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INCOME LEVEL AND ENVIRONMENTAL QUALITY IN THE MENA COUNTRIES: DISCUSSING THE ENVIRONMENTAL KUZNETS CURVE HYPOTHESIS

Hatem M'henni, Mohamed El Hedi Arouri, Adel Ben Youssef and Christophe Rault

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Abstract

This study extends the recent works of Liu (2005), Ang (2007), Apergis et al. (2009) and Payne (2010) by implementing recent bootstrap panel unit root tests and co-integration techniques to investigate the relationship between carbon dioxide emissions, energy consumption, and real GDP for 12 MENA countries over the period 1981–2005. Our results show that in the long-run energy consumption has a positive significant impact on CO2 emissions. More interestingly, we show that real GDP exhibits a quadratic relationship with CO2 emissions for the region as a whole. However, although the estimated long-run coefficients of income and its square satisfy the EKC hypothesis in most studied countries (except Tunisia, Morocco and UAE), the EKC turning points are very low in some cases and very high in the other cases, hence providing poor evidence in support of the EKC hypothesis (except for Jordan). Thus, our findings suggest that not all MENA countries need to sacrifice economic growth to decrease their emission levels as they may achieve CO2 emissions reduction via energy conservation without negative long run effects on economic growth.

ملخص

تمتد هذه الدراسة للأعمال الأخيرة من ليو (2005)، انج (2007)، Apergisوآخرون (2009) .وباين (2010)من خلال تنفيذ تقنيات التكامل المشترك واختبارات وحدة الجذر للتحقيق في العلاقة بين انبعاثات غاز ثاني أكسيد الكربون، واستهلاك الطاقة، والناتج المحلي الإجمالي الحقيقي للبلدان ال 12بالمنطقة خلال الفترة 1981-2005. تظهر نتائجنا أن استهلاك الطاقة على المدى الطويل له أثر إيجابي كبير على انبعاثات غاز ثاني أكسيد الكربون ومما يثير الاهتمام بالأكثر، هو أن الناتج المحلي الإجمالي الحقيقي يرتبط بعلاقة من الدرجة الثانية مع انبعاثات غاز ثاني أكسيد الكربون للمنطقة ككل .ومع ذلك، وعلى الرغم من أن المعاملات المقدرة على المدى الطويل الدخل ومربع في تلبية فرضية EKC المدروس في معظم البلدان (باستثناء المغرب وتونس والإمارات العربية المتحدة)، ونقطة تحول EKCمنخفضة جدا في بعض الحالات وعالية جدا في حالات أخرى، وبالتالي تقديم أدلة الفقراء دعما لفرضية EKC (باستثناء الأردن) .وهكذا، تشير نتائجنا الى ان ليس كل بلدان المنطقة في حاجة للتضحية بالنمو الاقتصادي لتخفيض مستويات الانبعاثات لأنها يمكن أن تحقق الحد من الانبعاثات عن طريق الحفاظ على الطاقة من دون الآثار السلبية على المدى البعيد على النمو الاقتصادي.

1. Introduction

The relationship between environmental quality and economic growth is puzzling. According to the Environmental Kuznets Curve (EKC) hypothesis, as income increases, emissions increase as well until some threshold level of income is reached after which emissions begin to decline. Beckerman (1992), states that environmental improvement will be an almost unavoidable consequence of economic growth. Firms and consumers change their patterns of production and consumption for more environmental friendly goods. In this sense, income growth may serve as a solution to environmental degradation rather than the source of the problem.

If we consider EKC as valid and that industrialized countries have shifted from the first stage of the curve, due to their income per capita level, to the second stage in some pollutants like Sulphur dioxide (Markandya et al. 2006), the picture seems quite different for developing countries, especially Middle East and North African (MENA) Countries.

For MENA region, the World Bank through its Global Monitoring Report 2008, states that "a number of countries in the region remain on an unsustainable path, consuming profits on natural resource exploitation rather than investing these profits to ensure long-term economic sustainability". The same report claimed, "The Middle East & North Africa region has increased its carbon dioxide emissions, faces diminishing critical per capita water resources, and is at risk on several fronts from climate variability".

In fact, MENA countries produce around 7% of worldwide greenhouse gases while accounting for around 6% of the world's population. More worrying is that emissions are increasing rapidly. Between 1990 and 2004, MENA's emissions grew by 88%, the third fastest increase in the world. The environmental damage cost in Middle East and North Africa in 2000 was estimated at US$ 9 billion per year, or 2.1-7.4% of GDP, with a mean estimate of 5.7% of GDP (Muawya, 2008).

Environmental Sustainability Index (ESI) report of 2005[1], shows that countries from the MENA region are characterized by a low or moderate system, stresses, vulnerability and low capacity and stewardship. The same conclusion is found by the new version of the ESI called the Environmental Performance Index (EPI)[2] in 2010. In the last report we noted that the best MENA country, which is Algeria is classified in42nd place followed by Morocco at 52. Saudi Arabia is 99 and the United Arab Emirates is only 152nd.

This last index, divide the MENA region into two distinct groups. The first one is composed of Algeria, Morocco, Tunisia, Syria, Egypt, Lebanon, Iran and Jordan. Their main characteristics are that they perform well in terms of environmental burden of disease and indoor air pollution. They also have roughly average results on most other indicators, but poor air pollution performance. Their scores on urban particulates and industrial carbon dioxide performance scores fall far below other clusters.

The second group is composed of Bahrain, Kuwait, Libya, Oman, Qatar, Saudi Arabia, United Arab Emirates, Sudan and Yemen. This cluster is comprised of mainly fossil fuel

[1] Between 1999 and 2005 the Yale and Columbia team published four Environmental Sustainability Index reports (http://sedac.ciesin.columbia.edu/es/esi/) aimed at gauging countries' overall progress towards "environmental sustainability." These indices covered up to 76 different elements of sustainability across economic, social and environmental issues. Since then the focus has shifted to environmental performance, measuring the ability of countries to actively manage and protect their environmental systems and shield their citizens from harmful environmental pollution.

[2] The 2010 EPI ranks 163 countries on 25 performance indicators tracked across ten well-established policy categories covering both environmental public health and ecosystem vitality. These indicators provide a gauge at a national government scale of how close countries are to established environmental policy goals. A pilot exercise was conducted in 2006 and a complete report was published in 2008.

producing and processing nations and too low income countries. They perform well on the environmental burden of disease but poorly on outdoor air pollution. Their scores are among the lowest in some of the water indicators, but most notably, they have the worst greenhouse gas per capita performance of all the clusters.

The question of sustainability of growth in MENA Countries becomes central. From the one hand, environmental constraints may lead to lower the necessary growth for the region in a context of demographic boom associated with a high level rate of unemployment. From the other hand new opportunities and benefits from technological transfer may lead to better trend of growth and sustainability. One of the most important questions that arise in this context is: what is until now, the nature of the relation between economic growth and environmental quality in MENA countries? Do we have the same trends than elsewhere, or is there some specificity for the region?

One of the most important tasks in order to verify the relationship between environment and economic growth is to consider a specific measure of environmental quality. "Most often, environmental quality is measured using variables that correlate negatively with the welfare of society, such as air pollution, water pollution and deforestation. Per capita gross domestic product (GDP) on the other hand is a common measure of development that is used in such studies (Markandya et al. 2006). If we look especially at Global Warm and Air Pollution different emissions were pointed including CO_2, NOx, VOC, CO, Air Toxics, PM10, SO_2, NH3, CH4, and NMVOC. The most studied pollutants in economics are CO_2 and SO_2. CO_2 is the main gas responsible for global warm and the most used by industry and consumers. This pollution is non-source point pollution and needs specific regulation. SO_2 is due basically to industry and is more localized pollutant. It's one of the main damageable pollutants given its impacts on health, acid rain, et cetera.

Three main arguments can be presented in order to justify CO_2 and SO_2 emissions as the environmental quality proxy in order to test the existence of the Kuznets Curve. First, CO_2 and SO_2 are the main Greenhouse emissions worldwide and are responsible for the global warm. Second, MENA Countries are performing poorly compared to others clusters of countries in matter of CO_2 and SO_2 emissions. There's a growing literature verifying the existence and the nature of the relationship between Energy consumption, Emissions of CO_2 and SO_2 and growth worldwide and to our knowledge there's no specific study for the whole MENA countries. We want to know since that whom countries have a correlation with growth. Third the homogeneity of the measure (CO_2 and SO_2) can allow us to stress the main differences between countries.

Starting from these considerations, the aims of this work are threefold: First, to verify the existence of EKC in the 12 countries belonging to MENA Countries in matter of Carbon' dioxide and Sulfur' dioxide. Second, to characterize the turning points until which the development improves the environmental quality in MENA Countries. Third, we want to understand the nature of the causality relationship between economic growth, energy consumption and emissions of CO_2 and SO_2. Finally based on these findings we are going to assess the possible evolutions of CO_2 emissions in each country as regard of political commitment and support. Our research relies on the empirical verification of EKC (Coondoo and Dinda, 2002 & 2006; Stern, 2004; Müller-Fürstenberger and Wagner, 2007; Ang, 2007; Caviglia-Harris et al. 2009; Apergis and Payne, 2009, Lee and Lee, 2009) and those focusing especially on MENA Countries (Lise, 2006; Mehrara, 2007; Akbostanci et al. 2009, Fodha and Zaghdoudi, 2009).

The article is structured as follows. Section 1 presents a synthesis of the associated empirical studies and discusses their findings. Section 2 surveys the theoretical foundation of the EKC.

Section 3 presents the data and the econometric models. Section 4 discusses the results. Section 5 offers some policy implications and concludes.

2. Empirical Verification of EKC: Methodologies and Results

EKC is basically an empirical relationship between environmental quality and growth. Given the variety of environmental quality variables, econometrics methods, periods of observation, countries, there's a plethora of empirical literature on the validity of EKC. We have identified more than two hundred empirical papers dealing with the issue of the EKC in all its forms. In order to survey them, keeping in mind our aims, we start by the basic ones and we identify three extension strategies.

2.1. The traditional estimation form

Many empirical papers have confirmed the pertinence of the EKC approach since the initial work of Grossman and Krueger (1991), (Shafik and Bandyopadhyay, 1992; Hettige, et al. 1992; Panayotou, 1993, Selden and Song, 1994). These studies, among others, have suggested that there is an inverted U relationship between environmental quality, and per capita income level. According to the EKC hypothesis, at the first stage of economic development environmental damage increase as per capita income increases, but after a critical turning point (for most of the pollution indicators, the estimated turning point lies within the income range of US$3000–10,000 (at a constant price, 1985 US dollar)) these damages diminish along with higher income levels.

These studies share the same reduced form equations that attempt to quantify the net effect of income per capita on the environment quality. The equation tested has usually the following form: $Z_{it} = ß_0 + ß_1 Y_{it} + ß_2 Y^2_{it} + ß_3 X_{it} + \mu_{it}$

Z_{it}, is an indicator of the environment quality for a country i at time t.

