρi = 1 ∀i) .The alternative hypothesis is that at least, one of each of the series in the panel data is stationary (H0 : ρi <1∀i. The statistical, T-bar specified by Im et al (2003) is the average of individual statistics ADF as shown in the following.

$$\bar{t}_{NT(\rho_i)} = 1/N \sum_{i=1}^{N} t_{iT}(\rho_i)$$

The alternative statistic "t-bar" allows testing the null hypothesis of the existence of unit root for all individuals. With, t_{iT} (ρi) represents the estimated ADF, N the number of individuals and T as the number of observations. Im et al. (2003) propose to use the following standardized statistic:

$$Z_i = (N)^{1/2}(\bar{t}_{NT} - E(\bar{t}_{NT}))/(var(\bar{t}_{NT}))^{1/2}$$

Where E ($\bar{t}_{NT}$), represents the arithmetic means and var ($\bar{t}_{NT}$), the variances of the ADF individual statistics.

Table 2 : Unit Root tests

	LLC TEST	PROB	TEST DE BREITING	PROB	TEST DE IPS	PROB	TEST .FISHER	PROB	TEST DE PP FISHER	PROB	TEST DE HADRI	PROB
Case 1 : model with constant terms [level form]												
LNCO2	-2.16845	0.0151	-2.08010	0.0188	-1.90012	0.0287	33.5720	0.0292	32.6261	0.0371	5.48506	0.0000
LNEC	0.70554	0.7598	1.39043	0.9178	3.35163	0.9996	6.38275	0.9983	6.29206	0.9984	8.24765	0.0000
LNGDP	2.46673	0.9932	0.44210	0.6708	5.11465	1.0000	2.84875	1.0000	1.76190	1.0000	8.44845	0.0000
LNURB	-3.73413	0.0001	0.03244	0.5129	-2.01263	0.0221	87.9771	0.0000	197.097	0.0000	9.99377	0.0000
LNLEXP	-10.7103	0.0000	4.57489	1.0000	-3.20570	0.0007	191.161	0.0000	611.412	0.0000	9.92641	0.0000
Case 2 : Model with Individual effects, individual linear trends												
LNCO2	-2.31114	0.0104	-	-	-2.85248	0.0022	38.8876	0.0069	45.1752	0.0010	3.92554	0.0000
LNEC	-0.94283	0.1729	-	-	0.17840	0.5708	20.2201	0.4442	19.9228	0.4628	6.45844	0.0000
LNGDP	-2.89278	0.0019	-	-	-2.78067	0.0027	39.7857	0.0053	16.7556	0.6688	6.29150	0.0000
LNURB	3.09509	0.9990	-	-	-4.58380	0.0000	66.1302	0.0000	327.984	0.0000	6.84184	0.0000
LNLEXP	1.67335	0.9529	-	-	-0.26993	0.3936	59.3903	0.0000	326.776	0.0000	6.90478	0.0000
Case 3 : Model with only constant term [first difference]												
LNCO2	-13.8323	0.0000	-6.42884	0.0000	-14.8899	0.0000	188.349	0.0000	433.168	0.0000	2.52874	0.0057
LNEC	-12.3592	0.0000	-3.49994	0.0002	-11.2735	0.0000	140.554	0.0000	149.063	0.0000	2.83482	0.0023
LNGDP	-10.6037	0.0000	-4.38148	0.0000	-9.30924	0.0000	111.176	0.0000	109.911	0.0000	2.63515	0.0042
LNURB	-0.02518	0.4900	3.12099	0.9991	-4.40755	0.0000	62.7401	0.0000	145.832	0.0000	5.78002	0.0000
LNLEXP	-9.20497	0.0000	0.64841	0.7416	-6.82674	0.0000	173.475	0.0000	268.681	0.0000	5.98804	0.0000
Case 4 : Model with only constant term [first difference] with trends												
LNCO2	-12.5762	0.0000	-	-	-13.0353	0.0000	134.735	0.0000	150.105	0.0000	5.91277	0.0000

LNEC	0.1729	0.0000	-	-	-10.4481	0.0000	108.765	0.0000	134.192	0.0000	3.52024	0.0002
LNGDP	-10.5190	0.0000	-	-	-8.36359	0.0000	92.8672	0.0000	91.7768	0.0000	4.97478	0.0000
LNURB	-18.0141	0.0000	-	-	-9.28276	0.0000	50.4115	0.0002	51.9622	0.0001	5.84522	0.0000
LNLEXP	-4.54097	0.0000	-	-	-10.0883	0.0000	96.5730	0.0000	67.4709	0.0000	12.1012	0.0000

*, **, *** coefficients are significant at the level of 1%, 5%, 10%.

