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Economic and Environmental Factors Determining the Amount of Carbon Dioxide Emissions in the MENA Countries

Alireza Tamizi*
Assistant Professor, Department of Economic Sciences, Payam Noor University, Iran

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Abstract: The gradual warming of the earth and its negative environmental and economic impacts contributed to pay attention to sustainable development considerably. Since climate change is a major cause of greenhouse gas emissions, including CO2, countries are seeking to prevent the rapid growth of emissions to reduce global climate change. Accordingly, and considering the importance of the subject, the present study examines the effects of variables such as per capita income, population, energy consumption structure, energy intensity, degree of trade openness, industry share of GDP on carbon dioxide emissions in MENA countries, during 1993-2015 based on the regression model of population stochastic effects, Stochastic Impacts by Regression on Population, Affluence and Technology (STRIPAT) and Spatial Durbin Panel Data Model (SDPDM). The results of this study indicate that the logarithm of GDP, population, energy structure and energy intensity have a positive and significant effect on carbon dioxide emissions, and the degree of trade openness has a negative and significant effect on carbon emissions. In addition, the positive and significant effect of the intermittent spatial variable indicates that carbon emissions are highly relevant among different regions. In general, the results of model estimation show that attention is more important to spatial correlation, heterogeneity and external effects in policymaking.

Keywords: Carbon Dioxide Emission, Spatial Durbin Panel Data Model, STIRPAT
JEL Classification: C23, O13, Q53, Q5

* Corresponding author: al_tamizi@yahoo.com

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1- Introduction

In recent years, different parts of the world are involved with essential environmental issues because of climate changes. This phenomenon, which is seen in the form of gradual warming of the earth atmosphere, and caused by greenhouse gases emissions in the atmosphere, has many negative effects on economy and people's quality of life. Among greenhouse gases, CO_2 is the most important one and about 60 percent of the greenhouse effects caused by human activities relates to the release of CO_2. Therefore, and according to essential importance of the subject, nowadays, reducing greenhouse gases emissions and atmospheric pollutants is the important goal of sustainable development policies in all countries. In order to do this effectively, the most important step is to recognize affective determinants of greenhouse gases emissions including carbon dioxide. Several studies have been conducted on the factors affecting greenhouse gases emissions and their impact. These factors have direct effects on the policies and strategies of countries to reduce CO2. It clarifies importance of further attention to the proper investigating of effective factors. Several studies have investigated determinants of environment quality, and have considered the effect and contribution of economic variables and different demographic variables including population size, urbanization rate, etc. on the amount of emissions of pollutants. Different results have been obtained (Liddle et al., 2015; Long et al, 2015; Wang et al., 2012). In these studies, population growth, among the factors like changes in consumption pattern, production methods, and economic activities enhancement, is known as the main determinants of greenhouse gases emissions and has a significant role in increasing average earth temperature. It is worth noting that most of the domestic studies had focused only on the impact of economic growth and energy on the environment. This study, however, intends to investigate the impact of factors such as the population scale and the economic structure of the society on carbon dioxide emissions and the quality of the environment, in addition to mentioned items. Moreover, another important point is that the issues such as air pollution and greenhouse gases emissions affect not only the diffuser areas themselves, but also the adjacent areas.

Accordingly, and given the necessity of analyzing the determinants of greenhouse gases emissions, in particular carbon dioxide, especially in average- and low-income countries, the question is that which factors affect carbon dioxide emissions. Another question is that whether spatial effects also influence greenhouse gas emissions. Therefore, this study aims to answer the questions in the selected MENA countries during 1993-2015. The organizing of the study is that the second and third sections are devoted to a review of theoretical and empirical literature; in Section 4, the methodology will be explained; in Section 5, experimental results are presented, and Section 6, will conclude and make suggestions.

2- Literature Review

a) Foreign Researches

This section is dedicated to a brief review of empirical studies on the effect of different socio-economic factors on environment. They include following studies:

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Poumanyvong et al., (2010) investigated urbanization effects on energy consumption and greenhouse gases emissions in a sample of 99 countries. In this study, different stages of development were investigated during 1975-2005 using the STIRPAT model and panel data. The results indicate that urbanization has a positive effect on carbon emissions in all income groups. This effect, however, in the average-income group is much more than other groups.

Zhu & Peng (2012) investigated the effects of population size, population structure and consumption level on greenhouse gases emissions in China based on STARPAT model during 1978-2007. The results indicate that changes in consumption level and population structure are known as the affecting factors on the level of greenhouse gases emissions, and population size has no effect on the spread of pollutant emissions.

Wang et al., (2012), investigated the effects of urbanization rate, economic growth, industrialization ratio, energy intensity and R&D on the amount of greenhouse gases emissions in Beijing using STIRPAT. This model was investigated using partial least squares regression. The results indicate that the urbanization rate, economic growth and industrialization have positive effect on CO_2 emissions, while energy intensity and R&D have negative effects on the pollutants emission. In addition, CO_2 emissions increase along with the GDP per capita growth, which does not support the Kuznets' environmental curve model hypothesis.

