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Regional Economic Growth and Spatial Spillover Effects in MENA Area

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Abstract

The main objective of this study is to estimate the spatial spillover effects of the economic growth among the selected countries of MENA region. For this purpose, the Spatial Durbin Model in the framework of spatial dynamic panel data was estimated during the period of 1970-2010. The spatial Diagnostic tests affirmed the occurrence of spatial positive autocorrelation phenomenon for the real per capita income. The obtained results indicated the positive spatial spillover of the economic growth among the MENA countries and the spatial elasticity of per capita GDP was estimated 0.39 percent. Also, according to visualization results, Iran has been surrounded by countries with high per capita income; so opportunity to benefit through the creation of artificial growth poles and economic collaboration with their adjacent countries is available for Iran. Other policy implications are discussed.

Keywords: Real Per Capita GDP, Convergence, Regional Spillover, MENA.
JEL Classification: R12, O47, O33.

1. Introduction

The Middle East region and North of Africa (abbreviated to MENA), have the geo-economic, geopolitical and geostrategic importance, and the energy resources existed in this area culminating in the focus of other countries on this region. According to the World Bank report, the Middle East and North of Africa regions are included in three groups of countries in terms of natural resources and labor force: A) countries that lack natural resources, but have abundant labor force, for instance Djibouti,

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Egypt, Jordan, Lebanon, Morocco and Tunisia, B) countries that are rich in terms of natural resources and have abundant labor force, such as Algeria, Iran, Iraq, Syria, and Yemen, and C) countries that are rich of natural resources, but devoid of labor force: like Bahrain, Kuwait, Libya, Oman, Qatar, Saudi Arabia, and United Arab Emirates. Furthermore, these countries are consisted of three groups in terms of development and economic efficiency: A) countries whose growth continuity is directly dependent on the price of their hydrocarbon materials, B) countries that belong to the non-oil society and are dependent on their food productions, C) countries which had been affected by the global financial market fluctuations, especially the US economic crisis. Tensions and regional unrest in the Arab spring and the Syrian civil war and their spillover to neighboring countries including Iraq have influenced the economic growth of the regional countries (Devarajan et al., 2014). In this regard, many studies exist to verify this entry that the economic situation of a country is affected not only by its inner performance, but also the performance of its neighboring countries (Pfaffermayr, 2009. Najafi Alamdarloo et al., 2013). Figure 1 demonstrates the spatial distribution of real per capita income of 27 countries of MENA region during 2012-2014. As observed, the distribution of real per capita GDP of these countries was heterogeneous in the two areas of Persian Gulf margin and North Africa. The countries in the margin of Persian Gulf had on average more real per capita income, whereas the countries of Northern Africa have on average less real per capita income.

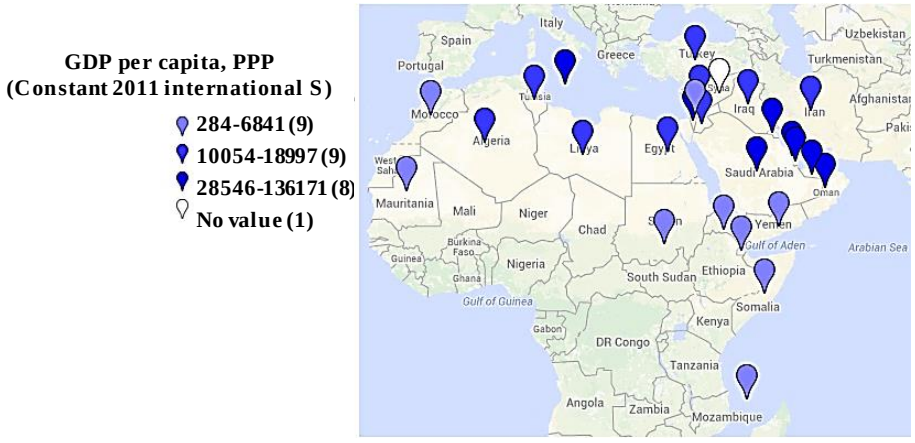

Figure 1: The Spatial Distribution of Per Capita GDP of 27 MENA Countries in 2012-2014(Averaging), Data Retrieved from Word Bank Online Database

Since the empirical works of Mankiw et al. (1992), many investigations have been conducted concerning the determinant factors of growth among countries. One of the factors which has been taken into account in recent years as an explaining factor of economic growth is adjacency and spatial position the countries. There is a fact that in the empirical investigations about the regional growth process, a region cannot be considered independent from other ones, because according to the *Tobler's first law of geography that "Everything is related to everything else, but near things are more related than distant things"*(Tobler, 1970). When we use in the research with data that has a local component, two issues are taking place, one for spatial dependence between the observations and the latter for the spatial heterogeneity in relationships intended to be modeling (Akbari, 2004). This subject later received the attention of many researchers in the social sciences, economics, geography, and biological sciences. Calculating the inter-unit (inter-regional) interactions in economic sciences is achieved through the creation of spatial weight matrices and considering of them in the classic econometric models. According to the econometric theories, not taking into account the spatial dependence and the spatial heterogeneity leads to the error of fitting estimation and thereby false statistical elicitation (Anselin, 1988).