This index can be composite, as it may represent one factor related to pollution. Y_{it} represents the average annual income per capita. Xit is a vector including other variables in the model. It is therefore an equation of the form $F = Z_{it}(Y_{it})$ that is being tested in the final. In particular, it is important to learn about the changing ratio $\delta Z_{it}/\delta Y_{it}$. In this case, we have $\delta Z_{it}/\delta Y_{it}=ß_1+2ß_2 Y_{it}$, as well as the critical threshold is reached $\delta Z_{it}/\delta Y_{it}=0$. The corresponding value for this threshold is $Y_{it}^*=-ß_1/2ß_2$ which is necessarily positive, implying that $ß_1$ and $ß_2$ must be of opposite signs.

There is today weak certitude about the existence of an EKC, at least in the primary meaning of an inverse U shaped curve. What remains consist of confining these models to country-panel studies more than to singular country. Results relative to solid pollutants are more robust than those relative to emissions. As noted by Hechler (1995), this model does not tell us whether this result can be verified regardless to the country, region and time or if some appropriate policies are necessary to achieve that target. In this context we can ask, what would prevent a significant improvement of the environmental situation before this critical threshold is reached? What about the more active developing countries in relation to the protection of the environment? And can we separate economic and environmental performances?

The traditional models are subject to omitted variables bias (Auci and Bacchetti, 2005). Different strategies were developed in order to go beyond the initial form of the relationship. The first strategy consists in adding cubic and quadratic income as explanatory variables.

It is worth noting that recent studies suggest that there are not two but three phases of evolution of environmental quality in relation to income. Some empirical works on a panel of countries like (Grossman and Krueger (1995) show that there may be distinct phases of decline, a rapid checked in a first phase followed by a less rapid during the second phase.

During the first stage, the degradation of the environment due to economic growth is rapid. This can be explained by the fact that when the per capita income is low, as in the case of the poorest countries, environmental concern is overshadowed by the pursuit of growth, which is the main objective of the economic policy. To this succeeds a second stage characterized by a slower degradation of the environment even when income increases. This fact can be explained by the realization by middle income countries to bracket, the environmental problem. This awareness may take the form of financial efforts allocated to the cleaning of water or air, grants or the creation of institutions that handle these cases. It can also take the form of new tax provisions requiring polluters to pay a certain fee, according to the principle of "polluter payers" or a variant of such a principle. Whatever its form, an effort to make lower the rate of degradation of the environment and this could be perceived by the new equation to estimate: $Z_{it} = ß_0 + ß_1 Y_{it} + ß_2 Y^2_{it} + ß_3 Y^3_{it} + ß_4 X_{it} + \mu_{it}$

The inflection point characterizing the end of the first phase and the beginning of the second must verify the following condition: $\delta^2 Z_{it}/\delta Y_{it}^2=0$ which corresponds to a per capita income equal to $(-ß_2/3ß_3)$. For this, $ß_2$ and $ß_3$ must be of opposite sign.

But growth isn't the unique explanation proposed by the theoretical and empirical researches. In a survey dedicated to the EKC hypothesis, Dinda (2004) identifies the following other factors: Income elasticity of environmental quality demand, scale, composition and technique effects, international trade, foreign direct investments, race to bottom hypothesis, diffusion of technology, international assistance, globalization, market mechanism, role of prices, role of economic agents, transition to market economy, information accessibility, regulations (formal and informal), property rights. In another survey Lieb (2003) considers other factors that could possibly explain the shape of the EKC including: Demand for environmental quality, substitution between pollutants, technological progress, increasing returns to scale in abatement, structural change, migration of dirty industries, income distribution, shocks, and irreversibilities.

When we look at recent contributions two lines of research seems to be at the heart of EKC extension. The first one adds more variables linked to the observed country or panel of countries. The second line of research focuses more on energy consumption as explanatory variable.

2.2 Adding specific country variables (population density, geography…)

Different studies have tried to stress differences between countries in order to adjust the EKC. For example, population density seems to be a key variable since it varies greatly between countries and explains environmental quality. In matter of emissions there's a great evidence of the correlation between population density and emissions.

Some contributions underline the role of national and local policies. They have concluded that income–environmental quality relationship is likely to be impacted significantly by national policies ceteris paribus (Arrow et al., 1995; Stern, 1997). Strong policies and institutions in the form of more secure property Rights, better enforcement and effective environmental regulations can help to 'flatten' the EKC (Panayotou, 1997).

Many other factors are always found in the literature and wait for more analytical and empirical confirmations such as: external shocks, corruption, education, health, total factor productivity, innovation and R&D.

2.3 Adding Energy consumption

Emissions of various pollutants, such as carbon dioxide, sulphur are tightly coupled to the use of energy. Hence, the EKC is a model of the relationship among energy use, economic growth, and the environment. Most of the contributions look into the relationship between energy intensity, CO_2 emission intensity and income (Kraft and Kraft, 1978; Soytas and al. 2007; Ang, 2007; Soytas and Sari, 2009)[3].

Our aim in this paper is to contribute to this line of research. For MENA Countries few contributions examined this research line. M'henni (2005) tests for the existence of the EKC in Tunisia from 1980 to 1997 by using the Generalized Method of Moments (GMM), time series data for CO_2 emissions, along with fertilizers concentration and the numbers of cars in traffic served to calculate an index for environmental quality; he also estimated a quadratic equation for each of the pollution indicators. The author concludes that there is no evidence to support the EKC for any of these pollutants.

In the same vein but with a different result, the co-integration analysis tested by Chebbi and al. (2009) reveals a positive linkage between trade openness and per capita emissions and a negative linkage between economic growth and per capita pollution emissions in the long-run.

Fodha and al. (2010) provide support for a long-run relationship between the per capita emissions of two pollutants and per capita GDP, indicating that there is a monotonically increasing linear relationship between per capita CO_2 emissions and per capita GDP, while the relationship between the other environmental indicator, i.e. SO_2 and per capita GDP follows an N-shape, representing the EKC hypothesis.

Akbostanci and al. (2009) examined the relationship between CO_2, SO_2 and PM10 emissions, energy consumption and economic growth in Turkey at two levels. They have looked for the EKC at national level and also for the 58 provinces in Turkey. They found a monotonic and increasing relationship at the national level. However, they found an N shaped curve at provinces levels. Their findings do not support the EKC.

Mehrara (2007) examined the causal relationship between per capita energy consumption and per capita GDP in oil exporting countries. In his sample seven MENA countries were examined (Algeria, Bahrain, Iran, Saudi Arabia, Oman, Kuwait, and United Arab Emirates). He found strong unidirectional causality from economic growth to energy consumption. He suggests reforming energy prices in these countries without loss of economic growth and with an improvement of environmental quality.

Sari and Soytas (2009) investigate the relationship between carbon emissions, income, energy and total employment in selected five OPEC countries (including Algeria and Saudi Arabia) for the period of 1971–2002. They mainly focus on the link between energy use and income. Employing the autoregressive distributed lag (ARDL) approach, they find that there is a co-integrating relationship between the variables in Saudi Arabia only and conclude that none of the countries need to sacrifice economic growth to decrease their emission levels

Recently, Narayan and al. (2010) test the Environment Kuznet's Curve (EKC) hypothesis for 43 developing countries for the period from 1980 to 2004. They examine the EKC hypothesis based on the short- and long-run income elasticities vis à vis CO_2 emissions; that is, if the long-run income elasticity is smaller than the short-run income elasticity then it is evident for them that a country has reduced carbon dioxide emissions as its income has increased. They found that for the Middle Eastern panel, the income elasticity in the long run is smaller than the short run, implying that carbon dioxide emission has fallen with a rise in income.

By using the same methodology Jaunky (2010) test the EKC hypothesis for 36 high-income countries (including Bahrain, Oman and UAE) over the period 1980-2005. Carbon dioxide (CO_2) emissions and GDP series are integrated of order one and cointegrated especially after controlling for cross-sectional dependence. Unidirectional causality running from real per

[3] Payne (2009) for a survey

capita GDP to per capita CO_2 emissions was uncovered in both the short run and long run. The empirical analysis based on individual countries suggests that for Oman (and for other 6 non Mena countries), as well as for the whole panel, CO_2 emissions have fallen as income rises in the long run. A 1% increase in GDP generates an increase of 0.68% in CO_2 emissions in the short run and 0.22% in the long run for the panel. These results do not provide evidence of an EKC but indicate that over time CO_2 emissions are stabilizing in the rich countries.

Our work extends the finding of this literature by examining the situation at two levels. The first level is for the whole region (12 MENA countries) and the second level is national level. Our findings support the sensitivity of the EKC to the level of observation.

2.4 Weakness of the econometrics of the EKC

An EKC found by cross-country or panel data estimations would simply reflect the juxtaposition of a positive relationship between pollution and income in developing countries with a negative one in developed countries, and not a single relationship that applies to both categories of countries (Vincent 1997). This argument does not apply only to cross-country studies, but also to cross-regional studies (see e.g. Carson et al. 1997), because these studies implicitly assume that all regions considered follow the same development path as is assumed for the countries in cross-country or panel data studies.

The general criticisms faced by most of the EKC studies are therefore the lack of coherence and comparability in the forms and turning points of the pollution-income relationship (Ekins, 1997 and Stern and Common, 2001).

Another concern is related to the environmental indicators' measurements. The "measures of the environmental degradation fall in two general categories: emission of the pollutants and environmental concentrations of pollutants" (Kaufman et al., 1998, p.210). These two measurements illustrate different aspects of the environmental degradation situation and neither of them can offer a comprehensive description. "Emission directly measures the amount of pollutants generated by economic activities during a period without regarding to the size of the area into which the pollutants are emitted". It is actually a flow measurement for the polluting capacity of economic activities. "The concentration measures the quality of pollutants per unit area without regarding to the activity that emitted them", it is more like a stock measurement describing the final result of the encounter between emission, abatement efforts and the self-purification capacities of nature. As concentration is a more direct environmental quality indicator and has more direct impact on productivity and public health, Selden and Song (1994) believe it should be easier to obtain an inverted-U curve for concentration than for emission indicators.

From an econometric point of view we can notice that the standard EKC regression model[4], is far from giving whole satisfaction for at least the following reasons: Firstly, Stern et al. (1996) raised the issue of heteroskedasticity that may be important in the context of regressions of grouped data (see Maddala, 1977); Secondly, Schmalensee et al. (1998) found that regression residuals from OLS were heteroskedastic with smaller residuals associated with countries with higher total GDP and population; Thirdly, Holtz-Eakin and Selden (1995) used Hausman tests for regressor exogeneity to directly address the simultaneity issue. They found no evidence of simultaneity.

