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Energy Consumption, Economic Growth and CO2 Emissions: Evidence from Panel Data for MENA Region

### 1. Introduction

The worldwide concern about the threat of global warming and climate change was increasing during the last two decades. It has become a dominating question both politically and economically. One of the most questions worried out the researchers is: how can we attenuate adverse effects of climate change? The 1997 Kyoto protocol had the objective of reducing greenhouse gases (GHG) that cause climate change by fixing the reduction of GHG emissions to 5.2% lower than the 1990 level during the period 2008-2012, and this came into force since 2005. There are several environmental pollutants which cause climate change, but Carbone dioxide (CO2) still the dominant gas of total GHG in the world and in 2010 was the highest in history (IEA, 2011). The 2002 Johannesburg summit on sustainable development pointed out the harmful impact of energy on environment despite its fundamental role as an engine

Sự tiêu thụ năng lượng, tăng trưởng kinh tế và lượng khí thải CO2: minh chứng từ dữ liệu bảng của khu vực MENA. **check**

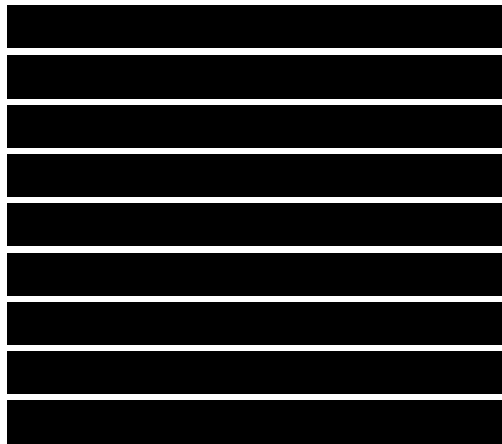
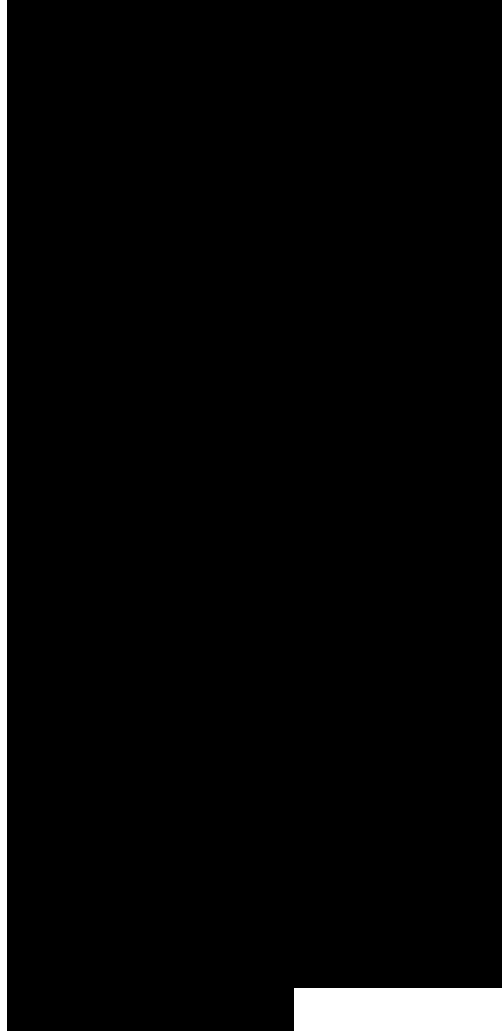
### 1. Giới thiệu

Trong suốt hai thập kỉ qua, thế giới ngày càng quan tâm đến mối đe dọa về sự ấm lên toàn cầu và thay đổi khí hậu. Nó đã trở thành vấn đề nổi bật xét về cả phương diện chính trị và kinh tế. Một trong những vấn đề làm các nhà nghiên cứu băn khoăn là: Làm sao để chúng ta có thể giảm bớt tác động tiêu cực của sự thay đổi khí hậu? Nghị định thư Kyoto 1997 nhằm mục tiêu cắt giảm lượng khí nhà kính (GHG), nguyên nhân chính gây ra thay đổi khí hậu qua việc duy trì giảm phát thải GHG 5.2% thấp hơn mức 1990 trong khoảng thời gian 2008-2012, và điều này có hiệu lực kể từ năm 2005. Có một số chất gây ô nhiễm trong môi trường gây ra thay đổi khí hậu, nhưng Carbone dioxide (CO2) vẫn chiếm ưu thế trong tổng lượng GHG trên thế giới và đạt đến ngưỡng cao nhất vào năm 2010 (IAE, 2011). Hội nghị thượng đỉnh Johannesburg 2002 về phát triển bền vững đã chỉ ra tác động tiêu cực của năng lượng đến môi trường mặc cho vai trò quan trọng của nó như một động lực phát triển kinh tế. Nó được xem là nguồn gốc phát thải những chất gây ô nhiễm, đặc biệt

