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Carbon Dioxide Emission in the Middle East and North African (MENA) Region: A Dynamic Panel Data Study

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Abstract

This empirical study investigates the determinants of CO_2 emission in 18 countries of the Middle East and North African region covering the period from 1971 to 2009. The analysis is based on a dynamic panel data model employing the Generalized Method of Moments (GMM) technique. The potential determinants of carbon emissions identified are per capita gross domestic product, energy usage, energy consumption from fossil fuel, foreign direct investment, urbanization, industrial production, agricultural production and education level. The results show per capita gross domestic product, energy consumption based on fossil fuel, foreign direct investment and agriculture production have significant impact on the growth of carbon emissions in the region.

Keywords: Carbon Dioxide; Dynamic panel data model; GMM estimations; GDP; Energy Usage; Middle East and North Africa

1. Introduction

The year 1991 saw developing countries to be held responsible for the rapid increase of the world's CO_2 emissions. Being identified to be the next potential largest emitters, the dramatic increase was contributed by their high demand for coal, oil and gas to cater their energy-intensive industrial production. Though the Middle East and North African (MENA) region contributes a large fraction of the world's oil, their energy consumption from fossil fuels and cement produce only 6.2 percent of the global CO_2 emissions. The Middle East had exhibited a dramatic singularity of CO_2 emissions in 1991 during the Kuwaiti oil field fires of which had caused 130 million metric tons of carbon being released to the atmosphere. Gas flaring has been a major source of regional emissions accounted for almost half of the total fossil fuel CO_2 emissions before infrastructure was available for gas use and reinjection. Growth has been nearly continuous since 1950, although it started from a very low base. Per capita emission underwent rapid growth until 1973. In the late 1970s and 1980s, not much change was evident. However,

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it had grown again during the 1990s to exceed the global average. Four Middle Eastern countries are among the five highest national per capita CO_2 emission rates in the world for 2007 i.e. Qatar (14.03 metric tons of carbon per person), Kuwait (9.30), United Arab Emirates (8.44), and Bahrain (8.06).

The priority concern is any effects of climate change are expected to be felt the most by these countries, the very countries that are least prepared to deal with them. Eventually their signatory to the Kyoto Protocol has also demanded them to put effort in reducing the CO_2 emissions. GDP per capita is the most common indicator of a country's economic development and is believed to be the prime variable that affects the level of carbon emissions. Earlier empirical studies focused more on examining the relationship between these two variables and relate them to the Environmental Kuznets Hypothesis aiming at either to establish their causal relations, prove its existence or identify the income level at which environmental degradation stabilize or reaching its turning point (Shafik and Bandyopadhyay (1992); Grossman and Kreuger (1995); Selden and Song (1994); Panayotou (2003)).

Subsequently researches found energy consumption to be another fundamental factor that is perceived to closely relate to economic growth and CO_2 emissions. It started with the introduction of an extended version of the IPAT framework known as the Kaya identity that added energy consumption and has become a central attention. However a majority of the studies conducted focuses on the unit root and cointegration approaches and estimates Granger causality between them. There are single country studies run by Soytas et al. (2007) on United States, Ang (2007, 2008) on France and Malaysia, and Zhang and Cheng (2009) and Li et al. (2011) on China while for multi-country studies by Liu (2005), Lee and Oh (2006), Apergis and Payne (2009a) and Apergis and Payne (2009b) of which their mixed results are concerned with the existence and direction of Granger causality between economic growth, energy consumption and carbon emissions.

There is simply no single relationship between emissions and economic growth or energy consumption hitherto the evolution of emissions is bound to be dependent on a range of factors which vary according to circumstances. There are studies conducted to examine the relationship within a multivariate framework examining socio-economic variables such as capital stock, labor force, population, government expenditures, consumer prices and international trade that may have impact on CO_2 emissions. Empirical evidence using various techniques like ARDL, VAR and Decomposition method from Hamilton and Turton (2002), Alam et al. (2007), Soytas et al. (2007) and Halicioglu (2009) aim to analyze and explore the sources of emission growth.