[4] $\ln(E/P)_{it} = \alpha_i + \gamma_t + \beta_1 \ln(GDP/P)_{it} + \beta_2 \ln(GDP/P)_{it}^2 + \varepsilon_{it}$, where E is emissions, P is population, and ln indicates natural logarithms. The first two terms on the RHS are intercept parameters which vary across countries or regions i and years t.

Stern (2004) asserts that a large portion of EKC literature is statistically weak and when these statistical problems are taken into account and appropriate techniques are used, EKC cannot exist." We challenge this view in our paper and we show that using recent and appropriate econometrics leads to the existence of EKC in MENA Countries.

3. Theoretical Explanations of EKC

Since EKC is an empirical relationship there is no specific theory explaining it. However several arguments were advocated in order to debate this relationship. We propose in the next section a synthesis of the main theoretical explanations.

Three main explanations are provided in order to explain the relationship between growth or development and environmental quality. First, Technological change due to development induce a change in the environmental quality. Second, Tastes of Economic agents and their awareness about environmental quality changes with growth. Third, Growth generates institutions and these institutions impact the environmental quality[5].

3.1. Technology, Scale Economies and EKC

The basic idea behind this first branch of literature is that incentives of the technological change are modified as income rise. Firms are less constrained and more able to invest in cleaner technologies.

Stokey (1998), for example, describes a static model with a choice of production technologies with varying degrees of pollution. Her critical assumption is that below a threshold level of economic activity, only the dirtiest technology can be used. With economic growth, pollution increases linearly with income until the threshold is passed and cleaner technologies can be used. The resulting pollution income path is therefore inverse-V-shaped, with a sharp peak at the threshold income where cleaner technologies become available.

John and Pecchenino (1994) present an overlapping generations' model in which environmental quality is a stock resource that degrades over time unless maintained by investments. An economy that begins with zero environmental investment will see its environmental quality decline with time and with economic growth until the point at which positive environmental investment is desired, when environmental quality will begin improving with economic growth. John and Pecchenino's pollution-income relationship also exhibits an inverse-V shape, peaking when the dynamic equilibrium switches from a corner solution of zero environmental investment to an interior optimum with positive investment.

Dinda (2005) argues that the U shaped relationship between pollution and Income is due to a change from insufficient to sufficient investment in abatement activity. Kelly (2003) explains the U shaped relationship by the change of marginal benefits and marginal costs of pollution as income rise.

3.2. Awareness of economic agent about Environmental Quality

Consumers can also play an important role in maintaining pressures for environmental protection. They may penalize firms that are known to be heavy polluters by boycotting their products; banks may refuse to grant credit because they are worried about environmental liability. Investors also appear to play an important role in encouraging clean production. Dirty emissions may signal to investors that a firm's production technologies are far from to be efficient. Investors also weigh potential financial losses from regulatory penalties and

[5] At higher levels of development, structural change towards information-intensive industries and services, coupled with increased environmental awareness, enforcement of environmental regulations, better technology, and higher environmental expenditures, result in levelling off and gradual decline of environmental degradation (Panayotou).

liability settlements. Studies suggest that multinational firms are important players in this context. These firms operate under close scrutiny from consumers and environmental organizations in the high-income economies. Stock markets react significantly to environmental news, generating gains from good news and losses from bad news (see the BP oil leak saga in 2010). As a consequence, multinational firms operating in low-income economies are often found to be environmentally friendlier than domestically owned firms (Afsah and Vincent, 1997).

Jaeger (1998) assumes that at low levels of pollution consumers' taste for clean air is satiated, and that the marginal benefit of additional environmental quality is zero. Consequently, with few firms and few individuals, the environmental resource constraint is non-binding. More pollution does not result in lower utility. With economic growth represented by a growing population of individuals and polluting firms, once the satiation threshold of consumers' preferences is passed, depending on the parameters, growth may be accompanied by improved environmental quality.

Bravo and Marelli (2007) proposed an extensive work detailing all the possible determinants coming from attitudes and behaviors of citizens. They claim that *"a change in the consumers' preferences in the direction of an increasing demand for environmental quality"* may be verified. This change should induce the spreading of environmental-friendly behaviors, an increasing demand of 'greener' goods, and a greater pressure to the institutional sector for more environmental regulations.

3.3. Institutions and Environmental quality

The relationship between income growth and environmental quality is not straightforward, but involves a complex feedback mechanism passing through various institutional channels affecting both market and political forces (Antle and Heidebrink, 1995). At least three types of channels may explain the role of institutions. First, institutions play a key role in the process of enforcement of contracts and for the definition and allocation of property rights. Second, institutions improve information and citizen literacy about environmental problems. The environmental awareness of citizen and consumers is improved through institutions and organizations dedicated to this task. Thirdly, institutions may act as a rampart against corruption and improve the decision making process.

Jones and Manuelli (2001) argue that poor countries may not have the necessary institutions for internalizing externalities. Their model consists of overlapping generation in which the younger generation sets pollution regulations. Depending on the collective decision-making institution, the pollution-income relationship can be an inverted-U, monotonically increasing, or even "N-shaped". One normative implication of their paper is that poor countries' inability to self-regulate leads to inefficiently high pollution, and that international aid organizations could improve global welfare by insisting on, or assisting with, regulatory standards and enforcement.

"It is also suggested that improved literacy, and democratic governing institutions and citizen participation in decision-making would weaken the income effect of the EKC hypothesis". Torras and Boyce (1998) reported that institutional factors affect of the EKC relationship, particularly in low-income countries, and suggest that wider literacy and greater political liberties and civil rights could positively affect environmental quality.

Some of the cross country empirical studies of institutions and economic growth have reported that politically open societies which respect the rule of law, private, and the market allocation of resources grew much faster than societies where these freedoms were restricted (Knack & Keefer, 1995; Scully, 1988).

Leitao (2006), shows that corruption could explain the differences in the turning points observed among the countries for Sulfur emissions.

3.4. The main economic effects

Generally the impacts of economic development on environment are disaggregated into three macro determinants: scale effect, technique effect, and composition effect (Grossman 1995; Copeland and Taylor 2004; Brock and Taylor 2006). The Scale Effect (SE) refers to the fact that increases in output require more inputs, and, as a by-product, imply more emissions. Economic growth therefore exhibits a scale effect that has a negative impact on the environment (Arrow, 1995). The Technique Effect (TE) refers to the invention of new technologies which are environmental friendly and to the application of these new technologies in production which in turn lead to the reduction of the pollution of the environment (Andreoni and Levinson, 2001). The impact of the technique effect is theoretically positive (de Bruyn 1997, Han and Chatterjie, 1997). The Composition Effect (CE) stems from changes in production of an economy caused by specialization (from agriculture or/and basic industries to high-tech services)[6]. All else equal, if the sectors with high emission intensities grow faster than sectors with low emission intensities, than composition changes will result in an upward pressure upon emission (Dasgupta, Mody, Roy, and Wheeler, 1995). The expected impact of the composition effect is positive deriving from the Rostow evolution postulate.

Due to the different nature of these individual effects, the overall impact of growth on the environment is ambiguous (Grossman and Krueger (1991), and Cole (2004)).

For Panayotou, T. (1997): "The decomposition of the EKC has revealed that those who argue that economic growth increases pollution levels are only partially right as they focus only on the scale and industrialization effects and ignore the abatement effect of higher incomes. When all effects are considered, the relationship between growth and the environment turns out to be much more complex with wide scope for active policy intervention to bring about more desirable (and in the presence of market failures) more efficient economic and environmental outcomes".

4. Methodology and empirical Results

4.1. Data

We investigate in this section the determinants of two pollutants CO_2 and SO_2. In this optic, we investigate the relationship between CO_2 emissions, energy consumption and GDP in MENA region using recent panel econometric methods. As several MENA countries have signed Kyoto protocol, there are still concerns regarding the environmental problems. As

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[6] From a theoretical point of view, we can contest the first wave of explanations of ECK. Rich people have incentives to improve the environment to the extent that they themselves are impacted by this degradation. This is not the case when these externalities change in time or space to other citizens. Because one troubling corollary to this "natural progression" theory is that the economic cleanup by rich nations may be facilitated by advanced economies exporting their pollution-intensive production processes to less-developed countries (Suri and Chapman, 1998). And if so, then the economic improvement noted in industrialized countries will not be indefinitely replicable, as the world's poorest countries will never have even poorer countries to which they can export their pollution. The argument more often advanced is that natural progression of economic development would lead from clean agrarian economies to polluting industrial economies to clean service economies (Arrow, et al., 1995) is inconclusive because it has no normative or predictive power. Since we cannot say what the next phase of economic development will bring us, we cannot predict the future pollution-income path. In addition, the service sector is an aggregate that includes activities with strong environmental impact (such as air transport or mass tourism) and the change in the composition of production could explain at most the decrease of environmental impact per unit of gross domestic product (GDP), but not in absolute terms.

discussed above, the relationship between CO_2 emissions, energy consumption and economic growth is a synthesis of the EKC and energy consumption growth literatures.

To conduct our empirical analysis, we need the following variables for all studied MENA countries:

- CO_2 emission (C);

- Energy consumption (E);

- Per capita real GDP (Y).

We collect data form World Bank Development Indicators (WDI) and (Joint Research Center, JRC| Netherlands Environmental Assessment Agency, PBL: EDGAR[7]). Our data are annual and cover the period 1981-2005 for the following MENA countries: Algeria, Bahrain, Egypt, Jordan, Kuwait, Lebanon, Morocco, Oman, Qatar, Saudi Arabia, Tunisia and UAE. The variables C, E, S and Y are measured in metric tons per capita, kt of oil equivalent per capita, metric tons (divided by the land area populated at more than five persons per square kilometer) and constant 2005 international dollar, respectively.

At first, we empirically investigate the following model based on variables in natural logarithms:

$$C_{it} = a_i + b_i E_{it} + c_i Y_{it} + d_i Y_{it}^2 + \varepsilon_{it} \qquad (1a)$$

The coefficients *b*, *c* and *d* represent the long-run elasticity estimates of CO_2 emissions with respect to energy consumption, real GDP and squared real GDP, respectively. According to the discussion above, we expect that an increase in energy consumption leads to an increase in CO_2 emissions ($b>0$). Moreover, under the EKC hypothesis an increase in income is associated with an increase in CO2 emissions($c>0$) and there is an inverted U-shape pattern at which point an increase in income leads to lower CO_2 emissions ($d<0$).

The second group of tests concern SO_2. We empirically investigate the following model based on variables in natural logarithms[8]:

$$S_{it} = a_i + b_i Y_{it} + c_i Y_{it}^2 + \varepsilon_{it} \qquad (1b)$$

The coefficients *b* and *c* represent the long-run elasticity estimates of SO_2 emissions with respect to real GDP and squared real GDP, respectively. According to the EKC hypothesis an increase in income is associated with an increase in CO_2 emissions($b>0$) and there is an inverted U-shape pattern at which point an increase in income leads to lower CO_2 emissions ($c<0$).