of economic development. It is considered the main responsible of pollutant emissions, particularly CO2 emissions. Exploring the link between energy consumption, economic growth and CO2 emissions become the challenge of recent studies since energy use is being considered as the best tool to obtain sustainable development. Despite the MENA countries didn't sign the Kyoto protocol since they are developing countries, these countries have to face the same challenges of reducing pollutant emissions and improving energy use and economic development by the way. Reaching these challenges remain difficult to meet in MENA countries since they are still in need of economic growth based essentially on energy use, main source of pollutant emissions.

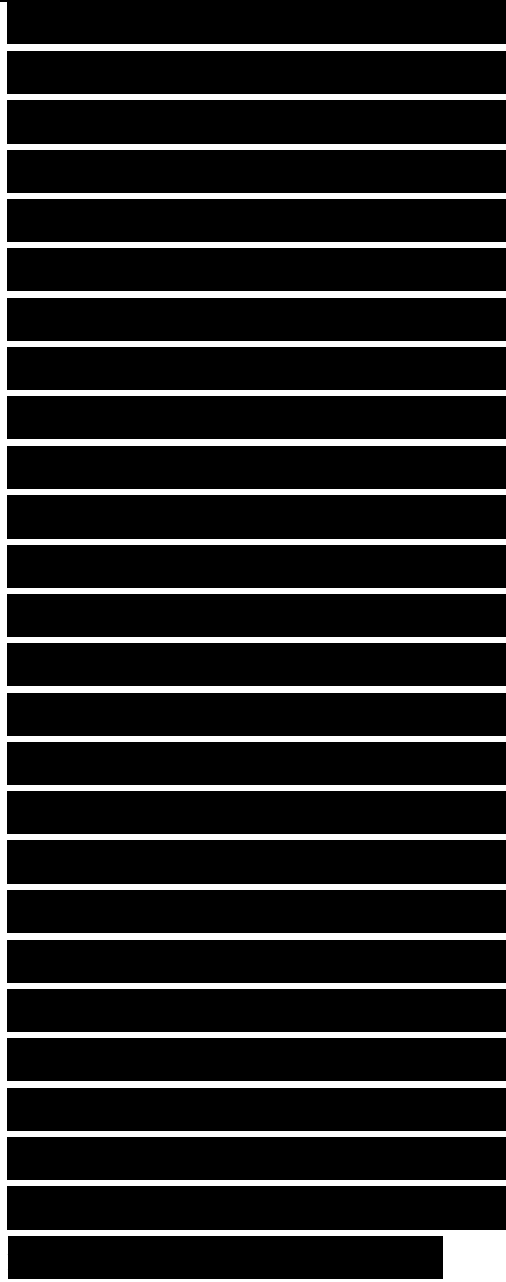
The MENA region benefits from abundant human and natural resources and it accounts for a large share of world petroleum production and exports. About two thirds of the world's known crude-oil reserves exist in MENA region, with one quarter located in Saudi Arabia. The Islamic Republic of

là CO2.



Iran has the about 15 percent of the world's total reserves of natural gas. The region also possesses several non-fuel mineral and non-mineral resources. In fact, Algeria, Morocco, Tunisia, Jordan, and the Syrian Arab Republic account for about one third of the world's phosphate production. Morocco alone has more than 30 percent of the world's phosphate rock and 40 percent of its phosphoric acid trade. The Islamic Republic of Iran possesses several natural resources such as potash, coal, ammonia and urea. Also Israel and Jordan possess potash, Mauritania has iron, and Qatar possesses ammonia and urea. We find copper and gypsum in Mauritania, cotton in Egypt and Sudan, tobacco in the Syrian Arab Republic, and coffee in the Republic of Yemen. In addition, almost all the GCC countries have coasts and fishing grounds (Al-Iriani, 2006).