Since there is no concrete evidence on what determines the level of CO_2 emissions, and with the believe that regions or countries may differ accordingly, this issue will remain open for discussion and it is to the best of our knowledge to explore all possible determinants in order to understand the complex process of the world's climate change. Thus the objective of this study is three-fold: (1) to investigate the eight possible factors that determine the level of per capita CO_2 emissions; (2) to identify the most relevant factor contributes to the CO_2 increase in MENA region; and (3) to employ the Arellano and Bond GMM estimator involving a dynamic panel specification within a multivariate framework which is rather limited in the study. The paper is organized as follows. Section 2 briefly reviews the theory and the empirical literature. Section 3 provides the methodology for the analysis. The empirical findings are presented and discussed in Section 4 whilst the final section, Section 5 concludes the study.

2. Literature Review

Two scientists Paul Ehrlich and John Holdren in 1971 presented their famous IPAT model discussing the issue on environmental problem. The IPAT model theoretical framework conventionally was formulated in the form of equation shown as:

$$\text{Environmental Impact (I)} = \text{Population (P)} * \text{Affluence (A)} * \text{Technology (T)}$$

This relationship suggests three main causal factors behind the environmental problems or deteriorations (I) which are population growth (P), growth in consumption per person (affluence, A), and the damage per unit of consumption resulting from the available technology (T). The equation has also raised the need to address the solutions of these three main drivers when overpopulation, overconsumption and dirty technologies may threaten future sustainability. Extensive studies are conducted linking the model with the socio-economic causes of deterioration in environmental quality in general before Cramer (1998) and York et al. (2003a) and York et al. (2003b) starting to give more attention to CO_2 emissions per se. Schmalensee et al. (1997), and Friedl and Getzner (2003) in their works clearly name CO_2 emissions to be the main cause of problem on a global scale. In the 1990s the concept of Environmental Kuznets Curve (EKC) was introduced to investigate the relationship between economic growth and CO_2 emissions.

The study becomes more extensive when energy consumption is identified to link closely to economic growth. Hence an extended version of the IPAT framework termed the Kaya identity has included energy consumption to be a critical factor in the identity. Yoichi Kaya, a Japanese energy economist has structured energy-related carbon emissions by decompose emissions or energy use as the product of four inputs population, per capita income, the energy intensity of output and the carbon intensity of energy. The Kaya identity for energy consumption is given by:

$$\text{Energy} = \text{Population} \times \left(\frac{\text{GDP}}{\text{Person}}\right) \times \left(\frac{\text{Energy}}{\text{GDP}}\right)$$

and CO_2 emissions is outlined as:

$$CO_2 \text{ Emissions} = \text{Population} \times \left(\frac{\text{GDP}}{\text{Person}}\right) \times \left(\frac{\text{Energy}}{\text{GDP}}\right) \times \left(\frac{CO_2}{\text{Energy}}\right)$$

Salim et al. (2008) pointed out the issue that remains unsettled is concerning whether or not economic growth is the cause or effect of energy consumption but Payne (2008) added the need to understand the impact of energy consumption on economic growth is crucial in the formulation of both energy and environmental policies. The various empirical evidences have one common outcome i.e. they have proved to show energy usage is indeed a critical factor in affecting the level of CO_2 emissions. However Liu (2005) estimated 24 OECD countries found adding energy consumption implies a negative relation between income and CO_2 emissions. This outcome is supported by Lee and Oh's (2006) study on 15 APEC countries divided into three income groups that saw energy intensity effect to contribute negatively to CO_2 emissions growth in developed but positively with developing countries except China.

Stern (2004) had expressed his concern on the econometric works that fail to note testing different variables individually is subject to the problem of potential omitted variables bias. Noting this there are studies conducted to examine the relationship not only among the three core variables i.e. CO_2 emissions, economic growth, and energy consumption but to look as well within a multivariate and integrated framework including other economic and socio-economic variables into the study. Alam et al. (2007) had added population and urbanization growth showed a positive impact on environmental degradation yet negatively significant to Pakistan economic development in the long run. Yet Zhang and Cheng's (2009) study on urban population in China did not show significant impact on carbon emissions. Sharma (2011) who had included trade openness and urbanization on 69 panels of countries divided into three income panels found negative impacts on the CO_2 emissions from global perspective.