The results of the application of the unit root tests (Levin, linen, chu; Breitung; Im, Pesaran and shin, ADF, PP and hadri) of the static relationship LNCO2, LNEC, LNGDPC, LNURB and LNLEXP, reported in the table 2, show that for majoriy of the unit root tests are lower than the critical value at the level of 1%. Thus, the null hypothesis is accepted.

We deduce that residuals of the static relationship among LNCO2, LNEC, LNGDP, LNURB and LNLEXP have a unit root, so they are non-stationary. The series of different variables are non-stationary in level but are stationary in the first difference level at level. Therefore, the series are co-integrated I (1). So we can deduce the existence of a long-run relationship between the CO2 emission in the MENA countries and LNEC, LNGDPC, LNURB and LNLEXP. It is possible to estimate the error correction model (ECM) because the error correction term is stationary at level.

Table 3: Unit Root tests of ECM

	Statistic	Prob
Levin, Lin & Chu t*	-3.45481	0.0003*
Im, Pesaran and Shin W-stat	-4.46015	0.0000*
ADF - Choi Z-stat	-4.30819	0.0000*
PP - Choi Z-stat	-4.38822	0.0000*

*, **, *** coefficients are significant at the level of 1%, 5%, 10%.

4.2. Co-integration tests

To study the existence of a cointegration relationship, we have referred to the work of Peter Pedroni (1999, 2004) where the null hypothesis is to test the absence of cointegration based on the unit roots tests applied to estimated residuals. Pedroni has developed seven co-integration tests which take into account, the heterogeneity of the cointegrating relationship. In other words, for each individual it exists one or more cointegration relationships which are not necessarily identical for each individual in the panel data.

Each of the seven statistics follows a standard normal distribution for sufficiently large N and

$$\text{T:} \quad \frac{z_{NT} - \mu\sqrt{N}}{\sqrt{\delta}} \rightarrow \mathbf{N\ (0,\ 1)}$$

With z_{NT} : one of the seven statistics; μ and δ are the values of tabulate moments of Pedroni.

Tab. 4: Cointegration test of pedroni (1999)

	Within dimension				Between dimension		
	Statistic	**Prob.**	**Statistic**	**Prob.**		**Statistic**	**Prob.**
Panel v-Statistic	-0.079959	0.5319	-0.429636	0.6663	Group rho-Statistic	1.308420	0.9046
Panel rho-Statistic	1.394150	0.9184	0.487075	0.6869	Group PP-Statistic	-4.917524	0.0000[a]
Panel PP-Statistic	-1.475531	0.0700[a]	-4.091995	0.0000[a]	Group ADF-Statistic	-3.010200	0.0013[a]
Panel ADF-Statistic	-2.719920	0.0033[a]	-4.049483	0.0000[a]			

Notes: Critical value at the 1% significance level denoted by “a” for the panel ρ, PP, ADF and group ρ, PP, ADF statistics is -2.719920. Critical value at the 1% significance level for the panel and group v-statistics is -3.0102. The total number of observations is 200.

Tabl.5: Cointegration test of Kao

	t-Statistic	**Prob.**
ADF	-5.799502	0.0000[a]
Residual variance	0.013426	
HAC variance	0.011633	

Notes: Critical value at the 1% significance level denoted by “a” for the panel, ADF statistics is -5.799502. The total number of observations is 200.

From the results of the cointegration tests of Pedroni, we note that all statistics (Panel: rho, ADF and pp; group: rho, ADF and pp) are less than the critical value of the normal distribution for a threshold 5%. Thus, we can conclude that all of these tests confirm the existence of a long term cointegration relationship between the co2 emissions and LNEC, LNGDPC, LNURB and LNLEXP.