In what follows, we start by testing for unit roots in our variables. If these variables are non-stationary in our country panel, we investigate the existence of long run co-integration relationships and investigate their magnitude. Finally, we estimate panel error correction models (ECM) in order to examine the interactions between short and long run dynamics of our environmental variables.

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[7] Emissions (EM) for a country C are calculated for each compound x on an annual basis (y) and sector wise (for i sectors, multiplying on the one hand the country-specific activity data (AD), quantifying the human activity for each of the i sectors, with the mix of j technologies (TECH) for each sector i, and with their abatement percentage by one of the k end-of-pipe (EOP) measures for each technology j, and on the other hand the country-specific emission factor (EF) for each sector i and technology j with relative reduction (RED) of the uncontrolled emission by installed abatement measure k.

[8] We choose not to introduce the variable E (energy consumption) among the determinants of SO2 following all empirical studies on this pollutant. Behind this choice, there is the fact that SO2 is more impacted by the production of energy commodities than by their consumption.

4.2. Panel unit root testing

The body of literature on panel unit root and panel cointegration testing has grown considerably in recent years and now distinguishes between the first-generation tests (Maddala and Wu 1999, Levin *et al.* 2002 and Im *et al.* 2003)) developed on the assumption of the cross-sectional independence of panel units (except for common time effects), the second-generation tests (Bai and Ng 2004, Smith *et al.*2004, Moon and Perron 2004, Choi 2006 and Pesaran 2007) allowing for a variety of dependence across the different units, and also panel data unit root tests that make it possible to accommodate structural breaks (Im and Lee, 2001). In addition, in recent years it has become more widely recognized that the advantages of panel data methods within the macro-panel setting include the use of data for which the spans of individual time series data are insufficient for the study of many hypotheses of interest. To test for the presence of such cross-sectional dependence in our data, we have implemented the simple test of Pesaran (2004) and have computed the CD statistic. This test is based on the average of pair-wise correlation coefficients of the OLS residuals obtained from standard augmented Dickey-Fuller regressions for each individual. Its null hypothesis is cross-sectional independence and is asymptotically distributed as a two-tailed standard normal distribution. Results available upon request indicate that the null hypothesis is always rejected regardless of the number of lags included in the augmented DF auxiliary regression (up to five lags) at the 5% level of significance[9]. This confirms that the MENA countries are, as expected, cross-sectionally correlated, which can indeed reflect here the presence of similar regulations in various fields (such as environmental policy and regulation, economy, finance, trade, customs, tourism, legislation, and administration), high economic, fiscal and political corporation and increasing financial and economic integration.

To determine the degree of integration of our series of interest (C, E, Y, and Y^2) and (S, Y, and Y^2) in our panel of 12 MENA countries, we employ the bootstrap tests of Smith et al. (2004), which use a sieve sampling scheme to account for both the time series and cross-sectional dependencies of the data through bootstrap blocks. The specific tests that we consider are denoted ,,, and . is the bootstrap version of the well known panel unit root test of Im et al. (2003), is a mean of the individual Lagrange Multiplier (LM_i) test statistics, originally introduced by Solo (1984), is the test of Leybourne (1995), and = is a (more powerful) variant of the individual Lagrange Multiplier (LM_i), with , where are based on forward and backward regressions (see Smith et al., 2004 for further details). We use bootstrap blocks of m=20.[10]All four tests are constructed with a unit root under the null hypothesis and heterogeneous autoregressive roots under the alternative, which indicates that a rejection should be taken as evidence in favour of stationarity for at least one country.

The results, shown in Table 1a and table 1b suggest that for all the series (taken in logarithms) the unit root null cannot be rejected at the five percent level of significance in our

[9] The CD test statistics vary from 12.21 to 31.36 depending on the series under investigation and is always highly significant at any conventional level of significance (the P-value being equal to zero in all cases). This provides strong evidence in favor of the existence of cross-sectional dependence in the data.

[10] The results are not very sensitive to the size of the bootstrap blocks.

country panel for the four tests.[11] We therefore conclude that the variables are non-stationary in our country panel. [12]

4.3. Panel cointegration

Given that all the series under investigation are integrated of order one, we now proceed with the two following steps. First, we perform secondgeneration panel data co-integration tests (that allow for cross-sectional dependence among countries) to test for the existence of co-integration between C and its potential determinants E, Y, Y^2 contained in X. Second, if a co-integrating relationship exists for all countries, we estimate for each country the cross-section augmented co-integrating regression

$$C_{it} = \alpha_i + \gamma_i X_{it} + \mu_1 \overline{C}_t + \mu_2 \overline{X}_t + u_{it}, \quad i = 1,...,N; \quad t = 1,...,T \quad (2a)$$

by the CCE estimation procedure proposed by Pesaran (2006) that allows for cross-section dependencies that potentially arise from multiple unobserved common factors. The cointegrating regression is augmented with the cross-section averages of the dependent variable and the observed regressors as proxies for the unobserved factors. Accordingly, $\overline{C}_t$ and $\overline{X}_t$ denote respectively the cross-section averages of C and X_i in year t. Note that the coefficients of the cross–sectional means (CSMs) do not need to have any economic meaning as their inclusion simply aims to improve the estimates of the coefficients of interest. Therefore, this procedure enables us to estimate the individual coefficients γ_i in a panel framework.[13]

In addition, we also compute the CCE-MG estimators of Pesaran (2006). For instance, for the γ parameter and its standard error for N cross-sectional units, they are easily obtained as follows: $\hat{\gamma}_{CCE-MG} = \frac{\sum_{i=1}^{N} \hat{\gamma}_{i-CCE}}{N}$, and $SE(\hat{\gamma}_{CCE-MG}) = \frac{\sum_{i=1}^{N} \sigma(\hat{\gamma}_{i-CCE})}{\sqrt{N}}$, where $\hat{\gamma}_{i-CCE}$ and $\sigma(\hat{\gamma}_{i-CCE})$ denote respectively the estimated individual country time-series coefficients and their standard deviations.

Note that we also carry out the same analysis for the other pollutant (SO_2) and estimate for each country the above cross-section augmented cointegrating regression

[11] The order of the sieve is permitted to increase with the number of time series observations at the rate T1/3 while the lag length of the individual unit root test regressions are determined using the Campbell and Perron (1991) procedure. Notice that, in order to investigate the robustness of our results concerning the statistical properties of the carbon dioxide emissions and potential determinants we have also implemented the panel unit-root tests by Bai and Ng (2004), Choi (2006) and Pesaran (2007) and we found that all tests lead to the conclusion that our series are integrated of order one, thus confirming the results of the tests by Smith et al. (2004). The results are available upon request.

[12] The lag order in the individual ADF type regressions is selected for each series using the AIC model selection criterion. Another crucial issue is the selection of the order of the deterministic component. In particular, since the cross-sectional dimension is rather large here, it may seem restrictive not to allow at least some of the units to be trending, suggesting that the model should be fitted with both a constant and trend. However, since the trending turned out not to be very pronounced, we have considered that a constant is enough in our analysis. Actually, the results of the bootstrap tests of Smith et al. (2004) are not very sensitive to the inclusion of a trend in addition to a constant in the estimated equation (see Statistic b in Tables 1a and 1b). We have of course also checked using the bootstrap tests of Smith et al. (2004) that the first difference of the series are stationary, hence confirming that the series expressed in level are integrated of order one.

[13] Note that in order to estimate the long-run coefficients we have also implemented the Pooled Mean Group (PMG) estimators (see Pesaran and Smith (1995), Pesaran, Shin and Smith (1999)), which allowed us to identify significant differences in country behaviour. However, we only report the results of the Common Correlated Effects (CCE) estimators developed by Pesaran (2006), since they allow taking unobservable factors into account, which would not be the case of the PMG estimators.

$$S_{it} = \alpha_i + \gamma_i X_{it} + \mu_1 \overline{S}_t + \mu_2 \overline{X}_t + u_{it}, \quad i = 1,...,N; \quad t = 1,...,T \quad (2b)$$

where $\overline{S}_t$ and $\overline{X}_t$ denote respectively the cross-section averages of S and X_i in year t.

We now use the bootstrap panel cointegration test proposed by Westerlund and Edgerton (2007). This test relies on the popular Lagrange multiplier test of McCoskey and Kao (1998), and makes it possible to accommodate correlation both within and between the individual cross-sectional units. In addition, this bootstrap test is based on the sieve-sampling scheme, and has the advantage of significantly reducing the distortions of the asymptotic test. Another appealing advantage is that the joint null hypothesis is that all countries in the panel are cointegrated. Therefore, in case of non-rejection of the null, we can assume that there is cointegration between C and its potential determinants contained in *X*.

The asymptotic test results (Table 2a) indicate the absence of cointegration. However, this is computed on the assumption of cross-sectional independence, not the case in our panel. Consequently, we also used bootstrap critical values. In this case we conclude that there is a long-run relationship between carbon dioxide emissions and potential determinants, implying that over the longer run they move together.

Similar results reported in Table 2b are obtained for the SO_2 for which we also conclude (using Bootstrap p-value) in favor of the existence of a cointegrating relationship between sulphur dioxide emissions and potential determinants, implying long-run co-movements between these variables.

4.4. The magnitudes of the co-integration relationship

Given the evidence of panel co-integration, the long-run pollution income relations can be further estimated by several methods for panel co-integration estimation. We estimate the two above equations (related to our two pollutants, CO_2 and SO_2) to assess the magnitude of the individual γ_i coefficient in the co-integrating relationship with the CCE estimation procedure developed by Pesaran (2006), which addresses cross-sectional dependency.

$$C_{it} = \alpha_i + \gamma_{1i} E_{it} + \gamma_{2i} Y_{it} + \gamma_{3i} Y_{it}^2 + u_{it}, \qquad (3a)$$

$$S_{it} = \alpha_i + \gamma_{1i} Y_{it} + \gamma_{2i} Y_{it}^2 + u_{it}, \qquad (3b)$$

with $i = 1,\dots,N$, $t = 1,\dots,T$, and the respective estimation results are reported in Tables 3a and 3b.

In most cases, the parameters are quite significant at a 1% level of significance. The relationship between energy consumption and CO_2 emissions is positive except for Bahrain, Egypt and Kuwait. The results indicate that a 1% increase in energy usage per capita increases CO_2 emissions per capita by 1.688% in Saudi Arabia and by only 0.052% in Oman.

From the sign of the parameter, the results show that there are inverse U-shaped relationships between per capita pollution and per capita GDP for all studied MENA countries, expect Morocco, Tunisia and UAE. For instance, for Egypt the elasticity of CO_2 emissions per capita with respect to real GDP per capita in the long-run is 0.817–0.438Y with the threshold income of 1.865 (in logarithms). While, for another north African country, Algeria, the elasticity is 2.473–0.340Y with the threshold income of 7.273 (in logarithms). For Saudi Arabia, the elasticity of CO_2 emissions with respect to real GDP is 0.385–2.488Y, implying a threshold income of only 0.154 (in logarithms).