The basics of growth models was firstly formed by Ramsey in 1928, and then developed by Solow and Swan in 1956. Exogenous growth models identified as a neoclassical growth model which is considered the basis for the growth models. In the neoclassical growth models with a diminishing marginal returns such as Solow and Swan (1956) and Cass and Koopmans (1965) models, the growth rate of per capita income of a country is reversely associated with the initial level of per capita income. Therefore in the absence of external shocks, poor and rich countries will be converged in terms of per capita income levels, and it can be expected that the other variables related to per capita income comply roughly with this rule (Makiyan and Khatami, 2011). On the other hand, the economy has assumed two parts in the neo-classic exogenous growth models, and a homogeneous commodity is produced and distributed between consumption and investment, therefore, in this model, the economies are independent of each other and would not affect each other, while the various regions

of the world are associated together in the form of knowledge and technology spillover, communications, mobility of production and trading factors, and in this case, the assumptions of Solow and Swan's neo-classic growth model were not established and we are forced to consider the relationship between countries in the presence of spatial dependence. Diverse empirical studies have been carried out in conjunction with economic convergence of the MENA region countries that can be pointed out in the studies of Andreano et al. (2013), Tunali and Yilanci (2010), Sameti et al. (2010), Makiyan and Khatami (2011), Najjarzadeh and Shaghaghi Shahri (2006), Khalili Araghi and Masoudi (2007) and Elahi and Nahavandian (2003). In these studies, the convergence has been investigated without considering the effects of the regional spillovers and the technology level in the sections (or countries) has been taken into account constant. The contributions of this study are the investigation of the convergence hypothesis of per capita income under the regional spatial spillover effects of economic growth and the consideration of time and country specific fixed effects in order to abandon Omitted Variable Bias (OVB). In fact, what is being looked for in this article is the answer to the main question of the research: whether the automatic positive cycle of economic growth is established in the countries of MENA region, or not? In other words, in this paper the theory of regional spillovers has been fitting because according to the Keller (2002), the spillovers desire to be regional as opposed to universal.

The continuation of current article has been set in this way; the background of the research is presented after stating the theoretical principles related to convergence (classic and spatial). In the following paragraphs of paper, the research methodology has been expressed and how to estimate the spatial spillover effects of economic growth and conditional convergence under the spatial dependence are explained. The results in the fifth part and finally the conclusion and policy suggestions have been given.

2. Theoretical Background

The most empirical studies about convergence include two conclusions in topic, one is microeconomics and marketing view and other is growth and macroeconomics. In the first approach, convergence is in

the form of purchasing power parity (PPP) and law of one price (LOOP) that is generated from market performance. In the second approach, convergence in the form of growth models and marginal diminishing return law and learning effects is presented. According to the law of one price, if there are no costs of transportation and trading obstacles, common goods in calculating with one unit joint currency ought to have common price in diverse countries or in provinces of one country. From theoretical point of view, profit searching and arbitrage operation equalize the price of common good in different countries. Convergence in the literature of growth economy is generated from the concepts of neoclassical growth model. Neoclassical growth theory predicts a long-run tendency toward convergence of output and income per capita across the world economy, because: (a) Technology is a global public good, so all countries should experience the same long-run rates of technical progress, (b) Diminishing returns imply that investment in rich countries should slow down while poor countries continue to accumulate, (c) International mobility of capital and labor, combined with commodity trade, should reinforce the market forces driving convergence toward common worldwide wage rates and profit rates, and hence common living standards (Bertram, 2004: 343-344). In endogenous growth models, even if the law of diminishing marginal returns is true, its effect is insignificant and the balanced growth path of the developed and developing countries is being divergent from each other. But, however the occurrence of convergence is feasible. In the endogenous growth model, the convergence is discussed in the form of technology absorption effects, or "learning effects". That means the imitation of technology is faster and less costly in comparison with the invention of technology. Based on endogenous growth models, the countries that have sufficient potential for technology attraction grow faster than other countries with high technology. Adam Smith who is a classic economist, mentioned in his endogenous growth theory that the new technology knowledge is either a public commodity or will be a public commodity, namely its essence is such that the usage of one does not preclude the use other and they are not refusal from others. In empirical studies, convergence concept is applicable for economical variants of per capita CO_2 emissions, Carbon Dioxide intensity, real per capita GDP, total factor productivity (TFP), consumer price index

(CPI), inflation, retail price of energy sources and energy intensity (or energy productivity). Making decisions about establishing or breakup regional blocs, market segmentation and fair environmental policies are important applications of convergence concept for governmental decision-makers and international organizations (Hamidi Razi and Feshari, 2015).