We note that the region countries vary substantially in resources, economic and geographical size, population, and standards of living. Besides, intra-regional interaction is weak, being restricted principally to labor flows, with limited trade in

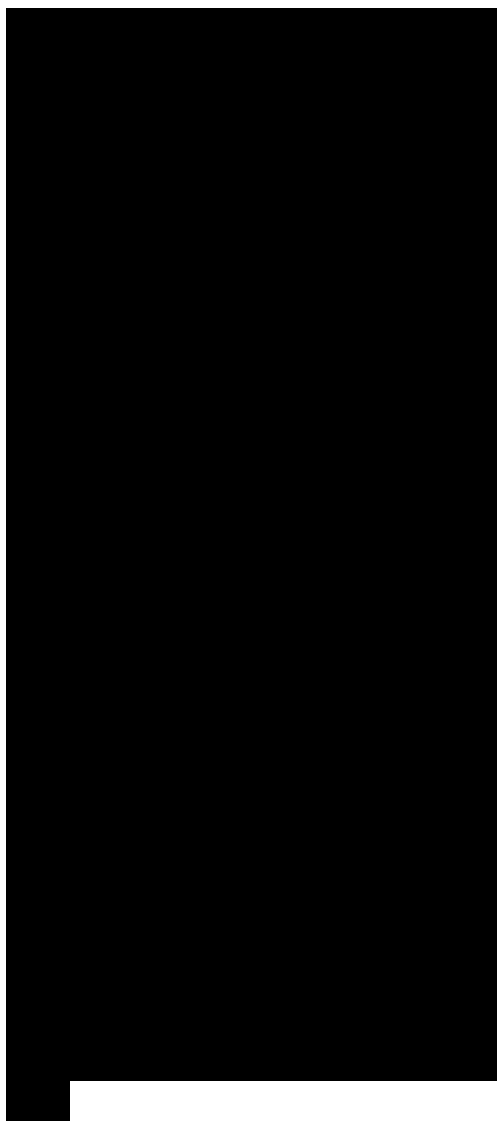
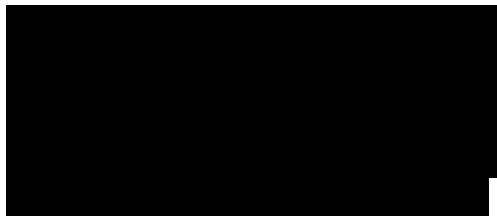


goods and services.

MENA countries especially trade with industrial economies. Their partners are the United States, Japan but the most important partners are EU countries.

The following graphs (1-3) reveal the evolution of the three variables, GDP, energy consumption and CO2 emissions in 15 MENA countries during 1973-2008.

Following these three graphs, we distinguish a first group from countries (Sudan, Morocco, Egypt, Tunisia, Turkey, Jordan) which present a similar evolution during the period with almost stable consumption energy, lower than 2000 kg of oil equivalent per capita in the end of the period. Morocco and Sudan present the weakest per capita consumption of energy while Jordan and Turkey are the more consumers within this group. The CO2 emissions in these countries did not cease recording a growth during the studied period, a growth justified by the increased requirements in energy by these countries.

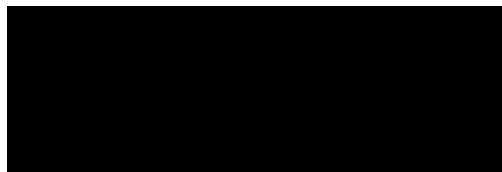
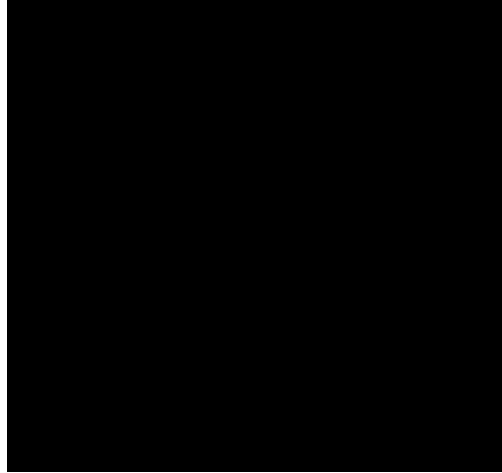


The second group made up of Iran, Israel and Cyprus records a per capita energy consumption which did not cease increasing during the period until to be stabilized around 3000 kg of oil equivalent per capita in 2008. Their CO2 emissions per capita remain nevertheless relatively weakest compared with the other countries of the area.