4.3. Cointegration relation

To estimate systems of cointegrated variables on panel data, and to identify tests on cointegration vectors, it is essential to apply an effective estimation method.

Indeed, it exists several estimation techniques, such the FMOLS method (Fully Modified Ordinary Least Squares) used by Pedroni, and the DOLS method (Dynamic Ordinary Least Squares) and GMM (Generalised Method of Moments). Pedroni (1996), Peter Phillips, Roger

Hyungsik and Moon (2000) and Kao Chihwa and Min-Hsien Chiang (1999) have showed that, in the case of panel data, the first two techniques lead to the asymptotically distributed estimators according to the standard normal distribution.

However, Kao and Chiang (1999), assume that OLS estimation in finite sample leads to biased estimators, relatively to the FMOLS method. But they also show the superiority of the DOLS method in comparison to FMOLS method. The authors consider this last as the most effective technique in estimating cointegration relationships using panel data. Indeed, the theorem of the representation of Engel and Granger establishes equivalence between the existence of a long-term relationship and the error correction model of the CO2 emission.

Thus we examine the direction of causality between variables in a group setting. Engle and Granger (1987) show that if two non-stationary variables are cointegrated, a vector autoregression (VAR) in first differences will be poorly specified.

As we found a long-term equilibrium relationship between CO2 emissions and LNEC, LNGDPC, LNURB and LNLEXP thus we specify a model with a dynamic representation of error correction term. This means that the traditional VAR model is increased with an error correction term delayed of a period ($\boldsymbol{ECT_{T-1}}$) which is obtained from the model based on co-integration OLS. Granger causality test is based on the following regression:

$$\Delta \boldsymbol{ln\,CO2_{it}} = \boldsymbol{A_{1i}} + \sum_p \boldsymbol{\beta_{10ip}}\,\Delta \boldsymbol{lnC02_{it-p}} + \sum_p \boldsymbol{\beta_{11ip}}\,\Delta \boldsymbol{lnEC_{it-p}} + \sum_p \boldsymbol{\beta_{12ip}}\,\Delta \boldsymbol{lnGDPC_{it-p}} + \\ + \sum_p \boldsymbol{\beta_{13ip}}\,\Delta \boldsymbol{lnURB_{it-p}} + + \sum_p \boldsymbol{\beta_{14ip}}\,\Delta \boldsymbol{lnLEXP_{it-p}} + \boldsymbol{\varphi_{1i}ECT_{T-1}} \quad \textbf{(5)}$$

With Δ represent the first difference of the variable, *p* the number of lags. The importance of the first differentiated variables is that they shows on the short-term direction of Granger causality, while the t-statistics on a delayed period in terms of error correction, represents the long term Granger causality. In the co2 consumption Eq (5), short run causality from energy consumption, GDP, urbanisation, and the EXP, are tested respectively, based on H0: $\beta_{11ip} = 0\ \forall ip$, H0: $\beta_{12ip} = 0\ \forall ip$, H0: $\beta_{13ip} = 0\ \forall ip$, and H0: $\beta_{14ip} = 0\ \forall ip$. The null hypothesis of no long run causality in each Eq (5) is tested by examining the significance of the p-value for the coefficient on the respective error correction term represented by ECT.

5. Results and interpretation

4.1 Short run effects

Table 6: Panel causality test results region MENA (individual and global), 1990–2010