Among various tests of convergence hypothesis (such as σ-convergence, β-convergence, stochastic convergence, and distribution dynamics) only the β-convergence can provide comprehensive information regarding the future distribution of per capita GDP. β convergence (conditional and absolute) is one of the important and at the same time more attractive concepts in the context of the growth economy. Barro (1991) was the first person who estimated the growth model in the field of the cross-country econometrics and in this model; he fitted the factors effective on the economic growth in different countries. One of the factors that he applied in his study was the initial level effect of per capita income, which is known to the Beta convergence in the literature of growth economics. The convergence of β can be derived from the growth rate equation below:

$$\gamma_y = \frac{d[\ln y_t]}{dt} \cong -\beta.\left[\ln\left(\frac{y_t}{y^*}\right)\right] \quad (1)$$

In which, y_t is the per capita income of the country at time t, γ_y is the growth rate of per capita income and y^* is the per capita income at the steady state. β is also a factor which determines how fast y_t approximate to y^*. Equation (1) is a first order differential equation. By solving this equation for $\ln y_t$ we will have:

$$\ln(y_t) = \left(1 - e^{-\beta t}\right).\ln(y^*) + e^{-\beta t}.\ln(y_0) \quad (2)$$

In Equation (2), the level of the country's per capita income at the current time (y_t) is dependent on the initial level of income (y_0) and the level of income in a steady status (y^*) and β also represents the convergence speed towards the long-term steady state (Barro and Sala-i-Martin, 1995: 36–38). It is worth mentioning, if in the above model, the level of income in a steady status (y^*) is to be considered the same for all economies, the convergence obtained in this mode will be of absolute one and the β measures the speed of absolute

convergence. In contrast, generally this steady level is characterized by growth determinants ($y^* = x\beta + \varepsilon$), where in which x is explanatory variable vector such as saving rate, human capital, etc. Therefore, if the equation (2) fitted by accompanying of the explanatory and control variables, the convergence arisen in this case would be the conditional convergence. β also measures the speed of conditional convergence.

3. Literature Review

In this section, empirical studies associated with topic and methodology of this article has been expressed. Andreano et al. (2013) have evaluated the absolute and conditional beta convergence hypothesis of real per capita income using the data of 26 countries of MENA region during the period (1950-2007). According to the results, the absolute convergence hypothesis was not verified, but on the contrary, the conditional convergence was accepted, and 1.495 % of the gap between the current level and steady state of per capita income countries disappears every year. Also, they used of environmental, demographic, human capital and foreign trade variables as conditional variables. Sameti et al. (2010) in their study investigated real per capita income convergence of 22 countries of MENA region during the period (1970-2003) with artificial neural networks approach. According to their results, artificial neural networks have less error in the convergence prediction and both of absolute and conditional convergences were accepted despite being of a lower convergence rate.

Some studies have been used (panel or time series) unit root tests for searching convergence (stochastic convergence). Tunali and Ilanji (2013) examined real per capita income convergence hypothesis of 19 selected countries of MENA region their study using nonlinear unit root tests for during the time (1950-2006). According to their outcomes, all countries except Iraq were divergent relative to the cross-sectional average and the process of per capita income was just catching up to the cross-sectional average was accepted for Iraq. Similarly, Serranito (2011) in his study investigated real per capita income of 8 MENA countries and the hypothesis of per capita income catching up of these countries to the per capita income level of the EU

during the time interval (1960-2008) using panel unit root test with structural break. According to the results, firstly, the periods which divergence has occurred in those are more than of those in which the convergence happened. Secondly, from 2000 year, all countries have been converged except Syria to the per capita income level of the EU.