Wang & Zhao (2015) investigated effective factors on CO_2 production including energy consumption, population, economic growth, technology level, urbanization, industrialization, and the degree of international trade at the provinces of China, according to three different levels of economic development (GDP per capita) during 1997 – 2012. The results of STIRPAT model estimation indicate that the effect of energy intensity on pollutant emissions is higher in developed regions. However, urbanization, industrialization and the degree of international trade have greater effects in developed regions compared to developing regions. The effect of population and GDP per capita on carbon emissions in developing region is higher than other regions. Accordingly, the results indicate that different actions should be done in order to reduce CO_2 according to local conditions of different regions.

Mate Balogh & Jambor (2017) investigated the causes of carbon dioxide emissions using GMM econometric approach in 168 countries during 24-year period 2013-19900, and confirmed the Kuznetz curve theory. They also found that the production of nuclear energy and renewable energy play a positive role in reducing carbon dioxide emissions. In addition, tourism expansion and international trade will result in an increase in CO_2 emissions. In addition, financial development will reduce the pollutants emissions.

b) Iranian Researches

Fitros et al., (2012), have studied and compared the urbanization effect on energy consumption and carbon dioxide emissions based on random effects model by regression on population, resources and technology. To this end, models have been estimated using the panel data of 18 countries during 1990-2007. The results indicate that the effect of urbanization growth on the amount of energy consumption

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and carbon dioxide is positive and significant in both selected country groups.

Sadeghi & Ebrahimi (2013), investigated the effect of financial development, gross domestic product, and energy consumption on carbon dioxide emissions during 1971-2008 in Iran using ARDL approach. The results suggest that financial development have positive effect on pollutant emissions in the short and long term. Also gross domestic product, energy consumption and commercial release have positive and significant effects on carbon dioxide emissions in the long term. In addition, the results confirm the environmental Kuzents' curve for Iran in the short and long term.

Mohammadi & Tirgary (2013) investigated the effect of trade expansion and the economic growth on the environment quality for 11 Middle Eastern countries during 1980 to 2010 using panel data. The results indicate that per capita income has a positive and significant effect on the amount of pollution and further increase in the per capita income causes a decrease in the environmental pollution. Commercial release has also negative insignificant effect on environmental pollution.

Sadeghi et al (2013) investigated the induction effect of energy price on the technology change and the amount of pollution emissions in Iranian industries during 1995-2007. The results indicate that there is not a specific relationship between the relative prices of energy and technology change in Iran during the study period and also there is a direct relationship between the relative prices of energy and pollution emissions during the study period.

Fallahi & Hekmati (2013) identify the economic and social factors affecting on environmental pollution during 2003-2007 in the provinces of the country. The results suggest that energy intensity, real per capita income, population size, and urbanization rate are the most important social and economic factors affecting on environmental pollution, so that the elasticity of co2 per capita emissions relative to these factors are obtained respectively 0.71, 0.95, 1.34 and 1.68.

Mohammadzadeh & Akbari (2014) investigated the determinants of carbon dioxide emissions by the urban households using the integrated data method and Hackman two-stage method and household income-expenditure data in 2009, and found that demand for natural gas, electricity and transportation have a positive and significant effects on carbon dioxide emissions. In addition, factors such as income, household size and supervisor age have a positive and significant correlation with carbon dioxide emissions.

Behbudi et al., (2015) investigated and estimated the effect of trade on the environment of OPEC countries during 1980-2005 using the panel data approach. The results of the model imply the negative effect of trade on the environment in the countries under study. In addition, according to the findings, Kuznets environmental hypothesis is not rejected. However, the pollution haven hypothesis is rejected.

Tamizi (2015) investigated the effects of the factors affecting on carbon dioxide in developing countries using the Bayesian econometric approach during the 23-year period data of 1992-2014. The results of this study indicate that energy consumption, electricity consumption

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and the variables related to industrialization have positive and almost important relationships with carbon dioxide emissions. In return, literacy rate and income inequality have had decreasing effects on CO_2 emissions.

Alishiri et al., (2017) study the factors affecting carbon dioxide emissions in the country using the data during 2001- 2012 and applying modified Laspeyre analysis approach. Their study results suggest that an increase in carbon dioxide emissions is inevitable with the industrialization current method. In addition, the effect of the emissions intensity is negative in three sectors of domestic and commercial, industry and agriculture.

3- Theoretical Background

Environmental Kuznets Curve hypothesis (EKC) based on investigating the relationship between economic growth and environmental degradation can be referred as the base of theoretical literature of environmental economics. This hypothesis implies the existence of an inverse U-relationship between these two variables. Further studies have indicated that in addition to economic growth, other factors such as population, technology, wealth and abundance of resources, energy structure, and economic structure of different countries affect the environmental variables; but these factors provide different roles in explaining it.

According to Shi (2003), the concern about the impact of population pressure on the environmental quality can be anticipated due to the population changes and lack of natural resources. There are two different points of view on the impact of population growth on the environmental quality: Boserup (1965 and 1981) states that population growth can reduce the negative impact on environment by stimulating technological innovation. In particular, according to Shi, increasing population density is a precondition for technological advances in agriculture. As a result, Malthus's followers predict that the effect of population on greenhouse gases emissions is a direct relationship, while Basrup's followers believe that there is not such a relationship or has a negative stretch, if any.