	Short-run elasticities [ln CO2 is the dependent variable]									
Country	DLNEC		DLNLEXP		DLNGDPC		DLNURB		ECM	
	Coeffi.	Prob.	Coeffi.	Prob.	Coeffi.	Prob.	Coeffi.	Prob.	Coeffi.	Prob.
ALGERIE	0.0624	0.8880	107.09	0.2149	-0.0531	0.6527	-49.787	0.1228	-0.8694***	0.0012
BAHRAIN	0.5534	0.2768	59.278	0.3018	0.2348	0.3013	-2.8124	0.9477	-0.9392***	0.0006
EGYPTE	0.1501	0.5328	11.910	0.2529	0.1852	0.1001	14.220	0.2101	-1.2052***	0.0002
EAU	0.2000	0.8589	24.071	0.8984	0.1490	0.7911	1.7092	0.9475	-0.6681**	0.0532
JORDANIE	0.9411***	0.0000	-98.484*	0.0643	-0.1614	0.1876	6.5992**	0.0461	-1.2870***	0.0000
KSA	1.1583**	0.0153	-17.997	0.6438	0.3360	0.1423	12.370	0.5918	-0.3759*	0.0997
MAROC	1.0182***	0.0004	4.9423	0.4953	0.0665	0.4826	-2.1080	0.5830	-0.6942**	0.0544
QATAR	0.2710	0.4294	-36.756	0.8724	0.3769*	0.0562	125.97**	0.0115	-0.6088**	0.0132
TUNISIE	-0.1094	0.6303	0.9476	0.4097	-0.0165	0.8899	3.0031	0.1353	-0.8755***	0.0009
YEMEN	0.3393	0.4542	18.596	0.8683	0.4004*	0.0991	1.5090	0.9662	-1.1873***	0.0026
PANEL	0.6660***	0.0000	2.2842	0.3470	0.1230*	0.0736	1.2477	0.2661	**-0.3720***	0.0000

*, **, *** coefficients are significant at the level of 1%, 5%, 10%.

The error correction terms (ECM) are statistically significant at the 1% level. This implies, relatively, the fast speed of the adjustment to the long-run equilibrium. The values of ECM are negatives and statistically significant. Indeed, the negative value of ECM is shows the speed of convergence of the short run to the long run. The coefficients of ECM, show that short run deviations are corrected by 37, 2% per cent in future for the all group of countries constituting the sample.

According to the table (6), we note, concerning the totality of the panel countries, constituting our sample, that CO2 emission is explained, in the short term, only, by two variables: energy consumption and economic growth per capita. Indeed, the coefficient of the energy consumption (0.666) is positive and significant at 1%. This seems logical because of the high correlation between energy consumption and CO2 emissions. Indeed, any increase in the energy consumption by one unit generates an increase in CO2 emissions by 0.66 units. Also, the per capita economic growth appears to have, in the short term, a positive and significant effect at 10% level. In other words, the relative increase in GDP per head of a unit causes a relative increase in CO2 emissions of 0.213 units.

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However, at the individual level we notice that the results are relatively heterogeneous. Indeed, about the effect of energy consumption on C02 emissions, the results showed that the said effect, is established for, only, three countries: Jordan, Saudi Arabia and Morocco, where the estimated coefficients were respectively 1.15 (significant at 1%); 1.018 (significant at 5%) and 0.94 (significant at 1%). A priori, in these three countries it turns out that the energy consumption is significantly the main cause of CO2 emissions. However, for the remaining countries (Algeria, Bahrain, Egypt, UAE, Qatar, Tunisia and Yemen) the estimated coefficients were not significant. This, allows us to say, without much risk, that there is not a causality relationship between energy consumption and CO2 emissions.

As for the effect of life expectancy on the CO2 emission we note it is generally non significance (both in global as individual level) except in the case of Jordan. Indeed, in this country the life expectancy has negative and significant effect at 10% on the CO2 emissions. This means that the increase in life expectancy cannot be achieved only at the expense of lowering CO2 emissions.

Regarding the effect of GDP per capita we notice that it is positive and significant at 10% for the group of MENA countries. At the individual level said effect is positive and significant at 10% only for the cases of Qatar and Yemen. Concerning the urbanization effect we notice that it is not significant on the global group while it is positive and significant at 5% for Jordan and Qatar.

4.2 Long run effects

Following Pedroni (2000), the fully modified OLS (FMOLS) and the dynamic OLS (DOLS) technique for heterogeneous cointegrated panels are estimated. Table 7.a and 7.b displays the FMOLS and DOLS results.