3. Methodology

3.1. Empirical model

A number of variables based on the literature of environmental economics are being considered as possible determinants of carbon dioxide emissions, and subsequently the eight selected variables are GDP per capita, energy usage, fossil fuel energy consumption, foreign direct investment, urbanization, industrial production, agriculture production and level of education. The model begins with the proposed multivariate framework function:

$$CO_2 = f\,(GDP, EUS, EFF, FDI, URB, IND, AGR, EDU) \tag{1}$$

where,

CO_2 = per capita CO_2 emissions (metric tons)
GDP = per capita GDP (USD$)
EUS = per capita total energy consumption
EFF = fossil fuel energy consumption
FDI = inflows of foreign direct investment
URB = urbanization
IND = industrial sector production
AGR = agricultural sector production
EDU = level of education proxy by education attainment for population age 15+

Equation (1) states that per capita GDP (GDP), per capita total energy consumption (EUS), fossil fuel energy consumption (EFF), inflows of foreign direct investment (FDI), urbanization (URB), industrial production (IND), agricultural sector production (AGR) and level of education (EDU) can possibly affect the level of CO_2 emissions. Following the foundation based on equation (1), our model would be:

$$lnCO_{2i} = \beta_0 + \beta_1 lnGDP_{it} + \beta_2 lnEUS_{it} + \beta_3 lnEFF_{it} + \beta_4 lnFDI_{it} + \beta_5 lnURB_{it} + \beta_6 lnIND_{it} + \beta_7 lnAGR_{it} + \beta_8 lnEDU_{it} + \varepsilon_{it} \tag{2}$$

The dependent variable is CO_2 emissions where i and t represent country (18) and time frame (1971-2009) respectively. The variable per capita GDP, EUS and EFF are expected to have a positive effect on carbon dioxide emissions because an increase in EUS catered by EFF leads to more economic activities meaning higher GDP yet end up with higher CO_2 emissions. There are many studies proven empirically on the relationship between economic growth, CO_2 emissions and energy consumption though these studies focus more on the causality running among the three variables. They also do not treat fossil fuel energy as one independent variable that determines CO_2 emissions. Theoretical and empirical works have shown evidence of investment to be the key ingredient to promote economic growth for developing economies. It is believed that FDI is less prone to crisis because direct investors are perceived to have a longer-term perspective when they decide to tie up in a host country. Yanchun (2010) found in her study FDI inflows have alleviated the pressure of carbon dioxide emissions in China resulting from FDI technology spillover nevertheless at the same time the use of foreign technology has some extent improved their environmental problems. In the case of urbanization most cities especially in developing nations are rapidly growing above the national average as endurance workers migrate from rural areas to urban areas in search of better jobs, education, living standards even into believing it will promise a luxury life (Itoh (2009), Deng et al.(2008)). It can be observed as population becomes more urbanized, they exert pressure on urban resources and environment leading to more pollution (Kahn and Schwartz (2008)). Hence, the more urbanized the city is the higher the pollution level meaning a positive relationship is expected between the two variables.

Industrial production is a critical variable to be the main cause of the increase in the level of CO_2 emissions in developed and developing countries. A recent study by Halkos and Tzeremes (2011) includes industrial production in their multivariate framework and found a significant positive correlation between industrial production and CO_2 emissions. It is observed that a majority of the developing economies still depends on agricultural production to contribute to their GDP growth. Thus it is not surprising that agricultural sector is reported to be one of the largest sources of CO_2 emissions after energy sector in these countries. In 2005 seventy four percent of total agricultural emissions were mostly responsible by developing countries from rice production and burning of biomass.[†] With this reported statement, a positive correlation between the two variables is anticipated. Education is a continuous process of learning aiming to enhance one's ability to acquire knowledge, understand the know-how as a way to improve one's well-being. Although empirical studies with regards to the impact of education level on CO_2 emissions per se are rather limited, as Farzin and Bond (2006) argue, educated people are more aware of and strongly prefer better environmental quality hence will enable them to create a democratically-minded public policymaker and organization that are more receptive to public demands for environmental quality. This is supported by Bimonte (2002) whose study found a strong positive correlation between the level of education and the demand for environmental amenities. By contrast, a recent study by Kinda (2010) on 85 countries suggested that education has no impact on the growth of air pollution in the developing countries but it does matter in the developed countries.

However since our analysis is based on a study using a dynamic panel specification of which lagged levels of CO_2 emissions are taken into consideration, we employ the Arellano and Bond (1991) GMM estimator. The equation is shown and explained in the following section.

