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Abstract

In this paper various spatial econometric models are performed to check the existence of spatial growth spillovers across a sample study including 73 countries from MENA, Asia, and Europe over the period 1996-2014. The results indicate the occurrence of positive spatial correlation in terms of economic growth within and between the different regions included in the study. However, the findings are somewhat disappointing for the MENA region since we did not find evidence of the presence of strong connections of MENA economies with the other regions namely Asia and Europe.

Keywords: Growth, Spatial Interactions, Comparative Studies.
JEL Classifications: O47, C31, C33, O57.

1. Introduction

Economic growth is a multidimensional and multidirectional concept and should be treated as such. Despite the presence of a vast body economic growth literature, most growth empirical studies treat the subject in an atomistic way with little attention to countries' interactions. What is observed at one point is determined by what is happening elsewhere in space. Indeed, spatial autocorrelation occurs when chock in one country is transmitted to other neighboring countries. Over the few last years, spatial effect has been recognized as a key force in the process of economic convergence (Rey and Montouri, 1999). In fact, spatial interdependence in the economic growth context matters (Tian and Chen, 2010). For instance, in the last decade, a large body of empirical research about economic convergence process has shown that spatial dependence is worth being considered. It is worthwhile to note that neglecting the spatial interactions would lead to serious misspecification (Abreu et al., 2005; Ertur and Koch, 2007).

The purpose of this work is to explore the spatial correlation in terms of economic growth within the MENA as well as the connection with other regions by using a panel data of 73 countries from Asia, Europe and MENA. The MENA region (especially the Middle East) has been for a long-time a propitious fiefdom of both internal and external conflicts, and this fact has paradoxically made the region interesting to explore. "The MENA region is daily at the center of economic and political debate, and this stylized fact represents a further source of interest" (Andreano et al.,2013, p.669). The long-term sluggish economic growth recorded in MENA could be explained by diverse factors including the oil curse (Apergis and Payne, 2020), the lack of good governance and transparency, and archaic political regimes. To boost the output, Rachdi et al. (2018, p.22) recommend that "MENA countries should reinforce their institutions quality by adopting good practice of governance and regulation".

In this paper various spatial econometric models are performed to check the existence of spatial growth spillovers across the sample study. In addition, treating the nature and the intensity of spatial dependence, and examining the potential growth regimes have also been considered. This work has twofold interest. First, detecting growth spillover effects between countries using spatial econometrics methods which is an interesting and seemingly understudied topic in the MENA region. Therefore, through this study we aim to fill the literature gap. Second, in terms of economic policy makers, the comparative analysis conducted (by including Asia and Europe in the empirical work) would be a good benchmark of what other regions have experienced.

2. The Spatial Econometric: A promising framework for the study of Economic Growth in Regional perspective

Given the importance geographical interferences in the context of economic growth in MENA region, it is surprising that this crucial aspect has been ignored by previous empirical works. Neglecting a key determinant of growth (the neighboring effect) will be probably felt in econometric results[1]. Indeed, the existence of spatial autocorrelation has been proved by many empirical research. Accordingly, the OLS econometric regressions will lead to biased results, if this prominent factor will not be included in the analysis (Anselin, 1988). As a result, the accuracy of the related economic policy might be altered. Therefore, the neighboring effects in MENA region as well as those emanating from other regions should be considered. This is an important aspect which is ought to add to the economic growth paradigm. The economic world is open and dynamic, and what arises in one country or region will spread to other areas. Especially those which are in immediate proximity. “Space, in fact, is not composed of units isolated from each other. What happens in each of them can influence others: there is spatial interaction”, (Jayet, 1993, p.7). Henceforth, it is recommended to consider the neglected spatial effect as a significant determinant in the MENA economic growth process,

The studies of spatial interdependence in the empirical growth date back to 90s with the pioneering work of Fingleton and McCombie (1998), López-Bazo et al. (1999) and Fingleton (1999) sparking the interest for the regional aspect of economic growth that has been forgotten for a long time. Nevertheless, it is worthwhile to mention that the authors have adopted an ad hoc spatial model that is disconnected from the theorical corpus. In other words, the aim was to prove mechanically the existence of spatial externalities in the empirical economic growth exercise without truly giving proof of a consistent theoretical background. The following works have tried to overcome this issue by implementing and accommodating the spatial dependence to both the classical and neoclassical models and the endogenous growth theory as well (see for example Bivand and Brundstad, 2006). Thus, spatial econometric models (especially spatial lag model and spatial error model) were performed under the hypothesis of the new generation of economic growth theory as well as those proposed by new economic geography models à la Fujita et al. (1999).