Tab.7 a: Long run estimation (FMOLS)

Country	Long-run elasticities [ln CO2 is the dependent variable]							
	LNEC		LNLEXP		LNGDPC		LNURB	
	Coeffi.	**Prob.**	**Coeffi.**	**Prob.**	**Coeffi.**	**Prob.**	**Coeffi.**	**Prob.**
ALGERIA	0.3412	0.5577	-0.3059	0.7394	0.0218	0.8980	-0.0215	0.9711
BAHRAIN	1.4155***	0.0018	-0.1484	0.9689	-0.1921	0.3043	-1.6054	0.6179
EGYPTE	0.6623***	0.0000	2.6962***	0.0001	0.0579	0.1208	-4.1161***	0.0000
EAU	0.7884***	0.0043	-11.247*	0.0695	0.1607	0.4986	9.7355*	0.0903
JORDAN	0.9024***	0.0000	-3.093***	0.0000	-0.0854**	0.0145	2.0094***	0.0015
KSA	0.5375	0.3194	-16.762**	0.0452	0.2399	0.1568	15.452**	0.0409
MAROC	1.1047***	0.0001	-2.1296***	0.0077	-0.0710	0.2527	0.8043	0.4271
QATAR	0.4701***	0.0004	-45.751***	0.0000	-0.4384***	0.0000	44.344***	0.0000
TUNISIA	0.8123***	0.0013	-0.7687	0.2170	0.0991	0.1305	-0.5181	0.5333
YEMEN	0.5218**	0.0254	-0.6236***	0.0042	0.1053	0.1277	-0.3535	0.1339
PANEL	0.8199***	0.0000	1.4247	0.2335	-0.0892	0.1022	-0.3864	0.2686

*, **, *** coefficients are significant at the level of 1%, 5% and 10 %.

Tab.7 b: Long run estimation (DOLS)

Country	Long-run elasticities [ln CO2 is the dependent variable]							
	LNEC		LNLEXP		LNGDPC		LNURB	
	Coeffi.	Prob.	Coeffi.	Prob.	Coeffi.	Prob.	Coeffi.	Prob.
ALGERIA	0.0784	0.8992	0.2868	0.7360	0.0925	0.5593	-0.3304	0.5135
BAHRAIN	**1.4792****	0.0322	-0.0572	0.9926	-0.1914	0.5317	-1.8236	0.7254
EGYPTE	**0.6506*****	0.0000	**2.9155*****	0.0007	0.0527	0.3619	**-4.3323*****	0.0000
EAU	**0.7245***	0.0625	-9.3172	0.2441	0.1170	0.7693	8.0820	0.2766
JORDAN	**0.8814*****	0.0000	**-3.0007*****	0.0005	**-0.0845***	0.0964	**1.9501*****	0.0068
KSA	0.7620	0.2217	**-21.335***	0.0661	0.2912	0.2051	**19.379***	0.0666
MAROC	**1.0902*****	0.0047	**-2.4922****	0.0210	-0.0863	0.3680	1.2393	0.3954
QATAR	0.4803	0.3151	**-41.215****	0.0309	**-0.4072****	0.0286	**39.941****	0.0353
TUNISIA	**0.7441*****	0.0094	-0.9321	0.1611	0.1000	0.2423	-0.2426	0.7824

YEMEN	0.4998	0.1639	**-0.6319****	0.0279	0.0973	0.3214	-0.2897	0.4131
PANEL	**2.7870*****	0.0000	**-2.4882*****	0.0000	**-0.7474*****	0.0000	-0.3072	0.2434

At the whole group level, we notice that the coefficient associated with the consumption of energy is positive and significant at the 1% level while the coefficients associated with life expectancy and per capita income, are negative and significant at the 1%. The positive and significant effect of energy consumption on the emission of CO2 is explained, in the long period, by the fact that the MENA group will retain its energy strategy at the consumption of pollutant energetic goods. Indeed, the estimation shows that a relative increase of 1% of the energy consumption will lead to an increase of 2,787% of CO2; this allows us to assume that the energy basket of goods which are currently consumed by these countries will have, in the long term, a multiplier effect of pollution.

The effect of life expectancy on the CO2 emission is negative and significant at the level 1%. Indeed, the relative increase in life expectancy of a unit decreases the CO2 emission by 2.4882% units. This result seems logical is consistent with theoretical expectations which converge to the hypothesis confirming that the increase in life expectancy requires less emission of Greenhouse Gas including CO2. The latter is often accused of being either the primary cause or the stimulus of several respiratory diseases or pathological.