Duncan (1959) investigated the effect of population size variable (P) along with the variables such as organization (O) and technology (T) on environment (E) for the first time. This model is called POET and has been used as the best environmental macro system widely in recent decades. This model enable environment to be evaluated as a dependent variable relative to demographic characteristics and economic consequences. Then, Ehrlich and Holdren emphasized the effect of population size on environment using IPAT model more than before; this model investigates the relationships of social, economic and environmental variables, so that population size (P) along with abundance or wealth which is measured by GDP index and technology (T) have been known the main factors affecting environment.

Saturn believes that population has a negative effect on carbon dioxide emissions through impact on productive and consuming activities (Satterthwaite, 2009).

According to Commoner, technology and industrialization (T) not only can be used as a useful tool for environment, but also is the most important factor of environmental negative effects. This theory, however, inserts an optimistic perspective of technology in IPAT equation. Based on this attitude, technology can be

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raised as a compensatory factor to reduce the negative environmental effects of the population increase and economic growth and development. IPAT equation can determine key factors of environmental changes and identify the relationship among factors and the effects of the variables. In addition, IPAT shows that the basic factors of the environmental effects are independent to each other and one factor cannot determine the environmental effects (York et al, 2003).

Ozstarck & Ajarojy (2012) state that the effect of international trade volume on energy consumption and carbon dioxide emission is affected by the fact that what goods are imported and exported in each country. If the exports are energy consumer, products of heavy industries and environmental destructive products, exports have destructive effect on the environment of the country. On the other hand, if the exports are from the product group with high technology and basic knowledge, they do not have destructive effect on environmental quality. In addition, if the imports are of capital goods with efficient technology and modern production methods, it can result in improving efficiency of energy consumption and reducing carbon dioxide emissions in the country (Ozturk & Acaravci, 2012).

International trade also influences environmental pollution in several ways. On the other hand, hypothesis of the pollution haven hypothesis (PHH) suggests that environmental hardenings between developing and developed countries encourage the developing countries to be specialized and obtain the relative benefits in production of environmental pollutant goods. In the other words, based on this hypothesis, since developed countries apply more severe environmental policies than developing countries, active polluting industries in developed countries transfer their operation and process to developing countries. Thus, developing countries are becoming a haven for absorbing polluting industries (Delphan, 2012). On the other hand, as Col and Neumayer (2004) pointed out, trade can decrease emissions of pollutant because of the more competitive pressures and the more access to green technology (Col & Neumayer, 2004).

Coondoo & Dinda about factors affecting the quality of environment believe that environmental quality is determined, as a public good, by relative power of community interest groups. This relative power is influenced by and dependent on income structure, the amount of income inequality and other social and economic inequalities. Moreover, people preferences for the use of consumer goods or public goods such as clean environment depend on the final rate of substitution between the consumption of private goods and the quality of the environment, as well as individual incomes. As income grows, the quality of the environment changes from one commodity to a luxury commodity (Coondoo & Dinda, 2008).

4- Research Methodology

The IPAT equation (population, welfare and technology effects), presented by Erlik and Holderen (1970), often studies the impact of human activities on environment. This equation is usually written using P, A, and T as follows:

$$I=PAT \tag{1}$$

Where I, P, A and T are environmental effects, population size, prosperity and wealth per capita (gross per capita GDP)

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and technology level, respectively. The ability of this equation is to identify key factors of environmental changes and also to investigate the relationships between factors and variables effects. This equation is developed by Scholes (2006). The IPAT equation allows us to investigate the role of a specific factor on environmental change, ceteris paribus. In addition, there is a proportional relationship in this model; so that if the population double, the effect will double as well, ceteris paribus. While the relationship between effective factors and the amount of pollutant emissions is usually non-linear and disproportionate. Therefore, it is seen that this equation is limited to the concept of accounting equation and there is no ability to do broader hypothesis test (York et al., 2003).

In response to such limitations, the IPAT equation was re-formulated in random conditions by Dietz and Rosa (1997) which allowed it be used empirically in the test of hypotheses. The new relationship is known as STIRPAT model, which represents the random effects of population, welfare and technology on the environment. On the other hand, this model can be developed by introducing different political, social and cultural factors (York et al, 2003). The new equation is composed as follows:

$$I_i = aP_i^b A_i^c T_i^d e_i \tag{2}$$

In this equation, the constant (a), as a model scale, is dimension in three factors: population, abundance and technology equal to (b,c,d) and also i, as a subtitle of I, P, A, and T, represents the difference in the values of the observed units. The error terms (e) or the residuals represent the deviation in the observed units. The term T is usually considered to be the remainder (e). The reason is that there is no operational definition or even an index related to T which is widely accepted. If a=b=c=d=1, STIRPAT model will be equivalent to the IPAT model. Incorporation of coefficients in STIRPAT model allows us to examine the disproportionate effects of factors affecting the pollutant emissions (Liu et al, 2014). By taking the natural logarithm on both sides of this equation, the equation 3 will be as follows:

$$\ln I = \ln a + b(\ln P) + c(\ln A) + d(\ln T) + \ln e \tag{3}$$

The coefficients in Equation 3 are interpreted as elasticity between independent and dependent variables. This model allows us to estimate the coefficients as well as analyzing the factors affecting environmental quality. In the present study, the effects of variables such as industrialization, energy consumption structure, energy intensity, economic growth and population on greenhouse gases emissions are investigated based on STRIPAT model.