Table 1: Summary of the Most Important Interior (in Persian) Studies Related to the Topic and Methodology of the Article

Author(s), (Year)	Statistical population (time reach)	Methodology	Summary the most important results
Makiyan & Khatami (2011)	15 selected MENA countries (1980-2008)	Stochastic convergence and unit root tests	Existing two convergence groups of to the cross-sectional average based on time series unit root time, convergence of whole sample to the cross-sectional average based on panel unit root tests.
Akbari and Movayyedfar (2004)	Provinces of Iran (1991-2001)	Cross-sectional spatial econometric	-Existing absolute convergence in per capita income between the provinces of Iran – 31% reduction in economic growth gap each year – positive spatial spillover of economic growth in the provinces of Iran.
Kasraie, (2007)	38 countries member of the Organization of Islamic Conference (OIC) (1980-2000)	Cross-sectional spatial Econometric	Conditional convergence speed equal to 0.44 for each year. Lack of spatial spillover, Necessity for establishing of artificial poles of growth and economic common markets in order to the convergence of these countries.
Khalili Araqi and Masoudi (2007)	10 selected MENA countries (1975-2002)	stochastic convergence and Chow test	Increasing the income gap of all countries from the income of the Japan as a leading country, except from Israel, Lebanon, Oman and Malta, Structural break of 1990 as the year of gap change to Islamic Republic of Iran.

There are rich empirical studies that considered spatial dimension in growth modes. Tian et al. (2010) conducted a study applying Solow's growth model with technology spillover and Spatial Durbin Model (SDM) over the period of 1991-2007 affirmed the positive spatial dependency between different regions of China. In this study, the absolute convergence was rejected, but in contrast, the conditional

convergence among the economic regions of China was accepted. Also, they stated that by discovering the club convergence that spatial interactions and regional economic growth have different behaviors. In the same way, Seya et al. (2012) in their empirical work by using Spatial Durbin Model (SDM) in the Bayesian statistics framework investigated the per capita income convergence in the regions of Japan in time reach of 1989-2007. The results showed that by considering spatial dependency, Sigma (σ) convergence and per capita income distribution reduction income have not occurred, but the occurrence of beta convergence was confirmed during the years of 1990-2007. Also, Ho et al. (2013) in a study using spatial econometric models in panel data structure and stipulating fixed and dynamic weighted matrices, have assessed the effects of economic growth spillover through trading and neighborhood between 26 countries member of the Organization of Economic Cooperation and Development (OECD) during the time 1970-2005. In this study, the spillover impacts through trading and the neighborhood were positively and significantly estimated, and the convergence rate of economic growth were upgraded after considering the spatial dependence.

In summing up the empirical studies, it could be said that the majority of studies the convergence has been estimated in cross-sectional where the level of technology has been intended the same for all countries. Also, cross-sectional convergence models used in these studies suffered from omitted variable bias (OVB). The contribution of this study is to investigate the spatial convergence in the form of dynamic panel data accompanying with country and temporal constant effects. Also, by reviewing the empirical studies, no study has been carried out titled with "spatial convergence and economic growth spillover in the countries of MENA region" to date. Political instability and unrests caused by the presence of terrorist groups in the MENA region, energy security and geopolitics in the region require the necessity of discussing regional convergence and deepening relations between the countries of the Middle East and North Africa.

4. Methodology and Research Pattern

Mankiw et al. (1992), in their empirical study, suggested relation (4) for per capita labor force assuming the Cobb–Douglas production

function with exogenous growth for technical progress (A) and labor force (L):

$$Y_t = K_t^{\alpha}(A_t L_t)^{1-\alpha}, \quad 0 < \alpha < 1, \; A_t = A_0 e^{gt}, \; L_t = L_0 e^{nt} \tag{3}$$

$$\Delta \ln Y_{it} = -\left(1 - e^{\beta t}\right) \ln Y_{i0} - \frac{\alpha\left(1-e^{\beta t}\right)}{1-\alpha} \ln(n_{it} + g + \delta) + \frac{\alpha\left(1-e^{\beta t}\right)}{1-\alpha} \ln(S_{it}) + \left(1 - e^{\beta t}\right) \ln A_{i0} + gt \tag{4}$$

In which, β is the cross-sectional convergence rate and the explanatory variables are included: growth rate of labor force (n), exogenous technical progress rate (g), capital depreciation rate (δ), saving rate (S) and per capita income of labor force in the beginning of the period(Y_{i0}). In most empirical studies concerning regional growth, the sum of technical progress rate and depreciation rate of constant capital is considered to be about 5% (Mankiw et al., 1992, Islam, 1995a, 2003b., Ertur and Koch, 2007). In empirical studies of growth econometrics, relation (4) is often fitted cross-sectional. The principal disadvantage of cross-sectional approach is that in this method, the technology dispersion between cross sections (or countries) is considered the same. This leads to the omitted variable bias. In integrated data, this problem is fixed by taking into account cross-sectional (country) constant effects and the level of technology between countries is variously intended and is appeared in the fixed effects.