[†] Smith, P., D. Martino, Z. Cai, D. Gwary, H. Janzen, P. Kumar, B. McCarl, S. Ogle, F. O'Mara, C. Rice, B. Scholes, O. Sirotenko, 2007: Agriculture. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

3.2. Econometric analysis

Martínez-Zarzoso and Bengochea-Morancho (2004), Aldy (2006) and Martínez-Zarzoso et al. (2007) have proven that pollution-income relationship is a dynamic one and assumed that last year's CO_2 emissions (given as CO_{2t-1}) will have an impact on this year's emissions. From the perspective of this developing region that in need of sustain growth, if a country emitted large amounts of CO_2 last year, this year's emissions is prone to be high too. Thus taking this into consideration, we apply the Arellano and Bond (1991) GMM estimator to equation (1) with a dynamic panel specification of lagged levels of CO_2 emissions to our study and the equation is:

$$lnCO_{2i} = \beta_0 lnCO_{2i,t-1} + \beta_1 lnGDP_{it} + \beta_2 lnEUS_{it} + \beta_3 lnEFF_{it} + \beta_4 lnFDI_{it} + \beta_5 lnURB_{it} + \beta_6 lnIND_{it} + \beta_7 lnAGR_{it} + \beta_8 lnEDU_{it} + \mu_{it} + \varepsilon_{it} \quad (3)$$

$i = 1,....., N; t = 1,...., T$

where,

$lnCO_{2i,t-1}$ = natural log of per capita CO_2 emissions of country i at time $t-1$
i = parameters to be estimated
μ = country-specific effects
ε = error term

Yet two problems will arise i.e. firstly, the country-specific effects problem and secondly, the correlation between the lagged dependent variable and the error term problem. If one uses the panel ordinary least square (OLS) estimator it is problematic since the lagged dependent variable is correlated with the error term, so, the option is to employ the Arellano and Bond estimator as country-specific effects can be eliminated. This is so because the method first differences the regression model resulting with: $E(\varepsilon_{i,t} - \varepsilon_{i,t-1}) = 0$ but $(gCO_{2i,t-1} - gCO_{2i,t-2})$ is dependent of $(\varepsilon_{i,t} - \varepsilon_{i,t-1})$. Hence the Arellano and Bond method provides a better solution when one uses two or more lags of the first difference of CO_2 emissions.

However Blundell and Bond (2000) warned that the usage of first-differenced GMM estimator was found to have poor finite sample properties as they are bias and imprecision when the lagged levels of the series are only weakly correlated with subsequent first differences, thus the instruments available for the equations became weak. This will often occur in the case when the variables are highly persistent or show a close to random walk processes and the number of time series observations is small. Bond, Hoeffler and Temple (2001) did a simulation study to prove these features are typically present in empirical growth models of which output is a highly persistent series, and to avoid modeling cyclical dynamics, most growth applications consider only a small number of time periods, usually based on five year averages. Thus they recommend the usage of a system GMM estimator introduced by Arellano and Bover (1995) and Blundell and Bond (2000), which exploits an assumption about the initial conditions to obtain moment conditions that remain informative even for persistent series. Arellano and Bover (1995) have developed a framework for efficient instrumental variables (IV) estimators with information in levels capable of accommodating models with lagged dependent variables and other predetermined variables. On the other hand Blundell and Bond (2000) explained using suitable lagged first differences of the variables as instruments for the equations in levels allow both sets of moment conditions be exploited as a linear GMM estimator in a system containing both first-differenced and levels equations. Thus when both sets of moment conditions are combined, this provides what they call the system (SYS) GMM estimator.

They wrapped up their research by advising future growth researchers (i) to preferable use the system GMM estimator rather than the first-differenced estimator in empirical growth work and (ii) researchers who report the standard first-differenced GMM estimates should probably check their results against those of alternative estimators. In the context of carrying out the research on CO_2 emissions, we foresee that the characteristics described above seem to be apparently similar and indeed could be predicted that the first-differenced GMM estimator will appear to be problematic. Thus in order to promote a fair insight on the employment of the GMM estimations, the findings extracted from both the first-differenced and the system GMM estimators are illustrated in the analysis.