Econometric Model

The method used in this study is spatial econometric method in which spatial panel data are used. The panel data is a combination of time series and cross-sectional series data that make it possible to investigate a large number of sections in a short period or large number of sections over a long period. Experimental analyzes in panel data are more important than other data. Anselin in 1988 introduced an econometric method that included the facts of spatial economics, for the first time. He states that the conventional econometric method which is based on the Gass-Markov assumption, is not suitable for regional studies, because in regional studies data, researcher is confronted with 2 issues of spatial

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dependence between observations and spatial anisotropy in the model; because the researcher on regional studies data is confronted with two phenomena and the problem of spatial dependence between observations and spatial heterogeneity in the model (Anselin, 1988).

Spacial dependence means that the observation of spatial area of i depends on other observations of the spatial area j. The spatial heterogeneity which is resulted from the relationships or parameters of the model, changes with the movement on coordinate page along with the sample data (Akbari & Asgari, 2001). To solve the problem, Etselin (1988) used the maximum likelihood method to estimate the model parameters. This study uses the adjacency which reflects the relative position of a regional unit observed at the level of geographic spatial locations, relative to other spatial units in order to determine the location and to form weighting spatial matrix, that is, for countries which have an adjacent to the desired country, number one, and in the case of non-neighboring, number zero is set. The resulting matrices which are the same as the adjacency matrix, are symmetric, and the main diameter elements of this matrix are always zero.

In spatial econometric models, the weighting spatial matrix or adjacency matrix is considered in order to illustrate the effect of adjacent observations is considered as the explanatory variable. There are several methods to form the adjacency matrix that the linear adjacency, loop-like, two-way linear, two-way loop-like and queen-like are the most important ones. In the adjacency matrix, the elements on the original diameter are zero and if the countries are adjacent of each other, the elements outside the main diameter take one. After the formation of the adjacency matrix, the standard matrix of it, known as the weighting space matrix, should be used to estimate the model.

In this matrix, standardization is done based on the sum of the rows of the adjacency matrix, and each of the adjacency matrix elements is divided over the sum of the matrix rows. The created matrix in this way is called first-order standardized adjacency matrix. A new variable is obtained by standardizing the adjacency matrix and multiplying it by the vector of the dependent variable; which shows the average of neighboring and adjacent regions observations and is called spatial lag. The model of spatial Durbin is a comprehensive spatial econometric model that includes spatial interruption of both dependent variable and independent variables.

5- Results

Regional Effects of Carbon Dioxide Emissions Overflow

One of the methods to investigate and test the existence of overflow effects is the use of the estimation point of one or more spatial regressions. However, Lesage and Pace (2009) argue that the estimation of multiple spatial regression points cause unbiased prediction of overflow effects. They often decompose the effects of overflow into two parts of direct and indirect effects.

The Spatial Durbin Panel Data Model (SDPDM) can be defined as follows:

(4)

$$Y_{it} = \delta \sum_{j=1}^{N} w_{ij} Y_{it} + \alpha + \sum_{i=1}^{m} \beta_i X_{it} + \sum_{j=1}^{N} wi_j Xi_{jt} \theta + \mu_i + \lambda_t + \varepsilon_{it}$$

$$Y_{it} = \delta W Y_{it} + X_{it}\beta + W X_{it}\theta + \mu_i + \lambda_t + \varepsilon_{it}$$

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$$Y_{it} = (I-\delta W)^{-1}(X_{it}\beta + WX_{it}\theta) + (I-\delta W)^{-1}\mu_i + (I-\delta W)^{-1}\lambda_t + (I-\delta W)^{-1}$$

Where Y_{it} is the independent variable of the region i in the period t, X_{it} is the vector of independent variables in the period t, α shows the intercept, the parameter θ like β is the K × 1 vector of the coefficients, μ_i is the individual fixed effects, λ_t is the time foxed effects. With respect to the partial derivatives of k_{th} independent variable X on both sides, the following relations are resulted:

$$\begin{bmatrix}\frac{\partial Y}{\partial x_{ik}} & \cdots & \frac{\partial Y}{\partial X_{Nk}}\end{bmatrix} = \begin{bmatrix}\frac{\partial y_1}{\partial x_{ik}} & \cdots & \frac{\partial y_1}{\partial x_{ik}} \\ \vdots & \ddots & \vdots \\ \frac{\partial y_N}{\partial x_{ik}} & \cdots & \frac{\partial y_N}{\partial x_{ik}}\end{bmatrix} = (I-\delta W)^{-1}\begin{bmatrix}\beta_k & w_{12}\theta_k & \cdots & w_{1N}\theta_k \\ w_{21}\theta_k & \beta_k & \cdots & w_{2N}\theta_k \\ \cdots & \cdots & \cdots & \cdots \\ w_{N1}\theta_k & w_{N2}\theta_k & \cdots & \beta_k\end{bmatrix} \quad (5)$$