The Tunisian case deserves special attention, since it is the only country where a positive monotonic relationship between income and emissions of CO_2 is found (the elasticity is 0.051 + 0.446Y).

Morocco and the UAE deserve further investigations because we found an inverted curve compared to what is predicted by the theory.

The results show that there are an inverse U-shaped relationships between per capita pollution and per capita GDP for all studied MENA countries, expect Kuwait, UAE and Qatar. For instance, for Algeria the elasticity of SO2 emissions per capita with respect to real GDP per capita in the long-run is 1.105 -0.04Y with the threshold income of 27.625 (in logarithms) which is very high (when transformed in dollars) compared to its level of real GDP in that period. For another North African country, Tunisia, the elasticity is 1.430-0.870Y with the threshold income of 1.644 (in logarithms). EKC hypothesis seems to hold in this case. We reach the same conclusion in the case of Egypt.

For Saudi Arabia, the elasticity of SO2 emissions with respect to real GDP is 1.037-0.704Y, implying a threshold income of only 1.473 (in logarithms) which is very low compared to the Saudi real GDP.

We have to point out that in all the cases (countries and types of emissions) where we found an EKC, we're confronted to the problem of the position of the threshold compared to the level of real GDP reached by each country during the period. Our calculations lead us to conclude that none of the studied cases (except Jordan) verified this particular EKC hypothesis.

Finally, the results from the common correlated effects mean group (CCE-MG) method are reported in Tables 4a and 4b.

On average, over the studied MENA countries, there is a positive relationship between CO_2 emissions and energy consumption: a 1% increase in energy consumption per capita increases CO_2 emissions per capita by 0.47% in the MENA region. As for the average EKC hypothesis: the elasticity of CO_2 emissions per capita with respect to real GDP per capita in the long-run is 1.23–0.34Y with the threshold income of 3.618 (in logarithms).

Taken together, our results are supportive of the EKC hypothesis in the MENA region: the level of CO_2 emissions first increases with income, stabilizes, and then declines. Thus, there appears to be an inverted U-shaped relationship between CO_2 emissions per capita and real GDP per capita in the MENA region when taken as a whole.

The last table shows that the elasticity of SO_2 emissions per capita with respect to real GDP per capita in the long-run is 0.250–0.054Y with the threshold income of 4.630 (in logarithms). This result is not supportive of the EKC hypothesis in the MENA region. This result was expected given the number of countries producing oil and gas in our sample[14].

All the results are resumed in the following tables (5a and 5b). The maximum GDP and the minimum one (the real value for each country) are added to verify the position of the turning point.

4.5. Estimation of a panel ECM representation

In the previous sub-section we have estimated the long-run relationships between carbon dioxide emissions and potential determinants for our panel of 12 MENA countries, using the common correlated effects mean group (CCE-MG) estimates (see Tables 4a, 4b). Having established the long-run structure of the underlying data and given that there exists a long-run

[14] The burning of fossil fuels is the most significant source of air pollutants such as SO_2, CO, certain nitrous oxides such as NO and NO_2 (known collectively as NO_x), SPM, volatile organic compounds (VOCs) and some heavy metals. It is also the major anthropogenic source of carbon dioxide (CO_2), one of the important greenhouse gases.

relationship for all countries in our four panel sets, we turn to the estimation of the complete panel error-correction model (PECM) described by equations (5a) and (5b):

We use the Pooled Mean Group (PMG) approach of Pesaran, Shin and Smith (1999), with long-run parameters obtained with CCE techniques, in order to obtain the estimates of the loading factors λ_i (weights or error correction parameters, or speed of adjustment to the equilibrium values), as well as of the short-run parameters β_j and θ_j for each country of our panel. Consequently, the loading factors and short-run coefficients are allowed to differ across countries.[15]

The lag length structure p is chosen using the Schwarz (SC) and Hannan-Quinn (HQ) selection criteria, and by carrying out a standard likelihood ratio testing-down type procedure to examine the lag significance from a long-lag structure (started with $p=4$) to a more parsimonious one. Afterwards, in order to improve the statistical specification of the model, we implemented systematically Wald tests of exclusion of lagged variables from the short-run dynamic (they are not reported here) to eliminate insignificant short-run estimates at the 5% level. We tested the residuals from each PECM model for the absence of hetero-scedasticity, autocorrelation, ARCH effect, and we can report that they are not subject to misspecification. The results of the PECM estimations based on (5a) and (5b) are reported in Tables 6a and 6b, only for significant short-run estimates at the 5% level.

Results from Table 6a, allow checking for two sources of causation: (1) the lagged difference terms (short-run causality) and/or (2) the error correction terms (long- run causality). The short-run dynamics confirms the evidence of significant positive causality from energy consumption to CO2 emissions. The causality from GDP to CO2 emissions depend on the level of economic growth. As for the long-run dynamics, the Loading factor, which measures the speed of adjustment back to the long-run equilibrium value, is significantly negative in all cases confirming that all the variables of our model move together over the long run. Thus, the long-run equilibrium deviation has a significant impact on the growth of CO2 emissions.

5. Conclusion and Policy implications

The question of sustainability of growth in MENA Countries has become of crucial economic importance. In a context of Global Warm and climate change "many countries of the region (MENA) remain on an sustainable path…the region has increased its carbon dioxide emissions, faces diminishing critical per capita water resources, and is at risk on several fronts from climate variability" (World Bank, 2008). It's obvious that a specific study for the relationship between growth and environmental degradation in the MENA Countries becomes central for policymakers. The pattern of sustainability for the region must be examined.

Several Studies have examined the relationship between Environmental quality and Growth. The basic idea behind the Environmental Kuznets Curve (EKC) is that economic growth degraded environment quality in a first stage. But the picture change until a turning point and environmental quality is growth improves the Environmental Quality. Since that environmental quality is a U or N shaped curve. For most of the pollution indicators, the estimated turning point lies within the income range of US$ 3,000–10,000 (at a constant price, 1985 US dollar).

[15] Note that before considering equation (3), we first used a Wald statistic to test for common parameters across countries (i.e $\lambda i= \lambda$, and $\gamma i=\gamma$, for i=1,...,N) with the CCE techniques of Pesaran, (2006), that allow common factors in the cross-equation covariances to be removed. We found that only the null hypothesis $\gamma i=\gamma$, for i=1,…,N was not rejected by data, whereas the speeds of adjustment λi vary considerably across countries (results are available upon request).

Three theoretical explanations are provided in order to explain this dynamics. Firstly, Growth impacts tastes of economic agents to a more environmental friendly products and production process. Citizen and consumers' awareness about environment induce a big change in the Market dynamics. Secondly, Innovation and technological change lead to use more friendly technologies and process following the market opportunities. Thirdly, economic growth leads to the set up of organizations, institutions and capacities in order to manage environmental problems. This new setting improves the situation through their action in order to enhance democratic decision-making, secure property rights, enforce contracts and act as ramparts against corruption.

From a technical point of view the impact of growth on environment is divided to three main effects: scale effect, technique effect and composition effect. The overall impacts of these effects are ambiguous and depend on the economic situation of each country.

The aims of this work are threefold: first we investigate the existence of EKC in 12 MENA Countries in matter of Carbon and Sulphur dioxide. Second, to emphasize that there is at least as different environmental degradations' trajectories as countries. Finally based on these findings we assess the possible evolutions of CO_2 and SO_2 emissions in each country as regard of political commitment and support.

CO_2 and SO_2 emissions are considered as the main environmental quality measure in order to test the existence of the Kuznets Curve. This is a first approximation since we are planning to extend our work to more pollutants in order to build an Environmental Index.

Our study extends the recent works of Liu (2005) and Ang (2007) and Apergis and Payne (2009) by implementing recent bootstrap unit root tests and panel co-integration techniques to investigate the relationship between carbon dioxide emissions, energy consumption, and real GDP for 12 MENA countries over the period 1981–2005. Our results show that in the long-run, energy consumption has a positive significant impact on CO_2 emissions. However, this impact varies considerably across MENA countries. More interestingly, we show that real GDP exhibits a quadratic relationship with CO_2 emissions. Taken together, our findings support an inverted U-shape pattern associated with the Environmental Kuznets Curve (EKC) hypothesis for the MENA region: CO_2 emissions increase with real GDP, stabilize, and then decrease.

However, although the estimated long-run coefficients of income and its square satisfy the EKC hypothesis in most studied countries, the EKC turning points are very low in some cases and very high in other cases, hence providing poor evidence in support of the EKC hypothesis. Thus, our findings suggest that not all MENA countries need to sacrifice economic growth to decrease their emission levels as they may achieve CO_2 emissions reduction via energy conservation without negative long run effects on economic growth.

Our findings extend the existent few studies that have investigated the relationship between the economic growth and the environmental degradation in the specific case of MENA Countries (M'henni, 2005; Fodha and Zaghdoudi, 2009; Chebbi et al. 2009) and validate the EKC for the whole region.

Our investigations about the other pollutant (SO2) lead to a symmetric result. No evidence is found for the EKC for any country of the region (except for Egypt and Tunisia) and for the region as a whole. This result is actually not very surprising given the number of countries producing oil and gas in our sample.

What is relevant here is that except for two countries, where income has reduced sulphur dioxide emissions, for the remaining 10 countries some form of pollution control measures are imperative, whether this is implemented at the regional or individual country level is a matter for further considerations.

To sum up it is clear that for the case of CO_2 we are facing a paradox: EKC holds for the region but did not in any country (except Jordan). This may mean that the overall situation has improved in recent years thanks to economic growth, but it must be specific countries' proactive policies to improve their situation in terms of emissions of pollutants. One feature of carbon emissions policy is carbon emissions tax. The literature on carbon emissions policies suggests a possible tax on polluters. A second feature of policy related to curbing carbon dioxide emissions is through a carbon emissions trading scheme. Whether a pollution tax or emissions trading scheme is more relevant is not an issue considered in this study.

References

Afsah, S. and J. Vincent, 1997, Putting Pressure on Polluters: Indonesia's PROPER Program. Case Study for Harvard Institute for International Development, Asia Environmental Economics Policy Seminar. Washington, DC: International Resources Group. Available at: www.worldbank.org/nipr.

Agras, J. and Chapman, D., 1999, "A dynamic approach to the Environmental Kuznets Curve hypothesis". *Ecological Economics* 28:267–277.

Akbostancı E., Turut-Asık S. and Tunç G., 2009, "The relationship between income and environment in Turkey: Is there an environmental Kuznets curve?". *Energy Policy* 37:861–867.

Andreoni, J. and Levinson, A., 2001, "The simple analytics of the environmental Kuznets curve". *Journal of Public Economics* 80:269–286.

Ang, J. B., 2007, CO2 emissions, energy consumption, and output in France, *Energy Policy*, 5:4772-4778.