Spatial econometric models (spatial lag model and spatial error model) deal with the unobserved determinants of economic growth that would be otherwise caught by the error term in OLS regression. In the spirit of spatial hypothesis, the growth in each country is not only associated with its own initial GDP per capita and its idiosyncratic factors (as suggested by the traditional theory), but also is affected by the factors prevailing in the other countries, notably those in immediate proximity. Indeed, the spatial impact from other regions declines with distance. A remote country is supposed to have a less significant effect than a close one. “Everything is related to everything else, but near things are more related than distant things” (Tobler 1970, p. 236)[2]. The same logic applies to chocks within the region and those coming from elsewhere. This mechanism

[1] Spatial econometric models (spatial lag model and spatial error model) deal with the unobserved determinants of economic growth that would be otherwise be caught by the error term in OLS regression.

[2] Tobler, W. (1979). “Cellular Geography.” In *Philo.oph"* in Geograph", edited by S. Gale and G. Olsson, pp. 579-86. Dordrecht: Reidel. Cited in (Anselin, 1988, p.8)

is apprehended by the famous weight matrix W that could be described as a simplistic theoretical configuration of the geographic space .

It is meaningful to note that most spatial empirical growth works have emphasized the spatial error models (SEM) to deal with the regional interdependence. "What is more surprising is that the empirical evidence on the preferred spatial specification is mixed, and seems to depend on the set of regions, time period, specification, etc." (Fingleton and López-Bazo, 2006, p.179). According to Fingleton and López-Bazo (2006) most studies have supported the spatial error model against the spatial lag regression. In other words, they put forward the nuisance spatial dependence (the random shocks) to explain the presence of regional spillovers. "However, the presence of residual spatial dependence, and its modelling as a spatial error model, may reflect a more insidious cause. It may be that it is a manifestation of the omission of one or more spatially autocorrelated variables", (Fingleton and López-Bazo, 2006, p.182). In addition, the authors underline that spatial error models in previous studies did not include additional variables in the estimated equation. This shortcoming will lead to inaccurate results since the simple spatial error equations are unlikely to catch all the causes behind regional spillovers. The authors advocate in favor of unconstrained models (spatial lag and spatial Durbin models) including conditioning variables that are excluded by the constrained error models. Hence, for these models, the preference is to capture the potential regional spillovers through physical channels (substantive spatial dependence). Contrary, in the spatial error models logic, the spillovers are just caught by the random shocks. In other words, the unconstrained models attempt to explain the causes of spillovers, and the unconstrained models simply treat the neighboring effects as nuisance variables.

Blongein et al. (2007) focus exclusively on spatial lag model. The reason behind that interest is that unlike the spatial error model (which the main contribution is to improve standard errors where estimation errors are spatially dependent), the spatial lag model allow the regional effect to manifest through the spatially lag dependent variable $\rho.W.y$ included in the right hand side of the regression equation. Indeed, the estimated ''spatial lag'' coefficient (the famous ρ) captures the simultaneous correlation between one country's economic growth and other neighbor countries' economic growth[3]. The Spatial Durbin Model (SDM) allows the identification of the effects from the other neighboring conditioning variables (i.e. the main spillover channels) coming from a third country.

2.2. The Spatial Analysis

2.2.1. The Weighted Spatial Matrix: A Prerequisite for the Spatial Analysis

The weighted spatial matrix W brings out the potential of interaction (between observations of each host countries pairs i, j of a given region. It is worthwhile to note that since each observation

[3] If there is no spatial dependence, and economic growth in a host country does not depend on neighboring growth values, the parameter ρ accounting for spatial autocorrelation of growth will be equal to zero. Econometrically speaking this consists to accept the null hypothesis: $\rho = 0$.

is weighted by the distance or proximity (contiguity for example); the potential of interaction increases with geographically proximate countries and decreases with remoteness ones. There are different techniques to specify the structure of the spatial weight matrix[4]. For example, when the location (i, j) are contiguous (sharing a common border) the spatial matrix can be weighted by contiguity. Consequently, we obtain a binary matrix taking the value 1 if the locations are contiguous otherwise a zero will be attributed. Another alternative is to use a band distance weight (i, j locations interact when they are within a critical distance band).

The scalar $\rho W_y Gr_{i,t}$ records the economic growth in year t $\{t \epsilon [1996, 2014]\}$ of 73 countries from Europe, Asia, and Middle East and North Africa weighted by the bilateral distance between country i and country j where $i, j = \{1,2, \ldots \ldots .73\} \forall\, i \neq j$. The parameter ρ will be estimated and in case of rejection of the null ($\rho = 0$), the spatial autocorrelation or dependence is proved. The square matrix W is composed by a block of diagonal matrix of dimension 73×73 $\{(n \times n)\}$ with each block apprehend a single year's observations for any year t, $t \epsilon [1996, 2014]$. Formally for any year t between 1996 and 2014 the matrix W_t can be represented as following:

$$\begin{bmatrix} 0 & W_t(d_{i,j}) & W_t(d_{i,n}) \\ W_t(d_{j,i}) & 0 & W_t(d_{j,n}) \\ W_t(d_{n,i}) & W_t(d_{n,j}) & 0 \end{bmatrix}$$

The cells $W_t(d_{i,j})$ show that for any couple of hot countries the weight will decrease with the distance. Geographically proximate countries will be attributed a higher weight and vice versa. Accordingly, the spillovers effect (positive or negative) will go down with remote countries. By contrast close countries are assumed to exercise a higher impact. "Everything is related to everything else, but near things are more related than distant things", (Tobler 1970, p. 236)[5].