In this equation, w_{ij}, (i,j) are the matrix elements. Direct effects are defined as the sum of the right elements of the defined matrix diameter while the indirect effect is defined as the average of other elements except the diagonal elements (27). The problem of calculation method of the direct and indirect effects is time-consuming of the calculation$(I-\delta W)^{-1}$. In order to solve this problem, Le Sage and Pace (2009) have proposed another method that is as follows:

$$(I-\delta W)^{-1} = I + \delta W + \delta^2 W^2 + \delta^2 W^2 + \cdots \quad (6)$$

The equations are used to examine direct, indirect and total effects.

Introduction of Research Model and Statistical Database

Based on theoretical literature and empirical studies such as Liu et al., (2014), in this study, the spatial Durbin panel data model is used to study the effect of factors such as per capita income, population, energy consumption structure, energy intensity, degree of trade openness, industry share of GDP on carbon dioxide emissions in countries in the Middle East and North Africa.

$$LnCO_{2it} = \alpha l + \beta_1 Ln(P) + \beta_2 Ln(OPEN) + \beta_3 Ln(GDP) + \beta_4 Ln(EI) + \beta_5 Ln(EC) + \beta_6 Ln(IS) + \varepsilon$$

Where $LnCO_2$: carbon dioxide emissions logarithm; LnGDP: logarithm of per capita GDP; LnIS: logarithm of industrial production ratio to GDP logarithm; LnEI: logarithm of energy intensity logarithm (consumption energy raitio to GDP); LnP: logarithm of population; LnEC: logarithm of energy consumption structure; LnOPEN: logarithm of openness degree and αl is the individual effects of each studied countries and l represents the vector n×1 which includes number 1. It is worth noting that statistics and information related to these variables are extracted from world development indicators for period 1994-2013. At first, the spatial Durbin model for panel data was estimated and then the Moran's test is used to examine the existence of spatial self-correlation among error terms.

In these tests, the null hypothesis implies that there is no spatial autocorrelation among the error terms and if the hypothesis is rejected, spatial autocorrelation is confirmed in the error terms.

In a lagged spatial system, it is assumed that the value of the dependent variable in a particular location is determined by the weighting spatial average of the total value of the dependent variable. Such models cannot be estimated by conventional econometric methods such as OLS and due to the occurrence of the coincidence problem among variables, the maximum likelihood method is used to estimate the model parameters. Using this method leads to unbiased and consistent estimators. In this study, spatial econometric method is used to study the effective factors on the emission of pollutants. Based on the

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generalized STIRPAT model, the spatial econometric model is formed given the fact that carbon dioxide emissions are heterogeneous and spatially correlated across regions and industries. The econometric model of spatial panel data, which integrates spatial econometrics (spatial effects) and panel data (time effect), makes spatial econometric analysis more efficient.

Therefore, the Spatial Durbin Panel Data Model in this study is as follows:

$$\begin{aligned} LnCO_{2it} &= \alpha l + \delta \sum w_{ij} LnCO_{2it} + \alpha + \beta_1(\ln p_{it}) \\ &+ \beta_2(\ln OPEN_{it}) + \beta_3(\ln GDP_{it}) + \beta_4(\ln EI_{it}) \\ &+ \beta_5(\ln IS_{it}) + \beta_6(\ln EC_{it}) + \theta_1 \sum w_{ij} \ln P_{ijt} \\ &+ \theta_2 \sum w_{ij} \ln OPEN_{ijt} + \theta_3 \sum w_{ij} \ln GDP_{ijt} \\ &+ \theta_4 \sum w_{ij} \ln EI_{ijt} + \theta_5 \sum w_{ij} \ln IS_{ijt} \\ &+ \theta_6 \sum w_{ij} \ln EC_{ijt} + \varepsilon_{it} \end{aligned}$$

$\sum w_{it} \ln CS_{it-1}$ represents the spatial correlation of the dependent variable between each region and its adjacent regions. The parameter of δ represents the spatial autocorrelation and w_{ij} is an element of the weighting spatial matrix, which expresses the spatial relationship between region i and j.

The developed STRIPAT model investigates the effect of independent variables on carbon dioxide emissions not only in the region, but also in the adjacent region. In addition, this model also measures the effects of carbon dioxide emissions of adjacent region on carbon dioxide emissions intensity of the region.