Apergis N. and Payne J.E., 2009, "CO2 emissions, energy usage and output in Central America". *Energy Policy* 37 2009:3282–3286

Arrow, K., Bolin, B., Costanza, R., Dasgupta, P., Folke, C., Holling, C. S., Jansson, B.-O., Levin, S., Mäler, K.-G., Perrings, C. A., and Pimentel, D. 1995, "Economic growth, carrying capacity, and the environment". *Science*, 268:520–521.

Bai, J., Ng, S., 2004, "A PANIC Attack on Unit Roots and Cointegration", *Econometrica*, 72 (4):127-1177.

Banerjee, A. and Carrion-i-Silvestre, J., 2006, "Cointegration in Panel Data with Breaks and Cross-section Dependence", *European Central Bank, Working Paper 591, February*.

Bhattarai, M., and Hammig, M., 2001, « Institutions and the Environmental Kuznets Curve for Deforestation: A Cross Country Analysis for Latin America, Africa and Asia », *World Development*.

Bandyopadhyay, S. and Shafik, N., 1992, "Economic growth and environmental quality". Working Papers. Policy Research. WPS 1672.

Beckerman, W., 1992, "Economic growth and the environment: whose growth? Whose environment?", *World Development*, Vol. 20:481-496.

Bertinelli, T.L and Strobl E., 2005, "The Environmental Kuznets Curve semi-parametrically revisited". *Economics Letters*, 88:350–357.

Bradford, D.F., Schlieckert, R. and Shore, S.H., 2000, "The environmental Kuznets curve: exploring a fresh specification". NBER Working Papers, N°8001.

Bradford, D.F., Fender R., Shore S. and Wagner M., 2005, "The Environmental Kuznets Curve: Exploring a Fresh Specification," Contributions to Economic Analysis & Policy, Berkeley Electronic Press, vol. 4(1):1073-1073.

Bradshaw C.J.A, Giam X., Sodhi N.S., 2010, "Evaluating the Relative Environmental Impact of Countries". PLoS ONE 5(5): e10440. doi:10.1371/ journal.pone.0010440

Bravo, G. and Marelli, B., 2007, "Micro-foundations of the Environmental Kuznets Curve hypothesis: an empirical analysis". *Int. J. Innovation and Sustainable Development*, 2(1):36–62.

de Bruyn S.M., van den Bergh J.C.J.M. and Opschoor J.B., 1998, "Economic growth and emissions: reconsidering the empirical basis of environmental Kuznets curves". *Ecological Economics* 25:161–175.

Campbell, J. and Perron, P., 1991, "Pitfalls and Opportunities: What Macroeconomists should know about Unit Roots," in Blanchard, O. and Fisher, S. (eds.), *NBER Macroeconomics Annual*. Cambridge, MA: MIT Press.

Caviglia-Harris Jill L., Chambers D. and Kahn James R., 2009, "Taking the "U" out of Kuznets a comprehensive analysis of the EKC and environmental degradation". *Ecological Economics* 68:1149-1159.

Chebbi. H.E., and Boujelbene Y., 2008, CO2 emissions, energy consumption and the economic growth in Tunisia, 12th Congress of the European Association of Agricultural Economists-EAAE 2008.

Chebbi H., Olarreaga M. and Zitouna H., 2009, "Trade openness and CO2 emissions in Tunisia". ERF 16th Annual Conference, November 7-9, 2009.

Chen, C-C. Yi-Tui and Chen Y-T., 2008, "Income effect or policy result: a test of the environmental Kuznets Curve". *Journal of Cleaner Production* 16:59-65.

Chimeli, A.B., 2007, "Growth and the environment: Are we looking at the right data?" *Economics Letters*, 96:9–96.

Choi, I., 2006, "Combination Unit Root Tests for Cross-Sectionally Correlated Panels". In: Corbae, D., Durlauf, S. and Hansen, B. (eds.), *Econometric Theory and Practice: Frontiers of Analysis and Applied Research*: Essays in Honor of Peter C. B. Phillips. Cambridge University Press, Chap. 11,:311-333.

Chowdhury, R.R., Moran, E. F., 2010, "Turning the curve; A critical review of Kuznets approaches". Applied Geography, doi:10.1016/j.apgeog.2010.07.004

CNE, 2009, "Les instruments juridiques au service de la protection de l'environnement au Maroc".

Costantini V. and Monni S., 2008, "Environment, human development and economic growth". Ecological Economics, 64:867-880.

Dasgupta, S. Mody, A. Roy, S. and Wheeler D., 1995, "Environmental regulation and development: a cross-country empirical analysis". Working Papers. Policy Research. WPS 1448.

Dasgupta, S., Laplante, B., Wang H. and Wheeler D., 2002, "Confronting the Environmental Kuznets Curve". Journal of Economic Perspectives, Volume 16, Number 1, Winter 2002:147–168

Dasgupta, S., Hamilton K., Pandey K.D. and David Wheeler D., 2006, “Environment During growth: Accounting for governance and vulnerability”. World Development, 34(9), September 2006:1597-1611.

Dasgupta S., Meisner C., and Wheeler D., 2009, “Stockpiles of Obsolete Pesticides and Cleanup Priorities; a Methodology and Application for Tunisia Policy”. Research Working Paper 4893, April 2009.

Dinda, S., 2004, “Environmental Kuznets Curve Hypothesis: A Survey”. Ecological Economics, 49:431– 455.

Ederington, J. and Levinson, A., 2003, “Footloose and pollution-free”. NBER Working Papers, N°9718.

Esty, D. C ; Levy, M.A and Winston, A., 2003, “Environmental Sustainability in the Arab World ”,:236-248.

Esty, Daniel C., M.A. Levy, C.H. Kim, A. de Sherbinin, Srebotnjak, T. and Mara. V., 2008, “2008 Environmental Performance Index”, New Haven: Yale Center for Environmental Law and Policy.

Ezzati, M. Singer B.H and Kammen, D.M., 2001, “Towards an Integrated Framework for Development and Environment Policy; The Dynamics of the environmental Kuznets Curve”. World Development, 29,(8):1421-1434.

Färe R., Grosskopf S. and Hernandez-Sancho F., 2004, “Environmental performance: an index number approach”. Resource and Energy Economics, 26:343–352.

Fodha M. and Zaghdoud O., 2010, “Economic growth and environmental degradation in Tunisia: An empirical analysis of the environmental Kuznets curve”, *Energy Policy 38* (2010): 1150–1156.

Gangadharan L. and Valenzuela M. R., 2001, “Interrelationships between income, health and the environment: extending the Environmental Kuznets Curve hypothesis”. Ecological Economics, 36:513–531.

González, A., Teräsvirta, T. and van Dijk, D., 2005, “Panel Smooth Transition Regression models”. Research paper 165. Quantitative Finance Research Centre, University of Technology, Sidney.

Grossman G. and Krueger A., 1995, “Economic growth and the environment”. Quarterly Journal of Economics. 110(2):353-377.

Harbaugh, W., Levinson, A. and Wilson, D., 2000, “Reexamining the empirical evidence for an environmental Kuznets curve”. NBER Working Papers, N°7711.

Heal, G., 2008, “Climate Economics: A Meta-Review and Some Suggestions.” NBER Working Papers 13927.

Heerink N., Mulatu A. and Bulte E., 2001, “Income inequality and the environment: aggregation bias in environmental Kuznets curves”. Ecological Economics 38:359–367.

Hettige H., Lucas R. and Wheeler D., 1992, "The toxic intensity of industrial production: global patterns, trends and trade policy". American Economic Review. Papers proceedings.

Hettige H., Muthukumura, M. and Wheeler D., 2000, "Industrial pollution in economic development: Kuznets revisited". Journal of Development Economics, 62:445–476.

Hilton H.F. and Levinson A., 1998, "Factoring the environmental Kuznets curve: evidence from automotive lead emissions". Journal of Environmental Economics and Management. 35:126-141.

Htun N., 1990, "The environmental challenge and the impact on the oil industry". Energy Policy January/February, 5-10.

Huang Bwo-Nung, Hwang M.J. and Yang C.W., 2008, "Causal relationship between energy consumption and GDP growth revisited: A dynamic panel data approach". *Ecological Economics*, 67:41-54.

Im, K., Pesaran, M. and Shin, Y., 2003, "Testing for unit roots in heterogeneous panels", *Journal of Econometrics*", 115:53-74.

Jaeger, W., 1998, "Growth and Environmental Resources: A Theoretical Basis for the U-shaped Environmental Path". mimeo, Williams College.

Jha, R., Murthy, K.V. Bhanu, 2003, "An Inverse Global Environmental Kuznets Curve". *Journal of Comparative Economics* 31:352–368.

Jones, Larry E. and Rodolfo E. Manuelli., 2001, "Endogenous Policy Choice: The Case of Pollution and Growth". *Review of Economic Dynamics*. 4,(2), April:369-405

Jaunky, V. C., 2010, "The CO2 Emissions-Income Nexus: Evidence from Rich Countries". Faculty of Social Studies and Humanities. Department of Economics and Statistics. University of Mauritius. August 2010

Kahn E.M., 1998, "A household level environmental Kuznets curve". *Economics Letters*. N°59. :269-273.

Kijima M., Nishide K., Ohyama A., 2010, "Economic models for the environmental Kuznets curve: A survey". Journal of Economic Dynamics & Control, 34 (2010):1187–1201.

Kraft, J., Kraft, A., 1978, "On the relationship between energy and GNP". *Journal of Energy and Development* 3:401–403.

Lamla M.J., 2009, "Long-run determinants of pollution: A robustness analysis". *Ecological Economics*, 69:135–144.

Levin, A., Lin, C.-F. and Chu, C.-S., 2002, "Unit Root Tests in Panel Data: Asymptotic and Finite Sample Properties", *Journal of Econometrics*, 108 (1):1-24.

Levinson A. ,2000, "The Ups and Downs of the Environmental Kuznets Curve". Prepared for the UCF/CentER conference on Environment, November 30-December 2, 2000 Orlando, FL

Leybourne, S., 1995, “Testing for unit roots using forward and reverse Dickey–Fuller regressions”, *Oxford Bulletin of Economics and Statistics* 57 (4):559–571.

Lieb, C.M., 2003, “The environmental Kuznets curve: a survey of the empirical evidence and of possible causes. Discussion Paper No. 391, University of Heidelberg, Department of Economics, working paper.

List J.A. and Gallet C.A., 1999, “The environmental Kuznets curve: does one size fit all?” *Ecological Economics*, 31:409–423.

Lindmark M., 2004, “Patterns of historical CO2 intensity transitions among high and low-income countries”. Explorations in Economic History, 41:426–447.

Liu, X., 2005, “Explaining the relationship between CO2 emissions and national income; the role of energy consumption”. *Economic Letters*, 87:325-328.