The third group joins together the countries which considerably increased their energy consumption exceeding 6000 kg of oil equivalent per capita during the last years. Kuwait and the UEA are the largest consumers of energy. The brutal fall recorded by the consumption of energy in Kuwait was due to the war in this country during the invasion of Iraq beginning of the Nineties.

The UEA is the country which emits the most CO2 per capita relatively to the other countries of the MENA region, even if this emission knew a fall during the years 2000.

From all that, we deduce that the consumption of energy seems to be the principal source of the CO2 emissions



since the two curves follow the same tendencies for the countries of this region during 1973-2008. Besides, most countries exhibit a positive correlation between growth and energy consumption and between growth and CO2 emissions.

These conclusions formulated by considering the graphs 1-3 push us to study the bonds of causality between the economic growth, energy consumption and CO2 emissions in an integrated framework for 15 MENA countries.

The rest of the paper is organized as follows. The next section presents a brief review of the literature on causality link between energy consumption, economic growth and CO2 emissions. Section 3 describes the data and methodology. Section 4 highlights the empirical results and the last one concludes and states the policy implications of the results.

## 2. Literature Review

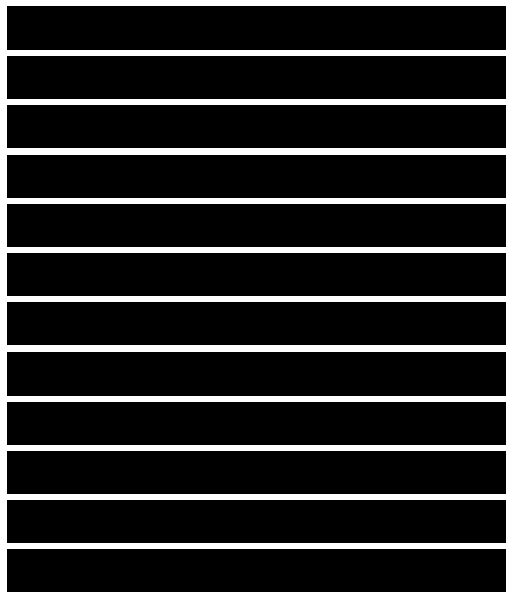
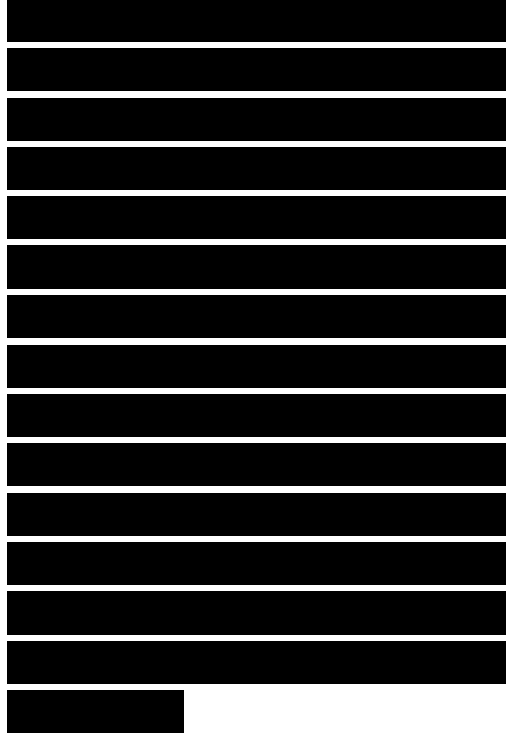
The relationship between energy consumption and



economic growth, as well as economic growth and environmental pollution, has been the subject of intense research during the last decades. Studies in this field may be divided into three lines of research.