Model Estimation and Analysis of Research Findings

Before estimating the model, it is necessary to evaluate the data used. This study is conducted for 20 countries of the Middle East and North Africa region (MENA) during 1994-2013. The statistical analysis of carbon dioxide per capita emissions (Figure 1) shows that Iran, Saudi Arabia and Turkey have the highest CO_2 emission level in this statistical society, respectively. In contrast, Djibouti, Sudan and Lebanon have the lowest CO_2 emissions. Figure 2 shows the distribution of pollutant emissions versus population size. It is seen that most of low-income countries are in the lower part of this upward chart. In contrast, countries such as Iran, Turkey and Egypt with higher population levels have a greater amount of pollutant emissions and are distributed in the upper parts of this curve. According to the statistical distribution, the hypothesis in STRIPAT equation based on the positive effect of the population on the pollutants emissions is confirmed. On the other hand, figure 3 indicates that a higher level of energy consumption causes higher pollutant emissions. Therefore, those Countries such as Iran and Saudi Arabia, with high-energy consumption, are at the top and bottom of this curve. Figure 4 shows the average distribution of the pollutant emission for the real income variable (GDP). In this chart, Turkey is located in the descending part of inversed U shape, so that in addition to high income, CO_2 emissions are lower in the country; as a result, the relationship between GDP and pollutant emissions seems in the form of inversed U shape. However many of the studied countries are at the first of this chart and its ascendant part. Accordingly, Kuznets' environmental curve hypothesis is not confirmed graphically in the studies sample.

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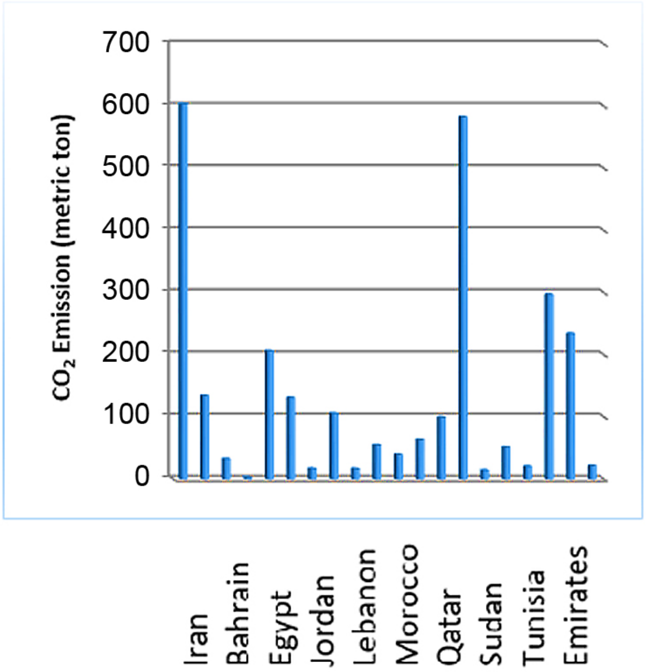

Fig1. CO_2 emissions of MENA countries in 2012
Source: (WDI)

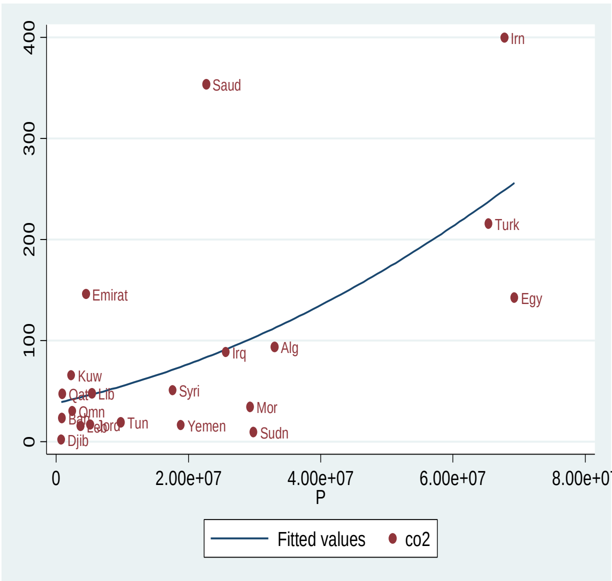

Fig2. The average distribution of pollutant emissions (CO_2) versus the average population size (P)
Source: (WDI)

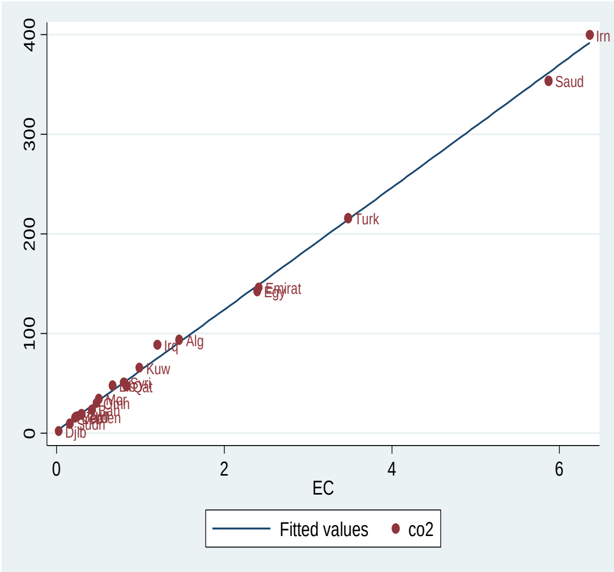

Fig3. The average distribution of pollutant emissions (CO_2) versus the average energy consumption