3.3. Data sources

The empirical study is based on data gathered for 18 countries covering a time span from 1971-2009. The source of CO_2 emissions data valued in metric tons per capita comes from the Carbon Dioxide Information Analysis Centre, Environmental Sciences Division, Oak Ridge National Laboratory, Tennessee, US and International Energy Association (IEA) 2010 report. GDP per capita is based on PPP Converted GDP Per Capita (Chain Series), at 2005 constant prices and extracted from Penn World Table version 7.0. Energy usage refers to the usage of primary energy before transformation to other end-use fuels, is measured based on kt of equivalent of which the source is mainly from IEA and WDI. Similarly data for fossil fuel energy consumption is measured as the percentage of total energy consumption is collected from the same source as energy usage. FDI is measured by inward FDI flows based on percentage of GDP extracted from UNCTAD. Urban population computed as an annual percentage of urban population growth whilst industrial production valued as a percentage of GDP comprises of value added in mining, manufacturing, construction, electricity, water, and gas, both data are collected from WDI. Agriculture is measured by the index of agriculture production merely because the data is available for all developing countries. The data is extracted from Food and Agriculture Organization of the United Nations (FAOSTAT). For a standardized measurement for level of education, Barro and Lee (2010) new data set on educational attainment is utilized.

4. Results and Discussion

Before discussing the results four aspects worth noting; firstly the time period understudy is 1971-2009 involving 18 countries, for all the analysis the panel data are time period corresponding to a five-year average for example 1971-1975, 1976-1980, 1981-1985 and so on, thus the overall region analysis for instance will have time dimension T=8 and the country dimension N=18. Relying on five year intervals or averages as stated in the literature is a standard procedure to mitigate the persistence in the data. In addition one other advantage of this five-year average specification is that it helps to control for measures of the average years of schooling, which are only available in this periodical manner for these countries. Secondly with regards to the estimation procedure, the results presented will exploit the first-difference-GMM (Arellano and Bond (1991)) and system-GMM (Arellano and Bover (1995); Blundell and Bond (2000)) robust approaches. Thirdly the choice of estimating by employing alternative GMM methods is essential for a more realistic, efficient and feasible discussion of results that caters for each country differences. Finally from a methodological point of view, the findings of using alternative GMM methods are anticipate to illustrate the most relevant, appropriate and reliable estimations to be able to justify the similarities and dissimilarities of each country in the region.

Table 1. Effect of socioeconomic factors on per capita CO_2 emissions

Log of carbon dioxide per capita emissions	GMM 1-DIF (1)	GMM 2-DIF (2)	GMM 1- SYS (3)	GMM 2- SYS (4)
Log of CO_{2t-1}	-0.311	-0.437	0.694***	0.076
	(-0.45)	(-1.07)	(7.71)	(0.13)
Log of GDP/cap	0.773	0.584	0.250***	0.658
	(0.74)	(0.96)	(3.14)	(0.95)
Log of EUS	-0.548	-0.609	0.011	-0.200
	(-0.40)	(-0.69)	(0.33)	(-1.15)
Log of EFF	18.23	13.67	1.025*	0.888
	(1.22)	(1.12)	(1.93)	(0.82)
Log of FDI	0.008	0.001	0.024**	-0.030
	(0.20)	(0.05)	(2.36)	(-1.07)
Log of URB	2.712	1.671	-0.012	-0.309
	(0.78)	(0.43)	(-0.09)	(0.31)
Log of IND	-0.200	-0.013	-0.003	0.573
	(-0.75)	(-0.06)	(-0.03)	(1.11)
Log of AGR	0.805	0.720	0.204*	0.223
	(0.95)	(1.21)	(1.75)	(0.71)
Log of EDU	-0.792	-0.127	0.194	1.080
	(-0.83)	(-0.13)	(1.26)	(1.35)
Year Dummy	0.025	0.030	-0.101**	-0.133
	(0.14)	(0.22)	(-2.41)	(-1.34)
No. of observations	46	46	63	63
No. of countries	12	12	14	14
m_1-test	0.426	0.245	0.024	0.572
m_2-test	0.653	0.829	0.273	0.661
Sargan test	0.855	0.855	0.499	0.499
Hansen test	0.998	0.998	1.000	1.000
Difference-Hansen	-	-	0.974	0.974
No. of instruments	14	14	22	22

Notes: 1. EUS = Energy Usage; EFF = Fossil Fuel Energy; FDI = Foreign Direct Investment; URB = Urbanization; IND = Industrial Production; AGR = Agriculture Production; EDU = Education.
2. Shown in parentheses are t-statistics. *, ** and *** denote significance at 10%, 5% and 1% level, respectively.
3. The values reported for m_1 and m_2 are the *p*-values for first and second order auto correlated disturbances.
4. The values reported for Hansen and the Difference-Hansen tests are the *p*-values.