Also, the effect of per capita income on the emission of CO2 is negative and significant at the 1%. This Implies that, when per capita income, increases by 1%, thus CO2 emission decreases by 0.7474%. This allows us to say that, in long term, the MENA group should generate the economic growth from the Economic Activity Sectors which are less pollutants and more cleaner. This finding seems to be logical since the EU (the first economic partner for, almost, the totality of MENA countries), becomes more severe in the matter of environmental regulation, which imposes to its Commercial partners to respect the environmentally Standards having as main goal the reduction of CO_2 emission.

At the individual level, we find that the positive relationship between energy consumption and CO_2 is strongly verified in the majority of countries in our sample (Bahrain, Egypt, UAE, Jordan, Tunisia and Morocco). This can be explained by the orientation of these countries, in the long run, for the conservation of their current strategies for energy consumption, or at least the absence of a willingness approved by these countries to substitute the energy goods currently consumed by others less polluting.

Regarding the effect of life expectancy on the CO_2 emission, we notice that it is negative and significant, respectively, at the levels of 1% (Jordan), 5% (morocco, Qatar and Yemen) and 10% (Saudi Arabia) and positive and significant at 1%, only for the Egyptian case. As already mentioned above, the majority of MENA countries will develop a new strategies aiming to improve the living conditions and protection of the environment and this requires, the existence of a collective conscience approved by these countries to reduce CO_2 emissions.

However, the positive and significant effect exerted by life expectancy on emissions of CO_2 in the Egyptian case, despite it is not conform with theoretical expectations, can be explained by the fact that, in the long period, improvement of living conditions should be achieved by the consumption and use of more polluting energy goods. In other words, as the Egypt will not change, in the long term, its energy consumption strategy, thus the improving living conditions, in the long run, remains dependent on its current energy policy. Thus, the increasing in life expectancy by one unit requires increased CO_2 emissions by 5.0126 units. This means that a portion of said emissions are the result of ameliorative activities living conditions (health, purifying, training, infrastructure etc.).

As for the effect of per capita income on CO2 emission, we notice that it is negative and significant for the cases of Jordan (at the level of 10%) and Qatar (at 1% level) and not significant for the remainder of the sample. Despite that this result is not consistent with theoretical expectations, we can say that it can be explained by the fact that the future economic strategy of Jordan and Qatar are not based upon current energy vector but seeks to invest in the economic sectors which are non-polluting and responding to the international environmental standards.

The effect of urbanization seems to be negative and significant at the level of 1% in the case of Egypt and positive and significant at the level of 1% in the case of Jordan, 5% for Qatar and 10% for 'Saudi Arabia. A priori, when the urban population increases, she requires and needs to consume more goods and social services which are strong generators of CO2 emissions

6. Conclusion

The main objective of this article is to explain the CO2 emissions by a set of economic and socio-economic variables within the MENA countries. The empirical results have covered two time horizons: the short and long term.

Indeed, in the short term we noticed for all countries of our sample, that the CO2 emission is explained by energy consumption and economic growth per capita which exert positive and significant effects. Indeed, it seems that in the short term there is a causal relationship between the consumption of energy (which generates, as a result, more of CO2 emissions) and economic growth. So this leads us to note that this group of countries continuing in the short run, to use the same energy vector either to the final consumption of households or at the intermediate consumption. Therefore, this energy vector increases per capita income and more CO2.

However, in the long run there will be a structural change in the economic orientation of all selected MENA countries in our sample. Thus, we noticed that the CO2 emission is always positively influée by energy consumption. This means that group of nations retain, in the long run, the same current energy carrier (in terms of consumption). The effect of life expectancy is negative and significant emissions of CO2 which means that the improvement of living conditions, in the long period, can not proceed without the lowering of CO2 emissions. Also, the effect of income per capita is negative and significant which means that the long-term economic strategy of these countries is based on activities and non-polluting sectors. In other words, growth-generating economic potential are located in non-polluting sectors and not generators of greenhouse gas.

In terms of recommendations and suggestions we can say, based on estimation results, if in the short term the strategy of MENA countries is based on a vector of consumption and production of energy goods pollutants there will be in the long-term strategic change that this group of countries will be looking at the least polluting sectors. This is no longer a choice but a constraint (imposed by the EU and requiring exporting countries to comply with environmental standards for CO2 emission and other). So long as life expectancy is negatively correlated to CO2 emissions then it would be logical that these countries invest in improving living conditions and reducing CO2 emissions.

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