In the methodology of spatial econometric, depending on the dependent variable or explanatory variables, or the error term has spatial dependency, different spatial model are introduced. In this study, to investigate the spatial convergence of real per capita income, and to estimate the spatial spillover effects of economic growth model, the following Spatial Durbin Model (SDM) is stipulated:

$$\ln Y_{it} = \rho \sum_{j=1}^{n} W_{ij} \ln Y_{jt} + \gamma \ln Y_{i,t-1} + \lambda \sum_{j=1}^{n} W_{ij} \ln Y_{j,t-1} + \beta_1 \ln(N_{it} + 0.05) + \beta_2 \ln S_{it} + \delta_i + \mu_t + \varepsilon_{it} \tag{5}$$

Where, $\ln Y_{it}$ is the logarithm of real per capita production in the current year as model's dependent variable, $Y_{i,t-1}$ is also the real per capita production in the last five years. N_{it}, is the annual average growth rate of population at the desired period, and $(N_{it} + 0.05)$

represents the sum of average growth rate of population, exogenous technical progress rate and capital depreciation rate. The variable that we used in the research as the saving rate, S_{it}, is the annual share of the investment volume in real GDP. As noted above, the relation (5) is fitted in panel framework accompanying with temporal and cross-sectional fixed effects, and δ_i represents the individual fixed effects, and μ_t shows temporal constant effects. Time fixed effects, indeed, the unobservable and immeasurable effects which are the same for all countries, but vary during the year, and affect per capita production.

On the other hand, in most studies due to the decrease in annual fluctuations effect over the estimation results, the entire temporal period of the study is divided to the five-year non-overlapping sub-periods, that for this purpose, the averages of the mentioned variables in these five years are used (Islam, 2003., Elmi and Ranjbar, 2012., Cuaresma et al., 2013). It should be noted that in relation (5), γ is the cross-country convergence rate of and the convergence speed in the period of research is equal to $\beta = \frac{-\ln \gamma}{T}$ (Islam, 2003). T also expresses the considered sub-period which is five-year in this research.

Spatial Durbin Model makes the possibility of spatial interactions for both dependent variable (per capita production of current year) and explanatory variable (e.g. per capita production of the beginning period). Considering $\sum_{j=1}^{n} W_{ij} \ln Y_{j,t-1}$ term in relation (5) leads to versatile stipulation of convergence equation, and not considering it according to the study of Tau and Yu (2012) causes to the significant bias in the results obtained from spatial regression. Expression $\sum_{j=1}^{n} W_{ij} \ln Y_{jt}$ is spatial auto-regression in order to fit the spillover effects and ρ, is spatial coefficient. In fact, the spatial auto-regression term models the spillover effects, and in the majority of empirical studies of regional growth is called as spatial lag (delay) variable or the Right-Hand-Side variable (RHS) which is spatially weighted average of the dependent variable (per capita production in this research) on the panel. As mentioned, the coefficient of spatial auto-regression (ρ) indicates that the dependent variable in a country how much is influenced by the dependent variable of neighboring countries (Drukker et al., 2013). W is spatially geographical weighted matrix, in which the countries that are adjacent and neighboring contain the most

weight, and the ones which are far from each other have the lowest weight. Components of w_{ij} in the weight matrix show how the spatial relation of country i with country j is considered from the distance point of view which are defined as $\frac{1}{d_{ij}}$ and $\frac{1}{d_{ij}{}^2}$. In order to determine the distance between two units (or countries) two Euclidean and Minkowski functions are used. In this study, the Euclidean function has been used in order to calculate the distance between two country i and j.

$$d_{ij} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2} \tag{6}$$

In which, x_i and y_i , are respectively the latitude and longitude of i country and x_j and y_j, indicate the latitude and longitude of j country, respectively. In this study, firstly the spatial weighted matrix was made based on the relationship, $\frac{1}{d_{ij}}$, and then being the row normal. In the row normal, each element in the row is divided to the sum of row, so that, after normalization the summed matrix of each row is being equal to one. However, if we define $w^*{}_{ij}$ the elements of spatial weighted matrix after normalization, then:

$$w^*{}_{ij} = \frac{w_{ij}}{\sum_{j=1}^{N} w_{ij}} \tag{7}$$

By multiplying this normal rowed matrix in dependent variable, the spatial lag variable is achieved. Also, according to the relationship, $\frac{1}{d_{ij}}$, whatever the distance dimension between two countries is getting farther or the economic distance is becoming further, this relative weight gets less and implies that with increasing distance the spillover effects is reduced. On the other hand, in spatial econometrics due to the inefficiency of conventional methods (OLS) in ignoring the spatial heterogeneity and spatial dependency, the methods of Maximum Likelihood Estimator (MLE) and Quasi Maximum Likelihood Estimator (QMLE) are used. In this research owing to the lowness of time series observations (resulting from averaging) of Quasi Maximum Likelihood Estimator method has been used to estimate the coefficients of spatial Durbin model (Lee and Yu, 2010).