The first focuses on the relationship between economic growth and energy consumption dating back to the pioneering work by Kraft and Kraft (1978) and leading to the use of Granger causality test approach as a tool for studying the relationship between energy consumption and economic growth in different countries, e.g. Stern (1993), Aqeel and Butt (2000), Yuan and al. (2008), Ghosh (2010), Lau

The second line of research focuses on the relationship between economic growth and environment, discussing the inverted U-shaped relationship between environmental pollutants and economic growth by testing the validity of environmental Kuznets curve (EKC) hypothesis. The empirical studies carried out by several authors drew different conclusions. Selden and Song





(1994) and Galeotti, Manera and Lanza (2009) provided empirical evidences on the validity of EKC hypothesis. However, Holtz-Eakin and Selden (1995) found a monotonic rising curve and Friedl and Getzner (2003) found an N-shaped curve. On the other hand, Agras and Chapman (1999) and Richmond and Kaufman (2006) concluded that there is no significant relationship between economic growth and environmental pollutants.

The third line of research investigates the relationships between pollutant emissions, energy consumption and economic growth by considering them simultaneously in a modeling framework. These studies have attempted to analyze the causal relationships between these three variables by combining the literature on EKC with the energy consumption-growth literature (Richmond and Kaufman, 2006; Soytas et al., 2007; Ang, 2007; Soytas and Sari, 2009; Akbostanci et al., 2009; Acaravci and Ozturk, 2010; Apergis and James, 2010; Ozturk and Acaravci, 2010; Arouri et al., 2011; and

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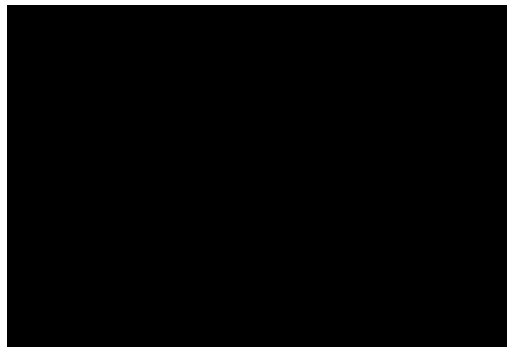
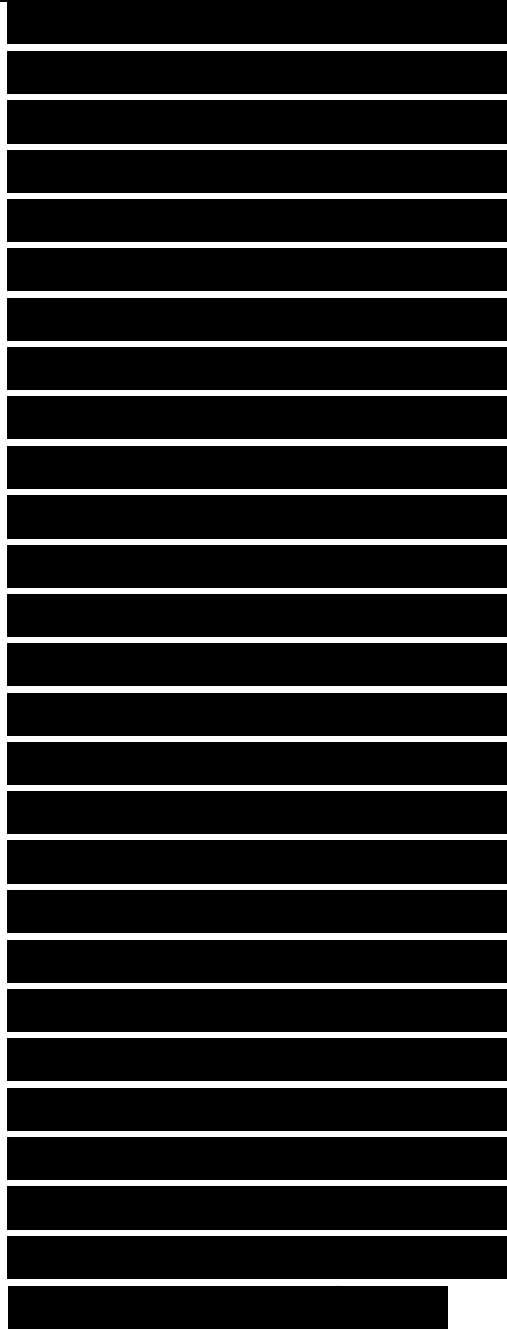
Wang et al., 2011).