In our empirical work the spatial weight matrix is a diagonal matrix accounting 146 matrices of dimension 73×73 in the main diagonal. The other matrices are zero-matrices of dimension 73×73. W is row standardized; in other words, the sum of each row is equal to unity.

Given the existence of a large variety of methods, the setup of the spatial weight matrix is rather intuitive. Hence, the establishment of such a matrix is quite arbitrary. To overcome this difficulty, we compute a Moran's spatial correlogram index to decide about the appropriate distance band for the implementation of the spatial weight matrix. To do this we run the command *spatcorr* based on the cumulative distance bands. For each distance band, the statistic Z-value of the null

[4] It is recommended to use a variety of weighted spatial matrix W in the estimation process because results may be very sensitive to the structure of matrix W.
[5] Tobler, W. (1979). "Cellular Geography." In *Philo.oph"* in Geograph", edited by S. Gale and G. Olsson, pp. 579-86. Dordrecht: Reidel. Cited in (Anselin, 1988, p.8)

hypothesis of global spatial independence. Based on the test results the appropriate distance band will be selected. Thus, to refine the choice of the distance band we rely on the statistics exposed in the Table.1 below.

Table. 1: The spatial correlogram of Moran's economic growth Index[6] (sample: 77 countries)

Distance bands	I	E(I)	sd(I)	z	p-value*
(0-10]	0.273	-0.014	0.086	3.323	0.000
(10-20]	0.334	-0.014	0.06	5.811	0.000
(20-30]	0.216	-0.014	0.053	4.36	0.000
(30-40]	0.109	-0.014	0.058	2.131	0.017
(40-50]	-0.014	-0.014	0.058	-0.004	0.498

*1-tail test

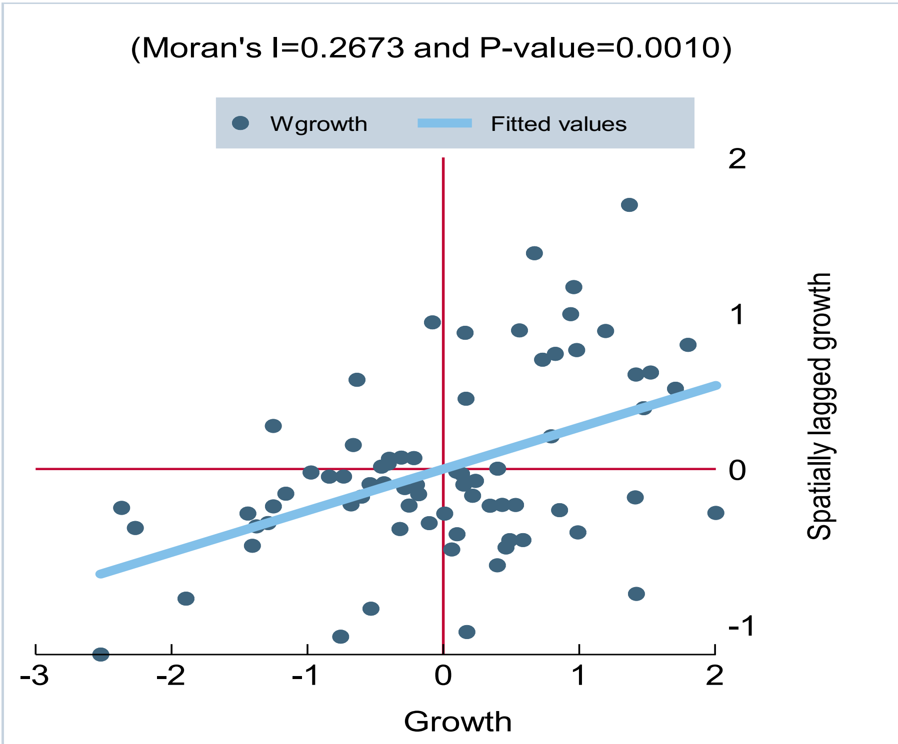
By combining the results of the statistic Z and its P-value provided by the Moran' I test, we select the Euclidean distance band of [10-20] which is equivalent to a band Km of [960- 1920] in Km. In other words, to be considered as neighbors, the distance $d_{i,j}$ between a couple of countries i and j $(i \neq j)$ the weight spatial matrix should not exceed the threshold distance of 1920 km. For each $d_{i,j}$ $\forall i \neq j \in [10 - 20\,]$ i and j are considered as neighbors. When the distance between the country *i and* j is not included in this range they will not be considered as neighbors and will not be weighted, *i.e.* they will be attributed a value of zero in the spatial weight matrix .