4.1 Spatial Diagnostic Tests

As cited in the introduction section, according to the Tobler's first geographical law "each location is dependent to another location, and locations that are closer to each other, mostly affect together compared to places farther away". Spatial correlation means that observations on the interactions process such as technology transfer, commercial exchanges, different social, economic, political etc., relations correlate together. In order to diagnose this dependency, diagnostic tests of globally and locally spatial autocorrelation of Moran's I, Geary's C and Getis and Ord's G were applied in studies. The zero hypotheses in each of these spatial autocorrelation tests are zero or spatial independency of each of the variables are under investigation.

A. Moran's I statistic test is defined below:

$$I = \frac{N}{\sum_i \sum_j w_{ij}} \frac{\sum_i \sum_j w_{ij}(Y_i - \bar{Y})(Y_j - \bar{Y})}{\sum_i (Y_i - Y)^2} \quad (8)$$

In equation (8), N is the number of spatial units (country) which are displayed by i and j. Y is the studied variable (real per capita GDP) and $\bar{Y}$ is the average of variable Y; and w_{ij} is the elements of the spatial weighted matrix. Negative value of this statistic expresses the negative spatial autocorrelation and positive value indicates positive spatial autocorrelation.

B. Geary's C index is defined as following:

$$C = \frac{(N-1)\sum_i \sum_j w_{ij}(Y_i - Y_j)^2}{2W\sum_i (Y_i - Y)^2} \quad (9)$$

In this index, W is the sum of spatial weighted matrix elements(w_{ij}). The statistic amount of this test is a number between 0 and 2. Value 1 means the lack of spatial autocorrelation; the values less than one indicate spatially increasing positive autocorrelation and the higher values show spatially increasing negative autocorrelation.

C. Based on the Getis and Ord's G index, the existence of spatial clustering of per capita income between the per capita incomes of the countries in the MENA region is investigated. The difference between this indicator with two previous indicator is either in the type of spatial weighted matrix applied in this index because in this index, the

global correlation of binary spatial weighted matrix has been used, or spatial positive diagnostic autocorrelation because this index is only able to diagnose the spatial positive autocorrelation (Getis, 2010). Spatial clustering comprises hot and cold spots. The order of hot spots is the values that have exceptionally high values and the cold spots are the ones that have an exceptionally have too low value. Getis and Ord's G index is defined as below:

$$G = \frac{\sum_i^n \sum_j^n w_{ij} Y_i Y_j}{\sum_i^n \sum_j^n Y_i Y_j}, \qquad \forall \quad j \neq i \tag{10}$$

Although globally spatial diagnostic tests examine the existence or lack of existence of globally spatial autocorrelation phenomenon, but these tests cannot show which region has greater spatial integration intensity. To this end, local statistics of mentioned spatial autocorrelation indices are used (YU, 2012). Moran's local scatter plot is also plotted in order to recognize the type and how the spatial distribution of per capita income in geographical locations. If the maximum distribution is at the first and third quarters of scattering plot, it means that the spatial positive dependence had been established, and the regions with high per capita income have been surrounded by the regions with low per capita income (first quarter of the scattering plot) and vice versa, the countries with low per capita income have been surrounded through countries with low income (third quarter of scattering plot). In contrast if the more of distribution is at second and fourth quarters, representing the negativity of spatial autocorrelation (Anselin, 1995). In the spatial negative autocorrelation, the countries with low per capita income have been encompassed by the ones with high per capita income (countries located at second quarter of Moran's local scattering plot), or the countries with high per capita income have been surrounded by countries with low per capita income (the countries located at fourth quarter of Moran's local scattering plot).

5. Empirical Results

5.1Data and Descriptive Statistics

According to the studies conducted by the paper authors, there is no single definition for MENA region. Based on the definition of League

of Arab States (LAS) and economic and social Commission of Western Asia located at United Nations (UN-ESCWA), MENA region includes 22 countries. According to the World Bank definition, MENA region covers 21 countries which the countries of Somalia, Sudan, Mauritania and the islands of Comoros have been excluded this definition, but in return the countries of Iran, Israel, and Malta have been included. In this study, in order to access to more observations like Nugent and Pesaran (2007) and Andrew et al. (2013), there has been an expanded definition of MENA region which comprises 27 countries. These countries include: Oman, Tunisia, Libya, UAE, Israel, Turkey, Egypt, Yemen, Palestine, Iran, Mauritania, Syria, Morocco, Saudi Arabia, Bahrain, Algeria, Iraq, Sudan, Comoros, Jordan, Eritrea, Qatar, Lebanon, Djibouti, Somalia, Kuwait, and Malta. The country of Palestine (West Bank and Gaza) has not been included in the estimated model because of lacking full time series data. All statistics related to real per capita GDP to international dollars, population and savings rate has been extracted from Penn World Table 8.0 and 8.1 from 1970 to 2010.