The analysis considers the eight determinants as shown in equation (3). The appropriate optimal lag period is determined base on the standardized average residuals autocovariance introduced by Arellano and Bond (1991) that is termed as m_j statistics where j is the order of autocorrelation with asymptotically N(0, 1) distributed under the null hypothesis of no autocorrelation. The reported first-differenced and system GMM estimates have treated per capita GDP, total energy usage and fossil fuels energy consumption rates (i.e. lagged values of the variables in levels) as potentially endogenous variables and the rest of the variables (i.e. FDI, URB, IND, AGR and EDU) to be strictly exogenous. The results in Table 1 (column 3) confirm only the one-step system GMM is to be chosen. It clearly satisfies and consistent with the appropriate diagnostic tests. It passes not only the Hansen J-test but also the Sargan test failing to reject the null hypothesis indicates the set of instruments is appropriate thus confirm the validity of the equation. The test of first and second-order serial correlation in the first-differenced residuals once more met the statistical *p*-values requirements of rejecting the null for first-order autocorrelation and does not reject the null of no autocorrelation for second-order autocorrelation.

However there are two noticeable points to note. First, seven of these nations namely Bahrain, Kuwait, Libya, Oman, Qatar, Saudi Arabia and UAE are the major oil exporting countries unquestionably a moderately high statistically significant positive coefficient is likely to be expected for the two major variables i.e. EUS and EFF yet they do not. Second, the findings for urbanization, industrial and agricultural production clearly diverged from the hypothetical expectations. Thus the need to detail each of these outcomes is very much anticipated to clarify the scenarios. The log of lagged carbon emissions documented a persistent positive coefficient of 0.69 significant at 1 percent level indicating the previous years' carbon emissions do play a vital role in affecting carbon emissions in the current year. GDP per capita as predicted has shown a positive coefficient value (0.25) associated with per capita carbon emissions significant at 1 percent significance level. In statistical term it means for every 1 percent increase in per capita GDP, per capita emissions increases by 0.25 percent, holding other factors constant. Another widely acknowledged prominent driver of CO_2 emissions (beside GDP) in this region is energy consumption from fossil fuels has revealed a 10 percent statistically significance level with coefficient value of positive 1.025. It is worth noting for every 1 percent increase in the consumption of EFF means the per capita CO_2 emissions will increase by 1.025 percent, ceteris paribus. The fact is thirty-nine percent of MENA countries alone account for approximately 35 percent of the world's oil exports that releases 50 percent more CO_2 emissions than natural gas but half of the coal emissions. It is rather unanticipated to observe the energy usage showing a low insignificant positive coefficient (0.01) relationship on per capita CO_2 emissions. Two possible reasons: (i) much of the increase in the local demand for energy use is sourced by natural gas which emits lower CO_2 emissions (ii) the heterogeneity of the MENA region made up of some richest and poorest developing countries in the world may explain their vast variations in energy use. The International Energy Authority (IEA) estimates that energy demand will grow at close to 3 percent over the next two decades due to high demand for electricity provided for growing populations. Given that energy consumption could be the most significant source of pollution in MENA and energy sector contributes almost 45 percent of emissions the result above may reflect differently in the near future.