2.2.2. A Diagnostic of the Spatial Interdependence

By indicating the existence and the nature of economic growth spatial autocorrelation between the countries included in the sample, the Moran's I could be very useful . According to the positive Moran's I values and the scatter plot (see Fig.1) we presume a positive relationship of economic growth within the sample countries (the Moran'I has a statistically significant positive value and the slope of line fitting the scatter is also positive). When the Moran's I is positive and significant the presence of clusters of like values is assumed, (Anselin, 1988).

[6] We use three alternative economic growth measures to compute the Moran's I statistic (growth of GDP/capita, growth of GDP and the logarithm of average annual growth rate per capita during the period 1996-2014). The results are similar and seems to be insensitive to the choice of the growth indicator.

Figure 1: Moran's scatter plot – Growth of GDP/Capita



Source: Author calculation

The Moran's I index is helpful for detecting the nature and magnitude of the global autocorrelation. In terms of interpretation the benefits of global spatial autocorrelation are palpable when spatial units i.e. observations exanimated are homogenous or at least relatively homogenous. Unfortunately, this is not the case, and studies are often constrained by heterogeneity issue making the results interpretation quite difficult. In that context, it is interesting to look more for local clusters of low or high values. The local clusters or local concentration can be interpreted as specific behaviors or isolated spatial idiosyncrasies. In our study, since we deal with economic growth, the clusters could be considered as convergence clubs showing similar growth path or growth process. Hence, to deepen the analysis, we calculate the local Moran's Index growth values (see Table.2) related to each country. The idea behind is to detect the connected economies and their potential spillovers effects (positive or negative). According to the results of the local Moran's Index displayed in the Table.2, the European and Asian countries are spatially and positively correlated, and the MENA countries are falling behind. Indeed, only Kuwait has a weak significant positive Moran's Index[7]. It seems that the European and Asian countries are probably clustered in term of economic growth.

[7] For sake of brevity and space the remaining countries with no significant Moran's I values are not retained in the table.

Table 2: Local Moran's I values

Region	Country	Ii	z	p-value*
Europe	Albania	0.289	1.556	0.060*
	Austria	0.311	1.469	0.071*
	Bulgaria	0.342	1.716	0.043**
	Croatia	0.39	1.881	0.030**
	Cyprus	0.589	2.691	0.004***
	Denmark	0.315	1.632	0.051**
	Finland	1.055	5.022	0.000***
	France	0.387	2.076	0.019***
	Germany	0.272	1.379	0.084*
	Greece	0.535	2.739	0.003***
	Italy	0.651	2.966	0.002**
	Latvia	0.251	1.417	0.078*
	Serbia	1.01	4.933	0.000***
	Ukraine	2.231	11.995	0.000***
	Negative Moran'I value:			
	Ireland	-0.653	-2.154	0.016***
	Malta	-0.797	-4.146	0.000***
	Moldova	-0.296	-1.512	0.065*
Asia	Bangladesh	0.82	2.322	0.010***
	Cambodia	1.261	2.906	0.002***
	China	0.783	1.402	0.081*
	India	1.497	3.122	0.001***
	Lao PDR	1.1	2.574	0.005***
	Malaysia	0.655	1.537	0.062*
	Mongolia	2.458	2.527	0.006***
	Myanmar	1.516	3.834	0.000***
	Nepal	1.185	2.467	0.007***
	Philippines	0.792	1.628	0.052**
	Viet Nam	1.225	2.517	0.006***
MENA	Kuwait	0.492	1.416	0.078*

Source: Author calculation

The beauty of local spatial autocorrelation is to check whether, for a given observation i (let say the growth rate of a given country at time t), is surrounded by similar observations of other countries, or in the opposite case if it is being surrounded by a very dissimilar observations. Explicitly it is about the identification of the cases in which the value of the observation i is positively (resemblance) or negatively connected (dissimilarity) with neighboring observations. Moreover, in contrast to global autocorrelation measurement, the detection of outliers (atypical localisations) becomes possible through the local spatial autocorrelation. In fact, in the local autocorrelation context we more likely to identify the patterns of high or low values clusters. This is commonly known as hot spots (high values) and cold spots (low values). The Moran scatter plot can be divided into four specific quadrants, each of them describes a kind of spatial correlation. For example, in the High-High quadrant (North-East) are displayed the weighted values of economic growth (the spatially lagged variable: W_{Growth}), whish is high and at the same time surrounded by observations of high values of the "raw" growth observation of neighboring countries. The low-low (South-West) quadrant is the opposite case: W_{Growth} is linked to low values of the neighboring countries. In the High-low (South-East) quadrant the high values of W_{Growth} coexist with low values of neighboring countries. In the opposite side, the Low-High (North-West) quadrant displays the case where the spatially lagged variable W_{Growth} is surrounded by high values of neighboring countries. In this study, the sample countries are classified following the same logic.