Some earlier panel studies reveal different results which depend upon the countries and the period held in the analysis, as well as the econometric techniques used.

Apergis and James (2010) explore the relationship between carbon dioxide emissions, energy consumption and real output for 11 countries of the Commonwealth of independent states over the period 1992-2004. They found that in the long-run, energy consumption has a positive and statistically significant impact on carbon dioxide emissions while real output follows an inverted U-shape pattern associated with the Environmental Kuznets Curve (EKC) hypothesis. They found bidirectional causality between energy consumption and CO2 emissions in the long run. But the short run dynamics reveal a unidirectional direction from energy consumption and real output, respectively, to carbon dioxide emissions and bidirectional causality between energy consumption and real output.

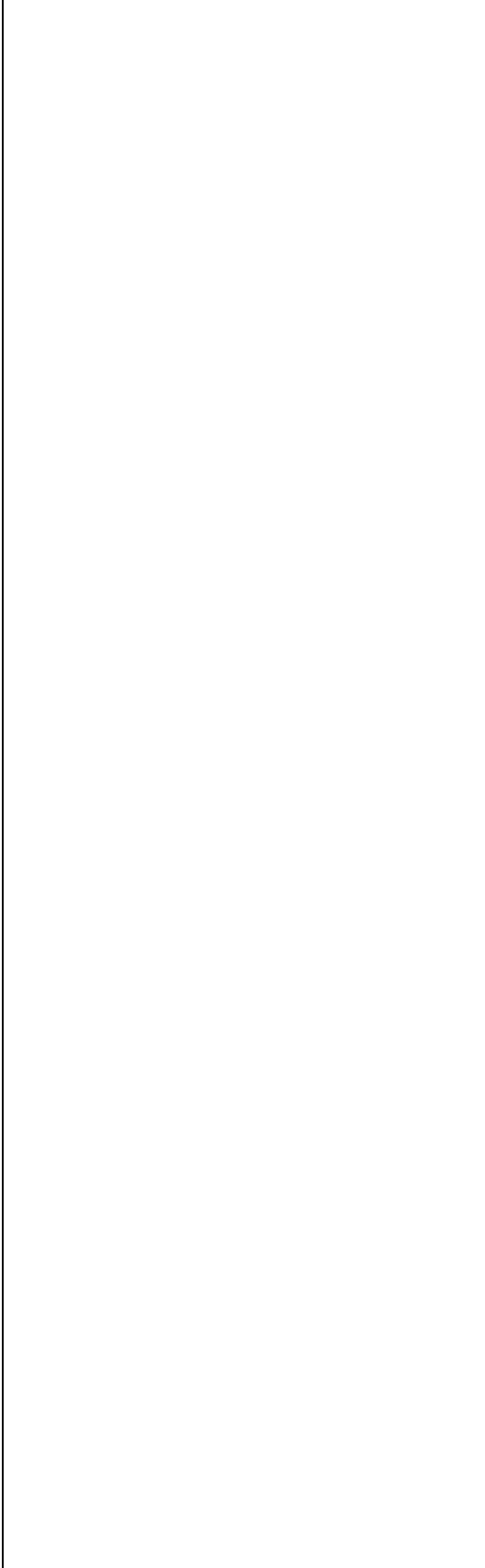
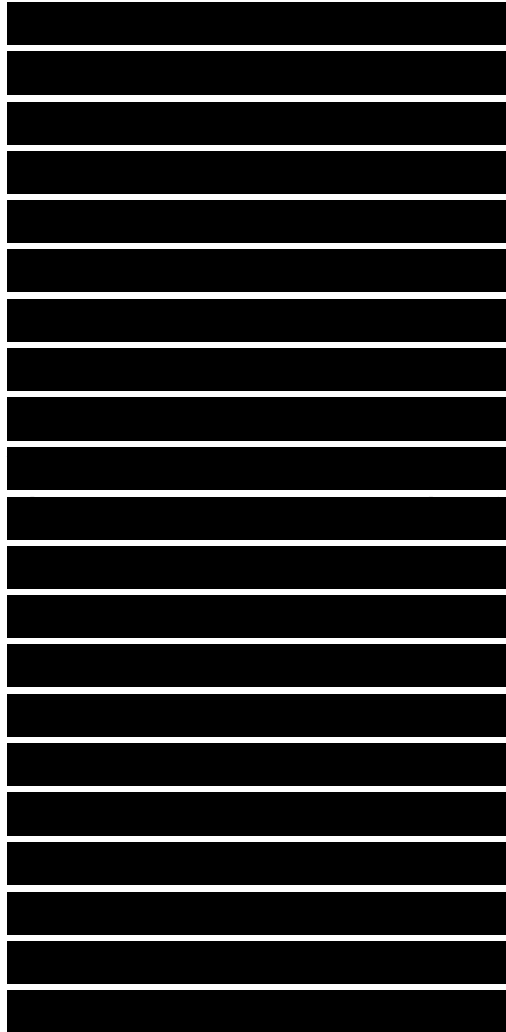
Acaravci and Ozturk (2010) investigate the dynamic relationship between these variables for 19 European countries by using autoregressive distributed lag (ARDL) bounds cointegration analysis developed by Pesaran and Shin (1999) and Pesaran et al., (2001), and error correction based Granger causality models. The bounds F-test for cointegration test yields evidence of a long-run relationship between carbon emissions per capita, energy consumption per capita, real gross domestic product (GDP) per capita and the square of per capita real GDP only for Denmark, Germany, Greece, Iceland, Italy, Portugal and Switzerland. Also, the cumulative sum and cumulative sum of squares tests reveal that the estimated parameters are stable for the sample period.