Table 2 represents the results of spatial diagnostic tests. All three tests affirm the existence of globally spatial autocorrelation of real per capita income among the countries of MENA region[1].

Table 2: Results of the Spatial Diagnostic Tests for 2012-2014 Real Per Capita GDP Averaging

Test type	Test statistics	Z statistics	Probability (PV)
Moran's I	0.266	3.516	***0.000
Geary's c	0.811	-1.424	*0.077
Getis and Ord's G	0.657	2.352	***0.009

Source: findings: ***: significance at the level of 1%. **:significance at the level of 5%. *:significance at the level of 10%. Data Source: Word Bank online database.

The amount of Moran's I statistics is positive and significant at the level of 1%. Also, the amount of Geary's C statistics is less than one which expresses the spatial positive autocorrelation. As mentioned, Getis and Ord's G test was solely able to diagnose positive spatial

1. It is worth noting that globally and locally spatial autocorrelation have just been computed for 2012-2014 averaging real per capita GDP. For the rest of the years, it can be put at disposal in the case of requesting from the corresponding author.

autocorrelation and identifies the hot and cold spots. The value of this statistic for 2012-2014 real per capita GDP averaging at significant level was 1% significant and positive spatial autocorrelation verifies per capita income. In other words, on average, in the MENA region, countries with high per capita income have been surrounded by countries with high per capita income and the reverse of this state is true for the countries with low per capita income, and these countries have been surrounded by ones with low per capita income. But nonetheless, there are countries which are outside of this spatial positive distribution. By the assistance of Moran's local scattering plot, it can be identified the countries which have heterogeneous spatial distribution.

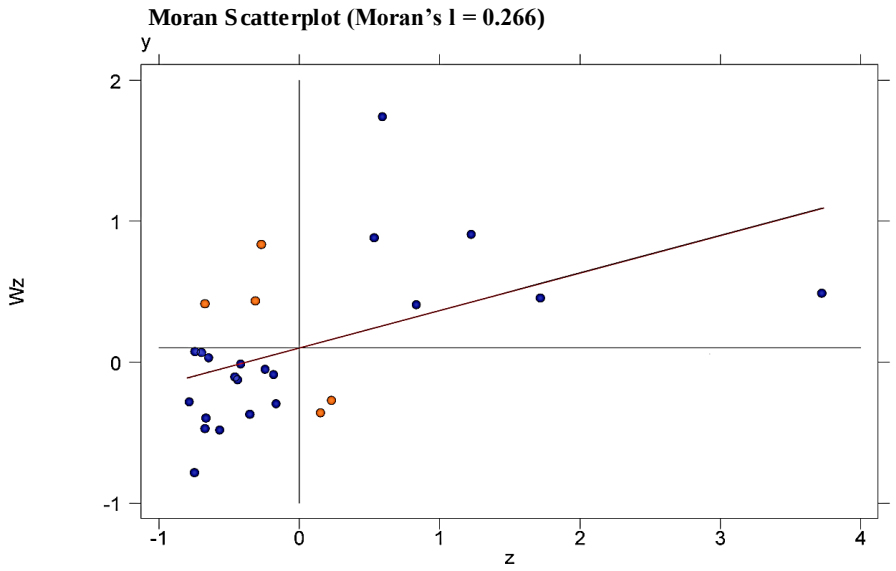

Figure 2: Moran's Local Scattering Plot of Real per Capita Income for the 2012-2014 Averaging

(Countries located at the first quarter: Oman, Saudi Arabia, Bahrain, United Arab Emirates, Kuwait, and Qatar. Second quarter: Iran, Iraq and Yemen. Third quarter: Mauritania, Comoros, Morocco, Algeria, Tunisia, Lebanon, Turkey, Eritrea, Djibouti, Sudan, Egypt, Somalia, Libya, Jordan and Palestine. Fourth quarter: Malta and Israel)

5.1 Model Estimation

As the spatial diagnostic tests showed, the variable of real per capita income of the countries in the MENA region has spatial positive autocorrelation, and accordingly not considering this spatial dependency leads to estimation error and statistical inference resulting from it will be

unreliable, that existing this fact is apparent at the previous studies that have investigated convergence by not taking into account space dimension. By considering this issue, classic Solow model along with inserting spatial dependency (relation 5) has been fitted for the variable of real per capita income and the results are given in Table 3.