A completely different development of FDI scenario has occupied the MENA region in recent years. It has experienced a sudden increase in FDI inflows growing tenfold from US$8.7 billion in 2001 to US$94 billion in 2008. The boom that took place in some countries was a result of economic liberalization and increased integration with the world economy. More glaringly, rising oil prices, which attracted higher levels of investment in the hydrocarbon sector, also drove the FDI flows. This sector is highly capital intensive occupies approximately two thirds of FDI inflows into MENA. Thus one could notice how the FDI in this region has shown impact on per capita emissions with a positive coefficient of 0.024 significant at 5 percent level. In line with the region being the world's well-known oil producing nations industrial sector relies heavily on hydrocarbons industry whereas manufactured exports consist a smaller share. It seems the estimated result did not describe the importance of industrial sector effect on per capita emissions. The negative coefficient value read a trivial 0.003 and insignificant. Instead the growing importance of services sector in the region with keen support via FDI for example in telecommunications, financial services, tourism, real estate and construction might cause the industrial sector to become less significant. Agriculture is another prominent economic sector though it contributes modestly to GDP it creates a sizable share of employment to the region's non-oil-exporting countries namely Djibouti, Egypt, Jordan, Lebanon, Morocco, Syria and Tunisia that suffer a stagnant growth between the periods 1990-99 and 2000-06.[‡] Even being the net agricultural importers the MENA countries still practice a relatively high level of agricultural protection as a way to support their farmers, reduce import dependence and generate revenue. No doubt agricultural sector is perceived to play an essential role not only to provide food security in this region but also a way to tap opportunities for international trade in the nearby high-income markets in Europe. The result has exposed its essentiality by portraying a positive significant at 10 percent significance level with coefficient 0.204 that able to affect per capita emissions.

The MENA region is relatively a latecomer in the global urban transition though it is catching up even quicker than other developing regions. It is additionally stated the populations of MENA cities are growing even faster than the populations of the countries as a whole.[§] The region recently experienced sharp urban populations increase begins in the 1990s, 2000 and 2010 except for Egypt, Syria and Yemen. Most of its well-developed urbanized cities are those rich-oil nations comprise of 80 to 90 per cent of international migrants labor force.[**] Therefore it is understandable the result of the coefficient of the rate of urbanization is not just insignificant but also having a negative (-0.012) relationship with per capita emissions. The rapid urbanization that occurs typically concentrates more in the Gulf States known as the 'oil urbanization processes' but not in the poorest MENA countries. The region's education coefficient (average year of total schooling) did show a positive association with per capita emissions but was statistically insignificant. The diversity of the countries in MENA region categorized by oil-exporting nations with high-income and non-oil exporting nations with low to lower-middle income may cause the average year of total schooling to have different effect on per capita emissions. A study by Akkari (2004) found the mean years of schooling in the Gulf countries are lower than the rest of the Third World countries in spite of their per capita GDP being much higher.

5. Conclusion

This paper examines the potential factors identified to be the key determinants of CO_2 emissions for the MENA region over the period of 1971–2009. The results show per capita gross domestic product (GDP), energy consumption based on fossil fuel (EFF), foreign direct investment (FDI) and agriculture production (AGR) have significant impact on the growth of carbon emissions in the region. Since GDP per capita, EFF, FDI and AGR are critical factors leading to higher carbon dioxide emissions, any policy prescriptions should centre on these variables. It is undeniable economic growth remains a necessity to eliminate poverty in this region yet energy usage sequentially is essential in order to generate growth. Being highly dependent on fossil type energy sources such as oil a high carbon emission is expected

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[‡] Trade liberalization and poverty in the Middle East and North Africa. International Food Policy Institute (IFPI), 2010.

[§] Revisiting urban planning in the Middle East North Africa Region by Dr Mostafa Madbouly for Global Report on Human Settlements 2009.

[**] State of the World's Cities: Trends in Middle East & North Africa Urbanization & Metropolitanization. United Nations Human Settlements Programme (UN-HABITAT).

which is harmful to the environment. Thus the region may need to embrace more energy conservation policies in order to reduce their emissions level.

A proper way is for the government to initiate and develop an environmental friendly atmosphere to educate their population the importance of protecting their environment. Energy should be efficiently allocated into more productive sectors of the economy without jeopardizing their economic growth. Having stringent environmental and energy policy regulated nationally would help monitoring the agriculture sector including as well the inflows of FDI. They should include them as part of their long-term policy agenda in developing their strategic development plan. The main implication is that as incomes in these countries grow, without any form of regulated environmental policies, the countries in this region will end up increasing further their level of CO_2 emissions.

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Appendix

A.1. List of Middle East and North African (MENA) countries

Algeria, Bahrain, Djibouti, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Syria, Tunisia, UAE & Yemen.