The Lisa cluster map (see Table 3) show that the hot spot (High-High) is composed by 13 Asian countries. In other side, the cold spot is mostly composed by 23 European countries and two countries from the MENA region namely Lebanon and Tunisia. The high low cluster is formed by 6 European countries and one country from Asia (Georgia). Two countries (Thailand and Honk Kong) are clustered in Low-High categories. For the remaining 26 countries (among them 15 countries from MENA) the spatial correlation is not significant. Henceforth, it seems that the European and Asian can be considered as belonging to two different kind of convergence club. MENA countries seem to be spatially disconnected except for Lebanon and Tunisia.

Table. 3: Countries classification by Lisa cluster criteria

High-High	Low-Low	High-Low	Low-High
Bangladesh	Albania	Hungary	Hong Kong
Cambodia	Austria	Luxembourg	Thailand
India	Bulgaria	Macedonia	
Indonesia	Croatia	Malta	
Kazakhstan	Czech Rep.	Moldova	
Lao PDR	Denmark	Romania	
Malaysia	Estonia	Georgia	
Myanmar	Finland		
Nepal	France		
Philippines	Germany		
Sri Lanka	Greece		
Uzbekistan	Italy		
Viet Nam	Latvia		
	Netherlands		
	Norway		
	Poland		
	Serbia		
	Slovakia		
	Slovenia		
	Sweden		
	Switzerland		
	Ukraine		
	United Kingdom		
	Lebanon		
	Tunisia		

Source: Author's calculation

3. Estimation Results

To run the spatial regression models, we follow Tian et al. (2010) by accommodating the Cobb-Douglas function to the spatial dependence concept. In line with Marshallian literature where two kinds of externalities are identified namely technological and pecuniary externalities, the authors stipulate that the main source of spatial effects is coming from externalities through regional interaction in terms of knowledge spillovers, factor mobility and trade. Tian et al. (2010) emphasis on technological externalities supposed to be generated by the accumulation of physical capital and externalities.

The Solow Cobb-Douglas equation proposed by the authors is a classical constant return to scale function taking the following form:

$$y_i(t) = A_i\,(t)K_i^{\propto}(t)L_i^{1-\propto}(t), 0 <\propto< 1 \qquad (1)$$

Where $y_i(t), A_i(t), K_i(t)$ and $L_i(t)$ represent respectively the output, aggregated level of technology, capital and labor, in region *i* and time *t* while $\propto$ is a parameter representing the capital elasticity. Moreover, Tian et al. (2010) rely on Ertur and Koch (2007) technology spillover function and assume that the steady growth rate of a region will be endogenously established by the interaction with other regions in term of spatial technology externalities. After resolving the system and making multiple algebraic transformations, Tian et al. (2010) obtain the following basic constrained spatial Durbin model[8]:

$$g_T = \beta_0 + \beta_1 Y_0 + \beta_2 S + \beta_3 NGD + \theta_2 WS + \theta_3 WNGD + \rho W g_T + \varepsilon \qquad (2)$$

Where g_T, Y_0, S, NGD are variables (in logarithm) that describe respectively the growth rate of per capita GDP, the initial per capita GDP , the physical capital accumulation, and the sum of population growth rate (n), technology growth rate[9] (δ) and capita depreciation rate (δ) $[NGD = (n + g + \delta)]$. The spatially lagged variables are proceeded by the weighted matrix W. Two kind of parameter restrictions are imposed by the authors. The first constraint is in line with Solow growth literature the coefficient β_2 and β_3 are equal in magnitude and opposite in sign ($\beta_2 = -\beta_3$) and the constraint is imposed to θ_2 and θ_3 ($\theta_2 = -\theta_3$). The second constraint admits that in case of the absence physical externalities the spatial autoregressive error model (SEM) is favored. To test the presence physical capital externalities the authors run LR common factor test (LRCOM) on the unconstrained spatial Durbin Model (SDM) against spatial error model (constrained spatial Durbin model). When LRCOM test for the null hypothesis is rejected, there is enough proof of significant physical capital externalities in the economic growth process. Finally, the authors augmented the Solow model by adding some control variables.

To estimate the determinants of economic growth we use a dataset of 73 countries from Europe (33 countries), Asia (23 countries) and the Middle East and North Africa (17 countries) between 1996 and 2014. The period and countries were selected to supply both balanced panel data and a large sample size dataset to adequately run the spatial regressions. Data are collected from the Penn World Table database (PWT 9.1) from the University of California and the University of Groningen, The World Bank (World Development Indicators and The Worldwide Governance Indicator), and the UNCTAD.