Maddala, G. and Wu, S., 1999, “A Comparative Study of Unit Root Tests and a New Simple Test”. *Oxford Bulletin of Economics and Statistics*, 61 (1):631-652.

Managi S. and Jena P.R., 2008, “Environmental productivity and Kuznets curve in India”. Ecological Economics, 65:432-440.

Mehrara M., 2007, “Energy consumption and economic growth: The case of oil exporting countries”. Energy Policy, 35: 2939–2945.

M’henni H., 2005, “Economic development, adjustment and environmental quality: the case of Tunisia for a Contingent Valuation Study”. Mediterranean Journal of Economics, *Agriculture and Environment*. 4(2):2005.

McCoskey, S. and Kao, C., 1998, “A Residual-Based Test of the Null of Cointegration in Panel Data”, *Econometric Reviews*, 17 (1):57-84.

McConnell, K. E., 1997, “Income and the demand for environmental quality”. *Environment and Development Economics*, 2:383–399.

Moon, H. and Perron, B. (2004): “Testing for a Unit Root in Panels with Dynamic Factors”, *Journal of Econometrics*, 122 (1), 8-126.

Muawya Ahmed Hussein, 2008, "Costs of environmental degradation: An analysis in the Middle East and North Africa region", *Management of Environmental Quality: An International Journal*, 19(3):305 - 317

Müller-Fürstenberger G. and Wagner M., 2007, “Exploring the environmental Kuznets hypothesis: Theoretical and econometric problems”. *Ecological Economics*, 62:648-660.

Munasinghe M., 1999, “Is environmental degradation an inevitable consequence of economic growth: tunneling through the environmental Kuznets curve”. *Ecological Economics*, 29:89–109.

Narayan P K, and Narayan S., 2010, “Carbon dioxide emissions and economic growth: Panel data evidence from developing countries”. *Energy Policy* 38 (2010):661–666

Panayotou, T., 1993, “Empirical tests and policy analysis of environmental degradation at different stages of economic development”. ILO, Technology and Employment Programme, Geneva.

Panayotou, T., 1997, “Demystifying the environmental Kuznets curve: turning a black box into a policy tool”. *Environment and Development Economics*, 2:465– 484.

Panayotou, T., 1999, “The economics of environments in transition”. *Environment and Development Economics*, 4 (4):401– 412.

Payne, J., 2010, “Survey of the international evidence on the causal relationship between energy consumption and growth. *Journal of Economic Studies*, 37(1), January:53-95.

Pesaran, M.H. and Smith R., 1995, “Estimating long-run relationships from dynamic heterogeneous panels”, *Journal of Econometrics*, 68:79-113.

Pesaran, M.H., Shin Y.C., and Smith R., 1999, “Pooled mean group estimation of dynamic heterogeneous panels,” Journal of the American Statistical Association, 94 (446):621-634.

Pesaran, M., 2004, “General Diagnostic Tests for Cross Section Dependence in Panels”. Cambridge Working Papers in Economics 435, and CESifo Working Paper Series 1229.

Pesaran, M.H., 2006, “Estimation and inference in large heterogenous panels with multifactor error structure”, *Econometrica*, 74:967-1012.

Pesaran, M., 2007, “A Simple Panel Unit Root Test in the Presence of Cross-Section Dependence”. *Journal of Applied Econometrics*, 22:265-312.

Ranjan R. and Shortle J., 2007, “The environmental Kuznets curve when the environment exhibits hysteresis”. *Ecological Economics*, 64:204-215.

Reid W.V. and Goldemberg J., 1998, “Developing countries are combating climate change Actions in developing countries that slow growth in carbon emissions”. *Energy Policy*, 26(3):233-237.

Richmond A. K. and Kaufmann R. K., 2006, “Is there a turning point in the relationship between income and energy use and/or carbon emissions? ”. *Ecological Economics* 56:176– 189.

Roberts J.T. and Grimes P.E., 1997, “Carbon Intensity and Economic Development 1962-91: A Brief Exploration of the Environmental Kuznets Curve”. *World Development*, 25(2):191-198.

Roca J., Padilla E., Farre M. and Galletto V.,2001, “Economic growth and atmospheric pollution in Spain: discussing the environmental Kuznets curve hypothesis”. *Ecological Economics* 39:85–99.

Sari, R. and Soytas, U., 2009, “Are global warming and economic growth combatable? evidence from five OPEC countries”. *Applied Energy*, 86:1887-1893.

Sarraf, M., Larsen, B. and Owaygen, M., 2004, “Cost of environmental degradation-The case of Lebanon and Tunisia”. Environmental economics series, paper no. 97, The World Bank Environment Department.

Selden T. and Song D.,1994, “Economic growth and environmental quality: is there a « Kuznets » curve for air pollution emissions?”. Journal of Environmental Economics and Management. 27:147-162.

Shafik, N., 1994, “Economic development and environmental quality: An econometric analysis”. *Oxford Economic Papers*, 46:757–773.

Shafik, N. and Bandyopadhyay S., 1992, “Economic growth and environmental quality: time series and cross-country evidence,” Background Paper for the World Development Report 1992 (Washington, DC: The World Bank, 1992).

Skea J., 1992, “Environmental issues facing the oil industry?” *Energy Policy*. October 1992:950-958.

Smith, V., Leybourne, S. and Kim, T.-H., 2004, “More Powerful Panel Unit Root Tests with an Application to the Mean Reversion in Real Exchange Rates”, *Journal of Applied Econometrics*, 19:147–170.

Solo, V.,1984, “The order of differencing in ARIMA models”, *Journal of the American Statistical Association,* 79:916-921.

Song T., Zheng T. and Tong L., 2008, “An empirical test of the environmental Kuznets curve in China: A panel cointegration approach”. *China Economic Review*, 19:381–392.

Soytas, U., Sari, R. and Ewing, T., 2007, “Energy consumption, income, and carbon emissions in the United States”. *Ecological Economics*, 62:482-489.

Soytas, U., Sari, R., 2009, “Energy consumption, economic growth, and carbon emissions: challenges faced by an EU candidate member. *Ecological Economics*, 68:1667–1675.

Stern D.I., 2004, “The Rise and fall of the Environmental Kuznets Curve”. *World Development*, 32,(8):1419–1439.

Stern D.I., Common M.S. and Barbier E. B., 2004, “Economic Growth and Environmental Degradation: The Environmental Kuznets Curve and Sustainable Development”. *World Development*, 24(7):1151-1160.

Stokey, N. L., 1998, “Are there limits to growth?”. *International Economic Review*, 39(1):1-31.

Strong M. F., 1992, “Energy, environment and development”. *Energy Policy*, June. 490-494.

Taylor L., 1996, “Sustainable development: an introduction”. *World Development*. 24(2):215-225.

Tsurumi T. and Managi S., 2010, “Decomposition of the environmental Kuznets curve: scale, technique, and composition effects”. *Environmental Economics and Policy Studies*, 11:19–36.

Ulph A., 1996, “Environmental policy and international trade when governments and producers act strategically”. *Journal of Environmental Economics and Management*. 30:265-281.

Westerlund, J. and Edgerton, D., 2007, “A Panel Bootstrap Cointegration Test”, *Economics Letters* 97:185-190.

Wheeler D., 2001, “Racing to the Bottom? Foreign Investment and Air Pollution in Developing Countries”. *Journal of Environment & Development*, 10(3), September:225-245.

Wolde-Rufael Y., 2005, “Energy demand and economic growth: The African experience”. *Journal of Policy Modeling*, 27:891–903.

Xepapadeas A.,(1997, “Economic development and environmental pollution: traps and growth”. *Structural Change and Economic Dynamics*, 8:327-350.

Zhang, X.P. and Cheng, X-M., 2009, “Energy consumption, carbon emissions and economic growth in China. *Ecological Economics* 68:2706-2712.

reference in arabic

- توقعات البيئة للمنطقة العربية البيئة من أجل التنمية ورفاهية الإنسان. برنامج الأمم المتحدة للبيئة سنة 2010

Table 1a: Panel unit root tests of Smith et al. (2004) for the carbon dioxide emissions and potential determinants (1981-2005)*

Test	Carbon Dioxide Emissions (C) Statistic (a)	Bootstrap P-value*	Statistic (b)	Bootstrap P-value*	Energy (E) Statistic (a)	Bootstrap P-value*	Statistic (b)	Bootstrap P-value*
	-1.406	0.643	-2.457	0.340	-1.512	0.526	-2.026	0.385
	3.319	0.266	5.819	0.225	5.505	0.229	6.645	0.198
	-0.829	0.777	-2.034	0.196	-1.063	0.435	-1.855	0.404
	2.268	0.189	4.464	0.172	2.513	0.112	4.221	0.255
Test	Per Capita Real GDP (Y) Statistic (a)	Bootstrap P-value*	Statistic (b)	Bootstrap P-value*	Square of Per Capita Real GDP (Y^2) Statistic (a)	Bootstrap P-value*	Statistic (b)	Bootstrap P-value*
	-1.521	0.492	-2.446 3	0.152	-2.393	0.187	-2.157	0.198
	3.891	0.123	5.841	0.133	4.692	0.264	3.504	0.384
	0.216	0.865	-0.685	0.974	0.327	0.846	-0.687	0.784
	2.177	0.224	1.954	0.993	2.161	0.237	1.972	0.814

Notes: (a) Model includes a constant. (b) Model includes both a constant and a time trend. * Test based on Smith et al. (2004). Rejection of the null hypothesis indicates stationarity at least in one country. All tests are based on 2,000 bootstrap replications to compute the p-values. Null hypothesis: unit root (heterogeneous roots under the alternative).

Table 1b: Panel unit root tests of Smith et al. (2004) for the sulphur dioxide emissions (1981-2005)*

Test	Sulphur Dioxide Emissions (S) Statistic (a)	Bootstrap P-value*	Statistic (b)	Bootstrap P-value*
	-1.309	0.738	-2.021	0.685
	3.197	0.287	4.456	0.617
	-0.537	0.952	-1.610	0.750
	1.650	0.518	3.264	0.670

Notes: (a) Model includes a constant. (b) Model includes both a constant and a time trend. * Test based on Smith et al. (2004). Rejection of the null hypothesis indicates stationarity at least in one country. All tests are based on 2,000 bootstrap replications to compute the p-values. Null hypothesis: unit root (heterogeneous roots under the alternative).

Table 2a: Panel co-integration between carbon dioxide emissions and potential determinants (1981-2005)

	LM-stat	Asymptotic p-value	Bootstrap p-value #
Model with a constant term	2.608	0.005	0.877

Notes: bootstrap based on 2000 replications. a - null hypothesis: co-integration of carbon dioxide emissions and potential determinant series. # Test based on Westerlund and Edgerton (2007).

Table 2b: Panel cointegration between sulphur dioxide emissions and potential determinants (1981-2005)

	LM-stat	Asymptotic p-value	Bootstrap p-value #
Model with a constant term	11.272	0.000	0.859

Notes: bootstrap based on 2000 replications. a - null hypothesis: cointegration of sulphur dioxide emissions and potential determinant series. # Test based on Westerlund and Edgerton (2007).