Source: (WDI)

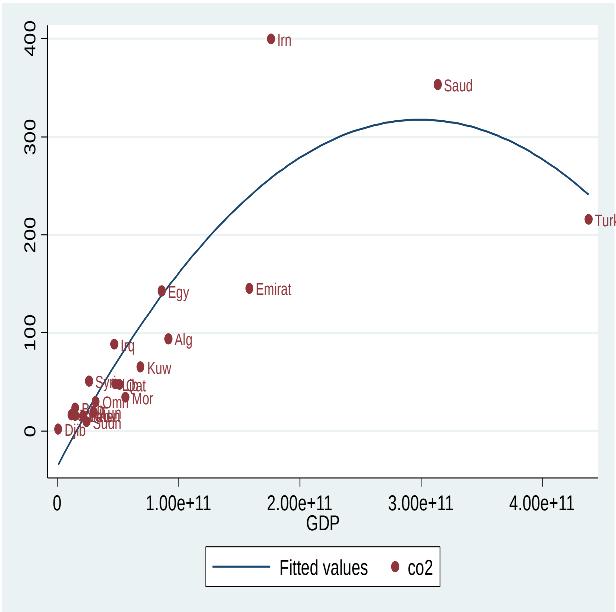

Fig4. The average distribution of pollutant emissions (CO_2) versus the average real income (GDP)

Source: (WDI)

In spatial econometric models, it is better to consider a general model first and then the tests related to spatial dependency and spatial autocorrelation among error term to investigated and finally to state which model is better for studying. In this part, it is necessary to examine spatial dependency and existence of autocorrelation among error terms before estimating the study model. For this purpose, the LM and Morelins tests have been used. The results of LM test are shown in table 1:

Table1. The statistic results of LM test for the significance of the effect of spatial dependency

P-value	Degree of freedom	χ^2 statistics
0.03	1	4.48

The results in table 1 shows that null hypothesis based on insignificance of spatial dependency among observations in the significant level 1% is rejected and so spatial dependency among observations is confirmed. In the next step autocorrelation among error terms is examined using Moran's test. The results of the test are as follows:

Table2. The results of Moran's test for spatial autocorrelation test among error terms

Probability value	Degrees of freedom	Statistics amount
0.28	1	1.07

Based on the results in the table 2, it can be stated that null hypothesis, which implies the absence of spatial autocorrelation among error terms, is not rejected in significant level 1% and so there is not spatial autocorrelation among error terms. Now, spatial Durbin model is used to investigate convergence of the income regions considering spatial dependency among observes. In this model, adjacency matrix is formed for 20 studied countries during 1993-2012, and it is set to zero for neighboring and adjacent countries and one for nonadjacent countries. So the adjacency matrix is a symmetric 20×20 matrix with the elements of zero on the main diameter and the elements of one or zero out of the main diameter. First-order standardized contiguity matrix is used to define weighting spatial matrix. In this matrix, standardization is based on the sum of each row of the adjacency matrix. The empirical model of research is estimated after forming the weighting spatial matrix. The results of model estimation are shown in table 3:

Table3. the results of the model estimation by spatial Durbin method (SDM) of dependent variable of per capita income growth

explanatory variables	coefficient	Amount of Z	Probability value
Width from source	-14.03	-22.40	0.000
logarithm of GDP	0.48	13.91	0.000
logarithm of population	0.81	5.92	0.000
logarithm of energy intensity	0.37	8.56	0.000
logarithm of ratio of industrial production to GDP	0.64	12.06	0.000
Logarithm of energy consumption structure	0.31	2.55	0.01
Logarithm of commercial openness degree	-0.076	-2.32	0.02
spatial logged of logarithm of GDP	-0.05	-5.81	0.000
Population spatial logged	0.001	0.13	0.89
Spatial logged of the logarithm of the ratio of industrial production to GDP	0.05	3.25	0.001
Spatial logged of energy intensity	0.009	0.95	0.34
Spatial logged of energy consumption structure	0.08	5.29	0.000
Spatial logged of commercial openness degree	0.02	2.26	0.024
Spatial dependence (ρ)	0.021	2.26	0.003
Error variance (σ^2)	0.19	18.11	0.000
Coefficient of determination (R^2)	0.98	-	-

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The results of the model estimation using SDM show that the coefficient related to the logarithm of GDP has a positive and significant effect on the carbon dioxide emissions. That is, increasing economic growth leads to an increase in carbon dioxide emissions. The negative and significant coefficients of the spatial logged of the logarithm of GDP (W × Log (GDP)) indicate that economic growth in some regions can affect the CO_2 emissions of other region through overflow effects. It also shows that the effects of economic development overflow on carbon intensity are higher than the carbon emission scale. Countries can save energy and reduce pollutant emissions by modifying the economic growth structure and shifting to a developmental path with low carbon dioxide emissions.