First, we run a Solow model by ordinary least square (OLS) before performing spatial regression on the basic and augmented form of Solow equation. In the first model [equation (3)] we regress the growth of GDP per capita dependent variable $G_r = \frac{Y_T - Y_0}{T}$ on the initial per capita GDP (lngdpcapita) (per capita GDP of the year 1996), the capital stock (lnck) (proxy of physical capital

[8] For sake of brevity the mathematical algorithm is not replicated in this paper. For more details see Tian et al. (2010).
[9] δ reflects the advancement of knowledge and is assumed to be exogenous and not country specific.

accumulation), and the sum of population growth, technology growth rate and capital depreciation rate (lnngd) [10] $[NGD = (n + g + \delta)]$. Moreover, all the variables are in logarithm are expressed in logarithm .

$$Gr_{i,t} = \beta_0 + \beta_i X_{i,j} + \epsilon_{i,t} \quad \text{where } X_{i,j} \text{ is the vector of explanatory variables} \qquad (3)$$

We start by running the model by OLS on the panel of 73 countries over the period 1996-2014. The restriction that the coefficient on the capital accumulation (lnck) and the explanatory variable (lngd) are equal in magnitude and opposite in sign are tested but the Wald test fail reject the null hypothesis (see Table 4). Thereafter restriction has been relaxed.

Table. 4: Determinants of economic growth (GLS regressions)
Period: 1996-2014, Sample: 73

Gr	Coef.	z	P>z
lninitial	-0.012***	-4.62	0.000
lnck	0.021***	11.81	0.000
lnngd	0.046***	3.51	0.000
_cons	-0.042	-1.05	0.293

R-sq=0.63, Wald chi2(3)=168.68, Number of obs= 1387, T=19, number of groups=73. lnck + lnngd = 0 chi2(1) *** = 26.64 , Prob > chi2 = 0.0000, The standard errors of the regression coefficients have been derived using White consistent cross-section standard errors & covariance. ***, **,* represent respectively statistical significance at 1, 5 and 10% level.

The econometric results show that all the explanatory variables are significant at a statistical level of 1%. The initial per capita GDP and the accumulation of capital have the expected sign. The negative sign of initial per capita GDP is in line with economic growth literature and decreasing return of capital: economies' per capita incomes will tend to grow at faster rates than richer economies. We note also that the variable lngd display an expected positive sign.

To test the spatial dependence, we run three alternative models [the spatial lag model (SAM), the spatial error model (SEM) and the spatial Durbin Model (SDM)] on the basic and augmented version of Solow's model (see Table 5). In addition, the LR common factor test is performed to test the unconstrained spatial Durbin Model (SDM) against spatial error model (constrained spatial Durbin model).

The results of the LR common factor test show that the spatial Durbin Model cannot be considered as nested in the spatial error model. Indeed, the likelihood-ratio test statistic is highly significant (LR chi2(1) = 191.37 and Prob > chi2 = 0.0000) indicating that spatial error model should not be

[10]Following the economic growth literature $g + \delta$ is supposed to be equal to 0.05.

favored against the spatial Durbin Model. Consequently, the idea of physical capital externalities can be supported.

The estimation results of the three alternative spatial models confirm the hypothesis of positive geographical dependence or the geographical diffusion of spillovers since the coefficients of the spatial variables (rho for SAR and SDM and Lambda for SEM) in the three models are significant at 1% and have a positive sign. In addition, the presence physical capital externalities hypothesis is proved by the positive and significant sign of the the spatially lag variable of the accumulation of capital in the SDM model. Hence, the economic growth in a given country is not only impacted by its own capital accumulation process but also depends positively on the capital accumulation prevailing in the neighboring countries.

Table 5: Maximum Likelihood regressions: Spatial Lag Model, Spatial Error Model and Spatial Durbin Model Period: 1996-2014, Sample: 73

SAR				SEM				SDM			
Gr	Coef.	z	P>z	Gr	Coef.	z	P>z	Gr	Coef.	z	P>z
lninitial	-0.008***	-3.880	0.000	lninitial	-0.008***	-3.830	0.000	lninitial	-0.009***	-4.1	0.000
lnck	0.009***	2.950	0.003	lnck	0.006	1.370	0.17	lnck	0.007**	2.1	0.036
lnngd	0.025***	2.530	0.011	lnngd	0.025***	3.000	0.003	lnngd	0.025***	2.68	0.007
_cons	-0.001	-0.020	0.988	_cons	0.072*	1.630	0.10	_cons	-0.113**	-1.86	0.063
Spatial				***Spatial***				Wx			
rho	0.758***	13.530	0.000	lambda	0.888***	29.270	0.000	Wx_lninitial	0.004	1.4	0.161
								Wx_lnck	0.007**	2.29	0.022
Variance				Variance				Wx_lnngd	-0.016	-0.86	0.390
lgt_theta	-1.976***	-8.190	0.000	ln_phi	0.590	0.970	0.332				
sigma2_e	0.00012***	8.190	0.000	sigma2_e***	0.00012	8.340	0.000	Spatial			
R-sq:	within	0.790		R-sq:	within	0.540		rho	0.702***	13.92	0.000
	between	0.00030			between	0.004					
	overall	0.130			overall	0.070		Variance			
N. of obs	1387							lgt_theta	-1.856783	-9.34	0.000
N. of groups	73							sigma2_e	0.000117***	8.3	0.000
T=19								R-sq:	within	0.79	
T: panel length									between	0.0004	
									overall	0.23	

