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CO_2 emissions, energy consumption and economic growth nexus in MENA countries: Evidence from simultaneous equations models

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ABSTRACT

This paper examines the nexus between CO_2 emissions, energy consumption and economic growth using simultaneous-equations models with panel data of 14 MENA countries over the period 1990–2011. Our empirical results show that there exists a bidirectional causal relationship between energy consumption and economic growth. However, the results support the occurrence of unidirectional causality from energy consumption to CO_2 emissions without any feedback effects, and there exists a bidirectional causal relationship between economic growth and CO_2 emissions for the region as a whole. The study suggests that environmental and energy policies should recognize the differences in the nexus between energy consumption and economic growth in order to maintain sustainable economic growth in the MENA region.

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1. Introduction

The nexus between environmental pollutant, energy consumption and economic growth has been the subject of considerable academic research over the past few decades. According to the Environmental Kuznets Curve (EKC) hypothesis, as output increases, carbon dioxide emissions increase as well until some threshold level of output was reached after which these emissions begin to decline. The main reason for studying carbon emissions is that they play a focal role in the current debate on the environment protection and sustainable development. Economic growth is also closely linked to energy consumption since higher level of energy consumption leads to higher economic growth. However, it is also likely that more efficient use of energy resources requires a higher level of economic growth.

In literature, the nexus between environment and energy and growth has attracted attention of researchers in different countries for a long time. Roughly, we can categorize past studies in this field into three strands. The first focuses on the validity of the Environmental Kuznets Curve (EKC) hypothesis. The EKC hypothesis postulates that the relationship between economic development and the environment resembles an inverted U-curve, e.g. Ang (2007) and Saboori et al. (2012). That is, environmental pollution levels increase as a country grows, but begin to decrease as rising incomes pass beyond a turning point. This hypothesis was first proposed and approved by Grossman and Krueger (1991). Dinda (2004) offer extensive review surveys of these studies. Further examples consist of Friedl and Getzner (2003) and Managi and Jena (2008). However, a higher level of national income does not necessarily warrant greater efforts to contain the CO_2 emissions. Recently, Jaunky (2010) investigated the Environmental Kuznets Curve (EKC) hypothesis for 36 high-income economies (including Bahrain, Oman and UAE) over the period 1980–2005. Unidirectional causality running from GDP per capita to CO_2 emissions per capita has been identified in both the short- and the long-run. However, Holtz-Eakin and Selden (1995) establish a monotonic rising curve and an N-shaped curve has been found by Friedl and Getzner (2003). On the other hand, Richmond and Kaufmann (2006) concluded that there is no significant relationship between economic growth and CO_2 emissions.

The second strand of researches focuses on the nexus between energy consumption and economic growth. This nexus suggests that higher economic growth requires more energy consumption and more efficient energy use needs a higher level of economic growth. Since the pioneer work of Kraft and Kraft (1978), Granger causality test approach has become a popular tool for studying the relationship between economic growth and energy consumption in different countries, e.g. Stern (1993), Belloumi (2009), Pao (2009) and Ghosh (2010). However, Belloumi (2009) has used a VECM Model and showed that, in Tunisia, there is a causal relationship between energy consumption and income over the period of 1971–2004. Similarly, Altinay and Karagol (2004) investigated the causal relationship between electricity consumption and real GDP in Turkey over the period of 1950–2000. They showed that both used tests have yielded a strong evidence for unidirectional causality running from the electricity consumption to income. This implies that the supply of electricity is vitally important to meet the growing electricity consumption, and hence to sustain economic growth in Turkey.

Finally, most previous studies have shown that economic growth would likely lead to changes in CO_2 emissions. It has also found that energy consumption is often a key determinant of CO_2 emissions. It is therefore worthwhile to examine the nexus between economic growth,

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energy and CO_2 emissions by considering them simultaneously in a modeling framework. In this strand, Ang (2007) and Soytas et al. (2007) initiated this combined strand of research. Recent works include Halicioglu (2009) and Zhang and Cheng (2009) for a single country study. Halicioglu (2009) and Zhang and Cheng (2009) extended the above mentioned multivariate framework further by including the impacts of foreign trade and urban population, respectively into the nexus, in order to address omitted variable bias in econometric estimation. Also, based on panel error-correction model (PECM), Arouri et al. (2012) have tested the relationship between CO_2 emissions, energy consumption, and real GDP for 12 Middle East and North African Countries (MENA) over the period 1981–2005. They showed that the real GDP exhibits a quadratic relationship with CO_2 emissions for the region as a whole. The econometric relationships derived in this study suggest that future reductions in carbon dioxide emissions per capita might be achieved at the same time as GDP per capita in the MENA region continues to grow.

Table 1 summarizes some previous findings on the linkages between CO_2 emissions, energy consumption, and economic growth including the method used, the techniques and main findings. More than 15 studies are considered in a wide range of countries, including MENA countries, France, Turkey, India, Malaysia and others. The number of studies dealing with the nexus between CO_2 emissions, energy consumption, and economic growth seems considerably fewer than those dealing with causality between energy consumption and real GDP.