Table 3: Estimation Results

Variables	Coefficients	t statistic	Probability Value (PV)
$\ln Y_{t-1}$	0.876	15.98	**0.000
$\ln(N_t + 0.05)$	-0.277	-2.25	**0.025
$\ln S_t$	0.081	1.69	*0.090
λ	-0.308	-1.67	*0.095
ρ	0.392	2.87	***0.004
Conditional convergence rate: 0.026, implicit Alpha (α): 0.395, F statistics: 80.61 (0.00)			

Notes: *** significance at the level of 1%. ** significance at the level of 5%. * significance at the level of 10%.

The coefficient of convergence is between zero and one, and the Beta conditional convergence rate is equal to 2.6% per year for each country. This coefficient suggests that on average each country moves to steady state with a rate of 2.6% on the balanced growth path, and every year 2.6% of the gap between the current level of income and the sustainable level of real per capita income has disappeared. Consistent to the calculation relation of real per capita income, the variable coefficient of population growth rate must be negative. The variable coefficient of total average population growth rate, technical progress rate and depreciation rate of fixed capital in this study were negative, and statistically is at the significant level of 5%. The variable coefficient of average saving rate is positive and statistically at the significant level of 10%. So according to the spatial Solow model, between the countries of the MENA region, those which have less population growth rate and more saving rate, they on average gain higher economic growth rate. Implicit Alpha[1] (α) actually represents the elasticity of per capita production compared to stock capital input. The coefficient of Alpha was equal to 0.39 in this study. This means

1. Implicit Alpha can be obtained by following relations: $\gamma = e^{-\beta t}$, $\beta_2 = \frac{\alpha}{1-\alpha}(1 - e^{-\beta t})$

that, by assuming constant of other inputs, if the inventory of physical capital increases one percent between the countries in the MENA region, on average it contributes an increasing of real per capita production to the size of 0.39%.

As pointed out in the methodology of research, Spatial Durbin Model (SDM) gives the feasibility of spatial interactions either to the dependent variable of per capita income or to the variable control of current per capita income at the beginning of each sub-period. The spatial coefficient of per capita income variable was negative at the beginning of each sub-period (λ) and at a significant level of 10%. Also, the coefficient of spatial autocorrelation (ρ) is positive and statistically significant at the level of 1%. This coefficient expresses the point that if the logarithmic weighted the average of per capita production regarding the adjacent countries of a country in the MENA region increases one percent, on average the logarithmic per capita income of that country rises to the size 0.39%, in which the spillover from the economic growth of adjacent and neighboring countries has the greatest amount and the density of these spillover effects decreases on the distance. According to the obtained results, the hypothesis of regional spillovers was right for the countries of Middle East and North Africa, and an automatic cycle of positive economic growth has been established in these countries. Furthermore, Iran accompanying Yemen and Iraq have a less per real capita income and have been surrounded by countries with high per capita income. However, the most optimal growth policy for these countries is commercial and economic collaboration through the creation of artificial growth poles with their adjacent countries, because the commercial costs have an inverse relationship with distance (Crozet & Koenig, 2004). Hence, according to Getis and Ord's G (1992) test, the effect of real per capita income shocks (e.g. war, political instability, etc.) decreases with distance and influences mostly the adjacent countries.

6. Conclusions and Policy Suggestions

with consideration of spillover effects and spatial dependence, the convergence in different regions of the world is related together, so that in this case the growth rate (convergence speed) of a region is no longer just depended on the initial level of income (production) of that region and will be also dependent on the initial level of income of its

neighboring regions. Furthermore, the steady state of a region will depend either on the structural parameters of its own region or on the structural parameters of its neighboring regions. And as noted, this relationship is achieved by spatial weighted matrix (Pfaffermayr, 2009:65). In this paper, the spatial Solow model was estimated for 26 countries in the MENA region during the period of 1970-2010. Spatial diagnostic tests indicated that the existence of positive spatial autocorrelation of real per capita income in the countries of MENA region and it is required to carry out the modeling of real per capita income of these countries at the presence of distance and space dimension. The study is different to other studies in two important aspects; first, the test of regional convergence hypothesis for the MENA countries in under the spatial spillover effects of economic growth, and second, avoiding omitted variable bias with the estimation of Solow model in the framework of spatial dynamic panel data considering the country and time fixed effects. The positive and significant value of spatial autocorrelation coefficient implies that part of the economic growth (0.39%) of each of the investigated countries had been through the distance effect (adjacency) and regional spatial spillover. The most important policy suggestion of this research for MENA countries is strengthening the automotive positive cycle of economic growth by the detailed and more efficient collaboration of economic and social infrastructures. In addition, according to the status of a country in the MENA region affecting by its adjacent countries, establishing regional stable security requires the cooperation of all MENA countries in the form of legal binding treaties.

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