Notes: Wx: the spatially lagged variable. ***, **,* represent respectively statistical significance at 1, 5 and 10% level.

To extend the analysis we augment the benchmark model (see Table 6) by adding some control variables[11] (the human capital (*KH*), the stock of FDI (*fdistock*), exports (*export*) of goods and services and a proxy of governance (gover) obtained by calculating the average of five governance indicators[12]). The results show that the three models are in some extent robust to the addition of control variables except the variable *lnck* that becomes insignificant probably due to multicollinearity problems. It is worthwhile to note that the multicollinearity is considered as among the major weaknesses of spatial Durbin model. In fact, the explanatory variables are included twice in the SDM in their original form (the direct effect) as well as in the form of spatially lagged form (the indirect effect) which could increase the risk of multicollinearity problem. In addition, we observe that the spatially lagged FDI variable (Wx_lnfdistock) show a positive and significant sign leading to support the idea of complementarity effect of the FDI stock between the countries included in the sample study.

[11] Except the variable governance all the other control variables are in logarithm.
[12] Voice and Accountability, Political Stability and Absence of Violence/Terrorism, Government Effectiveness, Regulatory Quality, Rule of Law and Control of Corruption.

Table 6: Maximum Likelihood Spatial Regressions (SAR, SEM and SDM) with control variable, Period: 1996-2014, Sample: 73

SAR				**SEM**				**SDM**			
Gr	Coef.	z	P>z	Gr	Coef.	z	P>z	Gr	Coef.	z	P>z
lninitial	-0.023***	-12.14	0.000	lninitial	-0.022***	-11.41	0.00	lninitial	-0.023***	-11.75	0.000
lnck	0.002**	2.26	0.024	lnck	0.0033**	2.26	0.024	lnck	0.001	1.26	0.209
lnngd	0.014***	4.52	0.000	lnngd	0.016***	5.37	0.000	lnngd	0.016***	4.93	0.000
lnkhwdi	0.023***	8.88	0.000	lnkhwdi	0.025***	9.33	0.000	lnkhwdi	0.024***	8.58	0.000
lnfdistock	0.002***	4.49	0.000	lnfdistock	0.0024***	3.62	0.000	lnfdistock	0.001***	2.4	0.01
lnexport	0.009***	12.68	0.000	lnexport	0.007***	10.33	0.000	lnexport	0.009***	11.59	0.000
gover	0.011***	6.63	0.000	gover	0.009***	5.79	0.000	gover	0.011***	6.56	0.000
_cons	-0.150***	-6.7	0.000	_cons	-0.12***	-3.81	0.000	_cons	-0.256***	-5.85	0.000
Spatial				***Spatial***				***Wx***			
rho	0.55***	22.54	0.000	**lambda**	0.84***	38.56	0.000	Wx_lninitial	0.009**	2.25	0.024
								Wx lnck	-0.001	-0.6	0.551
Variance				Variance				Wx lnngd	-0.021***	-2.82	0.005
lgt_theta	-2.21***	-18.78	0.000	ln_phi	1.58***	4.9	0.00	Wx lnkhwdi	-0.005	-0.97	0.332
sigma2_e	0.00009	25.47	0.000	sigma2_e	0.000094	24.77	0.00	Wx_lnfdistock	0.004***	3.43	0.001
R-sq:	within	0.85		R-sq:	Within	0.80		Wx nexport	0.001	0.83	0.404
	between	0.01			Between	0.05		Wx gover	-0.015***	-3.04	0.002
	overall	0.34			Overall	0.22					
								Spatial			
								rho	0.518***	15.38	0.000
								Variance			
								lgt_theta	-2.07***	-16.11	0.000
								sigma2_e	9.02E-05***	25.05	0.000
								R-sq:	within	0.85	
									between	0.03	
									overall	0.42	

Notes: Wx: the spatially lagged variable. ***, **,* represent respectively statistical significance at 1, 5 and 10% level.