Wang et al., (2011) confirm the existence of a relationship between the three variables using panel cointegration and panel vector error correction modeling techniques based on the panel data for 28 provinces in China during



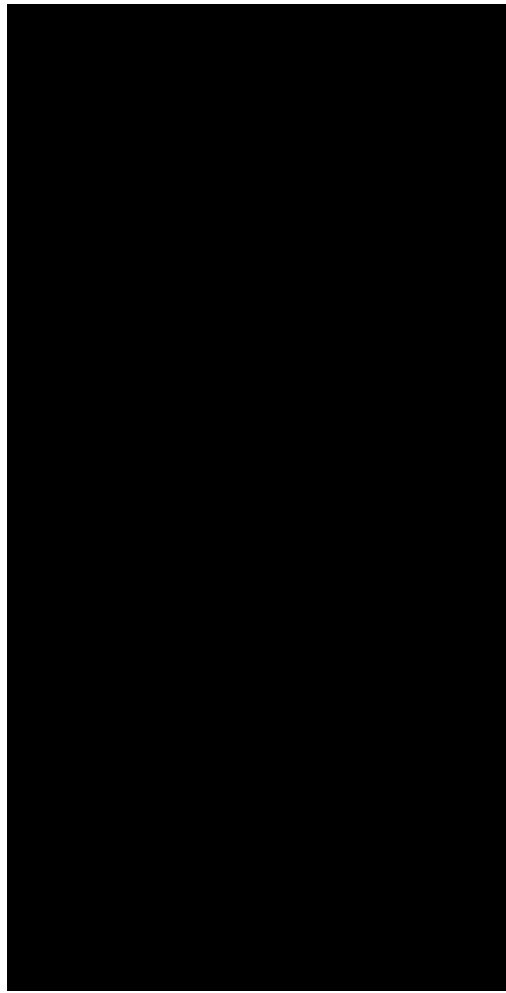
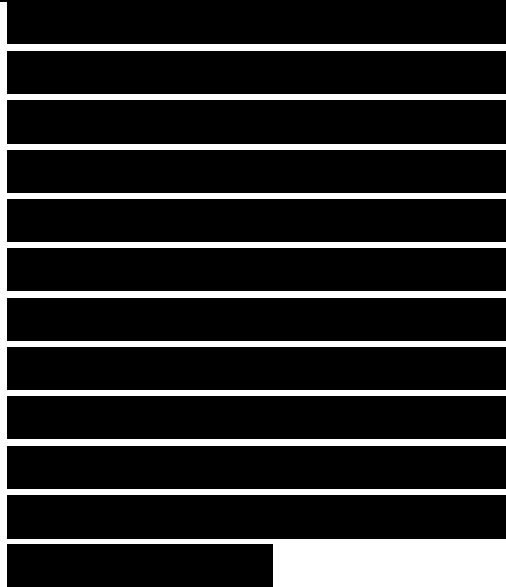
1995-2007. They found bidirectional causality between CO2 emissions and energy consumption as well as between energy consumption and economic growth. The authors also found that energy consumption and economic growth are the long-run causes for CO2 emissions and CO2 emissions and economic growth are the long-run causes for energy consumption.