The results of studies on the relationship between CO_2 emissions, energy consumption, and real GDP differ from country to another and vary depending to the used methodology. It is difficult to succinctly clarify these variations. First, some studies found that CO_2 emissions can influence the GDP and/or energy consumption. For example, Soytas and Sari (2009) and Ang (2007) found this relationship for Turkey; and Arouri et al. (2012) for MENA countries. These results imply that more CO_2 emissions lead to economic growth. Second, if the relationship goes from energy consumption to GDP and/or CO_2 emissions, then GDP and/or CO2 emissions can increase through more energy consumption. For example, Belloumi (2009) found this relationship for Tunisia; and Ozturk and Acaravci (2010) for Turkey. Finally, some studies showed the causality relationship goes from GDP to energy consumption and/or CO_2 emissions. For example, Halicioglu (2009) found this relationship for Turkey; and Lotfalipour et al. (2010) for Iran.

Compared to previous studies (see Table 1), this paper used simultaneous equations based on structural modeling to study of the nexus between energy consumption, CO2 emissions and economic growth in the Middle East and North Africa (MENA) region. As we can see, about the emerging economies, our literature review generally indicates that little attention has paid to smaller emerging economies, particularly in MENA region. This region has some of the largest energy reserves in the world. Yet, while the region is trying to industrialize and modernize its economies, there are the challenges of the carbon emissions. Moreover, energy consumption is the most significant source of pollution and, in terms of particulate matter concentrations; MENA represents the second most polluted region in the world – after South Asia – and the highest CO_2 producer per dollar of output. The model allows examining at the sometime the interrelationship between CO_2 emissions, energy consumption, and economic growth in case of 14 MENA countries over the period 1990–2011 estimated by the GMM-estimator. However, to the best of our knowledge, none of the empirical studies have focused to investigating the nexus between energy–environment–growth via the simultaneous-equations models. Specifically, this study uses three structural equation models, which allows one to simultaneously examine the impact of (i) CO_2 emissions and energy consumption on economic growth, (ii) CO_2 emissions and economic growth on energy consumption, (iii) economic growth and energy consumption on CO_2 emissions.

Table 1
Summary of the existing empirical studies on the relationships between CO_2 emissions, energy consumption, and economic growth.

Study	Countries	Periods	Methodologies	Causality relationship
CO_2 emissions and GDP nexus				
Holtz-Eakin and Selden (1995)	130 countries	1951–1986	EKC hypothesis	Monotonic rising curve
Richmond and Kaufmann (2006)	36 nations	1973–1997		No relationship
Saboori et al. (2012)	Malaysia	1980–2009	EKC hypothesis	C → Y (in the long-run) Inverted-U shape curve (in the long and short-run)
Energy consumtion and GDP nexus				
Stern (1993)	United States	1947–1990	Multivariate VAR model	E → Y
Yuan et al. (2007)	China	1963–2005	Johansen–Juselius, VECM	E → Y Y → E
Belloumi (2009)	Tunisia	1971–2004	Johansen–Juselius, VECM	E ↔ Y (in the long-run) E → Y (in the short-run)
Ghosh (2010)	India	1971–2006	ARDL bounds test, Johansen–Juselius, VECM	Miscellaneous
CO_2 emissions, energy consumption and GDP nexus				
Ang (2007)	France	1960–2000	EKC hypothesis,Johansen Juselius, VECM, ARDL bounds test.	E → Y
Soytas et al. (2007)	United States	1960–2004	EKC hypothesis, Granger causality test	E → C
Apergis and Payne (2009)	6 central American countries	1971–2004	EKC hypothesis, panel VECM	C ↔ Y; E → C Y → C Inverted U-shaped curve
Halicioglu (2009)	Turkey	1960–2005	ARDL bounds test, Johansen–Juselius, VECM	C ↔ income; C → E C ↔ square of income
Soytas and Sari (2009)	Turkey	1960–2000	Granger causality test	C↔ E (in the long-run)
Zhang and Cheng (2009)	China	1960–2007	Toda–Yamamoto procedure	Y → E E → C
Chang (2010)	China	1981–2006	Johansen cointegration VECM	Miscellaneous
Lean and Smyth (2010)	5 Asean countries	1980–2006	Panel cointegration EKC hypothesis, panel VECM	C → E Inverted U-shaped curve
Lotfalipour et al. (2010)	Iran	1967–2007	Toda-Yamamoto method	Y → C (in the long-run)
Ozturk and Acaravci (2010)	Turkey	1968–2005	ARDL bounds test, VECM	C → Y (in the long-run)
Arouri et al. (2012)	12 MENA countries	1981–2005	Panel unit root tests and cointegration	E ↔ C (in the long-run)

Note:
Y, C and E indicate GDP per capita, carbon dioxide emissions, and energy consumption, VAR represents vector auto regressive model, VECM refers to the vector error correct model, ARDL denotes the auto regressive distributed lag procedure and EKC refers to the environmental Kuznets curve.
→ and ↔ indicate unidirectional causality and feedback hypothesis, respectively.

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