Table 3a: Individual country CCE estimates for 12 MENA countries for the carbon dioxide emissions and potential determinants (1981-2005)

Country	E	Y	Y^2				Constant	
	γ_1	t-Stat	γ_2	t-Stat	γ_3	t-Stat	α	t-Stat
Algeria	1,034	2.248	2.473	4.015	-0.170	-2.417	-25.642	-3.537
Egypt	-0.443	-2.021	0.817	3.624	-0.218	-2.982	-4.357	-2.240
Jordan	0.823	6.691	0.435	2.924	-0.166	-2.806	-2.489	-3.676
Lebanon	0.116	2.991	0.935	2.920	-0.454	-2.045	-7.288	-5.932
Morroco	0.923	7.211	-0.407	-1.938	0.588	4.820	-7.477	-6.605
Tunisia	0.199	2.031	0.051	2.218	0.223	2.798	-0.133	-4.089
Bahrain	-0.017	-2.098	1.507	3.767	-1.100	-31.763	-7.833	-2.224
Kuwait	-0.041	-2.369	3.823	7.227	-1.927	-6.785	-11.488	-2.698
UAE	0.129	3.376	-2.337	-4.734	1.071	3.264	28.736	2.796
Oman	0.052	2.243	0.278	2.419	-0.228	-2.923	-2.835	-3.520
Qatar	0.759	4.288	3.039	2.569	-1.188	-4.702	-6.816	-3.735
Saudi	1.688	3.776	0.385	2.688	-1.244	-2.295	7.504	6.620

Note the coefficients of the variables of equation (2a) have not been reported in the table.

Table 3b: Individual country CCE estimates for 12 MENA countries for the sulphur dioxide emissions and potential determinants (1981-2005)

Country	Y		Y^2		Constant	
	γ_1	t-Stat	γ_2	t-Stat	α_i	t-Stat
Algeria	1.105	2.342	-0.020	-2.513	2.754	2.115
Egypt	2.066	2.949	-1.08	2.569	5.551	2.781
Jordan	1.833	2.679	-0.841	-3.689	4.849	2.898
Lebanon	4.513	4.073	-2.203	-4.253	-4.136	-2.417
Morroco	1.102	3.826	-0.343	-2.598	-0.205	-2.532
Tunisia	1.430	4.218	-0.435	-1.959	5.539	8.508
Bahrain	0.829	3.890	-0.203	-2.335	-3.672	-1.912
Kuwait	-5.165	-4.787	2.179	3.405	-14.200	-5.190
UAE	-2.310	-2.826	0.778	2.129	11.713	5.117
Oman	4.657	3.571	-1.490	-2.282	5.295	3.616
Qatar	-2.964	-2.715	1.813	2.772	-10.205	-5.818
Saudi	1.037	2.465	-0.352	-3.770	-4.734	-4.574

Note the coefficients of the variables of equation (2b) have not been reported in the table.

Table 4a: Results for common correlated effects mean group (CCE-MG) estimations, 12 MENA countries (1981-2005) for CO_2 emissions

	(1) X= (E, Y, Y^2)
Constant	-3.26
	(-5.22)
E	0.47
	(2.86)
Y	1.23
	(3.28)
Y^2	-0.17
	(-4.22)

Note: t-statistics are in parentheses.

Table 4b – Results for common correlated effects mean group (CCE-MG) estimations, 12 MENA countries (1981-2005) for SO_2 emissions

	(1) X= (Y, Y^2)
Constant	-3.42
	(-2.76)
Y	0.250
	(5.28)
Y^2	-0.027
	(-4.37)

Note: t-statistics are in parentheses.

Table 5a: EKC for CO2 in the MENA region (1981-2005)

Country	Intercept	Inverted U shape curve	Turning point	Ymax	Ymin	EKC
Algeria	2.473 - 0.34Y	Yes	1442.308	7.176	5.530	No
Egypt	0.817 - 0.436Y	Yes	6.514	4,318	2.460	No
Jordan	0.435 - 0.332Y	Yes	3.706	4.360	3.032	Yes
Lebanon	0.935 - 0.908Y	Yes	2.801	20.368	6.565	No
Morocco	-0.407 + 1.176Y	No	?	3,588	2.254	No
Tunisia	0.051 + 0.446Y	No	Monotonic	6.444	3.602	No
Bahrain	1.507 - 2.20Y	Yes	1,984	28.069	16.648	No
Kuwait	3.823 - 3.854Y	Yes	2.697	44.354	22.873	No
UAE	-2.337 + 2.142Y	No	?	90.478	41.862	No
Oman	0.278 - 0.456Y	Yes	1.840	19.544	10.269	No
Qatar	3.039 - 2.376Y	Yes	3.593	77.232	43.705	No
Saudi	0.385 - 2.488Y	Yes	1.168	34.116	18.243	No
12 countries	1.23 - 0.34Y	Yes	37.263	90.478	2,254	Yes

Table 5b: EKC for SO2 in the MENA region (1981-2005)

Country	Intercept	Inverted U shape curve	Turning point	Ymax	Ymin	EKC
Algeria	1.105 - 0.040 Y	Yes	Very high	7.176	5.530	No
Egypt	2.066 - 2.160 Y	Yes	2.651	4,318	2.460	Yes
Jordan	1.833 - 1.682 Y	Yes	2.971	4.360	3.032	No
Lebanon	4.513 - 4.406 Y	Yes	2.784	20.368	6.565	No
Morocco	1.102 - 0.686 Y	Yes	4.983	3,588	2.254	No
Tunisia	1.430 - 0.870 Y	Yes	5.175	6.444	3.602	Yes
Bahrain	0.829 - 0.406 Y	Yes	7.706	28.069	16.648	No
Kuwait	-5.165 + 4.358 Y	No	-	44.354	22.873	No
UAE	-2.310 + 1.556 Y	No	-	90.478	41.862	No
Oman	4.657 - 2.980 Y	Yes	4.773	19.544	10.269	No
Qatar	-2.964 + 3.626 Y	No	-	77.232	43.705	No
Saudi	1.037 - 0.704 Y	Yes	4.362	34.116	18.243	No
12 countries	0.250 - 0.054 Y	Yes	102.514	90.478	2.254	No

Table 6a: Panel Error-Correction estimations for C_{it}, X= (E, Y, Y^2), (1981-2005)

	D C_{it-1}	**D C_{it-2}**	**DE_{it}**	**DE_{it-1}**	**DY_t**	**DY_{it-1}**	**D Y^2_{it}**	**Loading factor λ_i**
Algeria	0.19		0.61		1.721		-0.017	-0.24
	(2.55)		(2.86)		(3.65)		(-2.43)	(-4.23)
Egypt	-0.33		0.25		0.53	1.54		-0.44
	(-1.80)		(2.13)		(2.26)	(2.98)		(-2.35)
Jordan			0.41		0.66	-0.25	0.015	-0.21
			(3.43)		(5.09)	(-1.99)	(2.49)	(-3.20)
Lebanon	-0.51							-0.02
	(-3.01)							(-2.71)
Morroco			0.25		0.54	-0.25	-0.031	-0.44
			(2.91)		(4.06)	(-2.22)	(-3.62)	(-4.09)
Tunisia	-0.62		0.38		0.94			0.05
	(-3.86)		(3.02)		(2.12)			(1.975)
Bahrain			0.54					-0.15
			(2.03)					(-1.98)
Kuwait			0.24		0.51		-0.029	-0.42
			(2.60)		(3.23)		(-2.25)	(-3.23)
UAE			0.31		0.67			-0.55
			(2.48)		(2.66)			(-2.73)
Oman			0.402					-0.18
			(2.57)					(-2.34)
Qatar	0.38		0.19		0.40			-0.33
	(2.90)		(2.05)		(2.18)			(-2.23)
Saudi			0.22		0.46		-0.02	-0.38
			(2.20)		(2.30)		(-2.91)	(-2.37)
CCE-MG	intercept	*E*	*Y*	Y^2				
	-3.26	0.47	1.23	-0.17				
	(-5.22)	(2.86)	(3.28)	(-4.22)				

Notes: The estimations are obtained from the Pooled Mean Group approach with long-run parameters estimated with CCE techniques. The coefficients of the variables of equation (2a) have not been reported in the table. t-statistics are in brackets. C – Carbon Dioxide Emissions; E – Energy; Y – Per Capita Real GDP; Y2 – Square of Per Capita Real GDP.

Table 6b: Panel Error-Correction estimations for S_{it}, X= (Y, Y^2), (1981-2005)

	D S_{it-1}	**DY_t**	**DY_{it-1}**	**D Y^2_{it}**	**D Y^2_{t-1}**	**Loading factor λ_i**
Algeria	0.40	0.41	-	-0.015	-0.10	-0.52
	(2.08)	(3.14)		(-2.76)	(2.82)	(-4.95)
Egypt	-	0.55	-	-0.21	-0.04	-0.86
		(2.23)		(-4.48)	(-2.72)	(-3.22)
Jordan	-	0.57	-	-0.18	-0.05	-0.76
		(2.76)		(-4.36)	(-3.37)	(-4.13)
Lebanon	-	0.58	-	-0.17	-0.03	-0.81
		(1.98)		(-4.76)	(-3.18)	(-3.38)
Morroco		0.43	-	0.13	-0.09	-0.78
	-	(2.21)		(3.77)	(-2.85)	(-5 .72)
Tunisia	-	0.15	-	-0.05	-	-0.27
		(2.13)		(-2.39)		(-2.75)
Bahrain	0.28	0.10	0.07	-0.03	-	-0.14
	(2.48)	(2.10)	(2.91)	(-2.53)		(-2.62)
Kuwait	-	0.05	-	-0.21	-0.01	-0.65
		(2.63)		(-4.48)	(-2.28)	(-3.41)
UAE	-	0.31	-	-0.38	-	-0.05
		(4.42)		(-5.25)		(-2.72)
Oman	-	0.21	-	-0.21	-	-0.58
		(3.21)		(-4.48)		(-3.27)
Qatar	-	0.25	-	-0.22	-0.07	-0.45
		(2.74)		(-3.79)	(5.14)	(-5.21)
Saudi	-	0.22	-	-0.08	-0.07	-0.40
		(2.16)		(-2.82)	(-2.94)	(-3.52)
CCE-MG	intercept	*Y*	Y^2			
	-3.19	0.37	-0.21			
	(-6.15)	(4.19)	(-4.48)			

Notes: The estimations are obtained from the Pooled Mean Group approach with long-run parameters estimated with CCE techniques. The coefficients of the variables of equation (2b) have not been reported in the table. t-statistics are in brackets. S– Sulfur Dioxide Emissions; Y – Per Capita Real GDP; Y^2 – Square of Per Capita Real GDP.