In another study, Arouri et al., (2012) tried first to verify the existence of EKC in 12 MENA Countries over the period 1981-2005 and, second to characterize the turning points until which the development improves the environmental quality in these countries. Their results provide poor evidence in support of the EKC hypothesis for MENA countries suggesting that not all MENA countries need to sacrifice economic growth to decrease their emission levels but they may achieve CO2 emissions reduction via energy conservation without negative long run effects on economic growth. Finally, and by using panel unit root tests and cointegration techniques to investigate the



relationship between carbon dioxide emissions, energy consumption, and real GDP for the 12 MENA countries, they found that energy consumption has a positive significant impact on CO2 emissions in the long-run and that real GDP exhibits a quadratic relationship with CO2 emissions for the region as a whole.

Al-Mulali (2011) uses a panel model for the MENA countries during the period 1980-2009. Based on cointegration test results, he found that CO2 emission, and oil consumption has a long-run relationship with economic growth. The empirical results reveal also a bi-directional Granger causality between oil consumption, CO2 emission and economic growth in short and long run. The author concludes that oil consumption plays a crucial role in the economic growth of the MENA countries. This study extend the recent works cited above by applying the panel unit root tests, panel cointegration methods and panel causality test to



investigate the relationship between energy consumption, economic growth and CO2 emissions for 15 MENA countries covering the annual period 1973-2008.

### 5. Conclusion and Policy Implications

The principal aim of this paper was to seek for the linkages among energy consumption, economic growth and carbon emissions in 15 MENA countries and during the period starting from 1973 to 2008. We employed in this study the panel unit root, panel cointegration method and panel causality test. Our panel cointegration test reveal the existence of a panel long- run equilibrium relationship between energy consumption, real income (GDP), and the CO2 emissions, meaning that these three variables move together in the long run.

A panel-based on error correction model (ECM) followed by the two steps of Engle and Granger (1987)

was employed to investigate the long-run and short-run dynamic relationships. In sum, our empirical results show that in the short run, there is no evidence of short-run causality running from economic growth and CO2 emissions to energy consumption. But we found a short-run causality running from energy consumption to economic growth and CO2 emissions. The results indicate that an increase in energy consumption may lead to increase in the income and the CO2 emission. Furthermore, we can say that the policies attempting to consume more efficient energy may not retard economic growth and income. In fact and in the long run, only the estimated coefficient of ECT in the energy consumption equation is significant, implying that energy consumption could play an important adjustment factor as the system departs from the long-run equilibrium. The policymakers should then take into consideration the degree of economic growth in each country when energy consumption policy is formulated.

We then test whether or not strong relationship between energy consumption, economic growth and CO2 emissions holds consistently for all countries of the panel by doing individual and panel OLS, FMOLS and DOLS. The results show that for some countries (Algeria, Cyprus, Jordan, Morocco, Sudan and Syria), a high level of economic growth leads to high level of energy-demand of energy explaining the strong relationship between energy consumption and economic growth. For the relationship runs from CO2 to EC and among the individual country tests, data from all countries produce rejections at the 5% level for the OLS except Egypt, Oman and Sudan.

In the same line, we find the same result for the FMOLS, but for the DOLS, we except Cyprus too and we will obtain four countries: Cyprus, Egypt, Oman and Sudan. For the panel tests, it is observed that the strong relationship which runs from GDP to EC and from CO2 to EC was overwhelmingly rejected.