The effects of population size on carbon dioxide emissions is positive and significant, which shows that increasing population leads to the more intense of carbon emissions. Demand for energy consumption is increasing dramatically with population growth that, in turn, generates more greenhouse gas emissions. Energy saving and reduction of pollutant emission have become an important aspect in adjusting the structure of the economies of the countries and their development path. The logarithm of the rate of industrial production to GDP has a positive and significant effect on carbon dioxide emissions.

Therefore, in order to achieve the goal of reducing greenhouse gases emissions, countries need to adjust their economic structure and pay attention to the development of high technology and modern service industries that produce lower emission levels. On the other hand, the effects of industrial structure overflow on carbon emissions level are positive and significant. This shows that the effect of industrial structure overflow on carbon emissions intensity exist. Several indexes of carbon emissions intensity in energy production and consumption step for countries have been proposed as incentives to adjust the structure and strategies of energy production and consumption that could reduce carbon emissions.

Coefficient of the energy consumption structure is positive and significant, that means the changes in energy consumption structure related to non-fossil energy such as wind, nuclear, solar and biomass. The use of gas should be increased by adjusting industrial policy and international trade policies. In addition, the positive and significant the spatial logged of the energy consumption structure reflects the effects of carbon dioxide emissions overflow which results from an increase in energy consumption. The logarithm of the trade openness degree, however, has negative and significant effect on CO_2 emissions. The process of globalization and open policies applied in countries drives the economy of these countries forward and provides many achievements. The results show that the coefficients of many independent variables are significant and their signs are as expected. The coefficient of spatial logged is also positive and significant. This indicates that carbon dioxide emissions in different regions are related to each other.

The variable energy intensity has positive and significant effect on carbon dioxide emissions, which indicates that the technology innovation in the MENA region and the corresponding reduction of energy intensity can be a major contributor to reduce carbon dioxide emissions. Since

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adjusting industry structure and energy consumption is difficult, target counties need to look for appropriate ways as the technology innovation to improve energy efficiency and reduce carbon emissions. Developing low carbon emissions technologies such as energy alternative clean technologies, renewable energy technology and new energies, which are in the process of discovering energy, evolution and surveying applications currently, will have significant support to achieve the goal of reducing pollutant emissions by 2020. In general, the reduction in the energy intensity is resulted from the technology innovation that, in turn, can affect the carbon emissions intensity. Since the coefficient W × Log (EI) is positive but not significant, there is no spatial overflow for energy intensity on carbon dioxide emissions. The reason can be that the flow of carbon emissions from one region to another is difficult to come true. The imitation of development of co2 emissions reducing technologies is largely influenced by regional, economic development and innovation capability.

Table4. The results of direct, indirect, and total effects

Explanatory Variables	Direct Effect	Indirect Effect	Total Effect
Logarithm of primary income	0.61	-0.10	0.51
Logarithm of population	0.87	-0.14	0.73
Logarithm of energy intensity	0.47	-0.08	0.39
Logarithm of the ratio of industrial production to GDP	0.80	-0.13	0.67
Logarithm of energy consumption structure	0.48	-0.07	0.40
Logarithm of commercial openness degree	-0.24	0.04	-0.20

The results of the direct, indirect and total effects indicate that the direct and total effects related to all variables are positive but their indirect effects are negative. Just for trade openness degree, the direct and total effects are negative and the indirect effects are positive.

6- Conclusion and Discussion

In this study the factor affecting the scale and intensity of pollutants emissions in MENA countries have been evaluated in the regional level, using generalized regression model of the random effects of population, welfare and technology (STRIPAT). Accordingly, spatial Durbin model with panel data of countries during 1994 -2013 was used to study the effects of the factors affecting carbon dioxide emissions and the spatial correlation between carbon emissions and the effects of the overflows of these factors. The results suggest that:

The results of the model estimation show that the logarithm of GDP has a positive and significant effect on CO2 emissions. This means that with the increase in per capita income, carbon dioxide emissions will also increase. This may be because most MENA countries are at a low level of development and have not reached the desired level of development yet. Therefore, according to Kuznets, as growth and development in these countries increases, pollution and emissions of greenhouse gases increase. As expected, population size also was positively correlated to CO2 emissions. An increase in human population rises human malnutrition. It resulted in some damages in the environment. As expected, the structure of energy consumption and

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energy intensity also has a positive and significant effect on carbon dioxide emissions. Trade openness also has a significant and negative effect on CO2 emissions. Analysis shows that more attention to the spatial correlation, heterogeneity and external effects is very important in the policymaking. Carbon emissions control is not possible by reducing production, but a low carbon emissions path can be achieved by low energy consumption. Given the fact that carbon emissions vary among regions and industries, the following strategies are proposed to reduce carbon emissions by maintaining economic growth:

- Strengthening innovation in technology, optimizing the structure of the industry, expanding open policies for international trade and investment, choosing technologies with low CO2 emissions
- Thinking of arrangements to promote production technology and formulate energy saving models.
- Adopting incentive and punitive policies to optimize population levels
- Interregional policy-making by the governments of neighboring countries to reduce greenhouse gases emissions in the whole region related to per country.

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