In a last step we split the sample in three groups (Europe, Asia and MENA) and we run the model with control variables to conduct a comparative analysis between the three regions. The idea behind is to explore specific regional features in term of spatial correlation in the process of economic growth (see Table 7, 8 and 9 in appendix). Broadly, we can say that in the case of MENA region the spatial correlation is only confirmed by the SAR model contrary to Asia and Europe where the coefficients of the spatially lagged variable are still strongly significant. This is match well with the results related to local spatial correlations and already found in this study. MENA countries seems to be disconnected both locally (within the MENA region) and globally (with the other regions namely Asia and Europe).

4. Conclusion

In this study we focus on the intraregional and interregional spatial correlation in terms of economic growth in a panel of 73 countries from Asia, Europe, and MENA region. We investigate the global spatial correlation and local spatial dependence. We have strived to overcome the classical ad hoc approach (considered as a pure mechanic approach) on which the spatial regression has been anchored. Indeed, we have accommodated the Solow's model to the context of MENA region. The results indicate the existence of positive spatial correlation in terms of economic growth within and between the different regions included in the study. However, the findings are somewhat disappointing for the MENA region since we did not find evidence of the presence of strong connections of MENA economies with the other regions namely Asia and Europe.

Almost two main growth regimes have been detected: a high economic growth club (composed by Asian countries) and a low growth club (mostly including European Economies and four MENA countries). Additionally, inside the MENA region it seems that MENA countries seem to be individually disconnected from each other in terms of economic growth (absence of local spatial correlation). In fact, according to the results we observe the absence of significant clusters within the MENA region. The lack of interference with other regions namely Asia and Europe, is also a factor that should be noticed. In fact, MENA countries are not taking part of Asian and/or European convergence clubs. Another, important finding is that spatial models seem to be less accurate when it comes to identifying the spillover channel due to the presence of multicollinearity problems.

The geographic proximity does not mean that the positive spillover effects should be taken for granted. Indeed, economic, and psychic proximity count more. Likewise, the chronological sluggish economic growth in MENA region should not be explained by geographic remoteness but more by structural weakness and long-term instability. Finally, a new social contract as well as a new political and economic paradigm must be found and adopted to boost the economic growth in MENA region.

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Appendix

Data source

Indicators	Sources
Stock of Foreign direct investment in millions of current US $	United Nations Conference on Trade and Development, UNCTAD Statistics database online, 2019. http://unctadstat.unctad.org
Population growth (annual %) GDP per capita (current US$) GDP per capita growth (annual %)	World Bank, World Development Indicators Database online, 2019. http://data.worldbank.org/indicator
Average depreciation rate of the capital stock Capital stock at current PPPs (in mil. 2011US$)	Penn World Tables PWT Version 9.0 The University of California and The University of Groningen. Database online, 2016. http://cid.econ.ucdavis.edu/pwt.html
Distance (Km) between capital cities Latitude and Longitude (in degree)	CEPII- Database http://www.cepii.fr/
The Worldwide Governance Indicators (WGI) project	Daniel Kaufmann, Natural Resource Governance Institute (NRGI) and Brookings Institution and Aart Kraay, World Bank Development Research Group. https://info.worldbank.org/governance/wgi/

Table.7: Maximum Likelihood Spatial Regressions (SAR, SEM and SDM) with control variable in MENA Region, Period: 1996-2014, Sample: 17

SAR				SEM				SDM			
Gr	**Coef.**	**z**	**P>z**	**Gr**	**Coef.**	**z**	**P>z**	**Gr**	**Coef.**	**z**	**P>z**
lninitial	-0.019***	-3.120	0.002	lninitial	-0.021***	-2.800	0.005	lninitial	-0.017***	-3.610	0.000
lnck	0.008**	2.000	0.045	lnck	0.010***	3.080	0.002	lnck	0.006***	4.230	0.000
lnngd	0.003	0.370	0.714	lnngd	0.001	0.150	0.882	lnngd	0.004	1.130	0.258
lnkhwdi	0.029***	2.770	0.006	lnkhwdi	0.030***	3.130	0.002	lnkhwdi	0.026***	5.310	0.000
lnfdistock	-0.002	-0.840	0.403	lnfdistock	0.000	-0.120	0.901	lnfdistock	-0.003***	-2.690	0.007
lnexport	0.016***	4.120	0.000	lnexport	0.018***	4.850	0.000	lnexport	0.013***	6.730	0.000
gover	-0.005	-0.660	0.512	gover	-0.007	-1.010	0.313	gover	-0.003	-0.830	0.404
_cons	-0.399***	-5.350	0.000	_cons	-0.490***	-6.440	0.000	_cons	-0.360***	-3.000	0.003
Spatial				***Spatial***				***Wx***			
rho	0.212***	2.440	0.01	lambda	-0.114	-0.750	0.454	Wx_lninitial	-0.006	-0.610	0.540
								Wx_lnck	0.005***	2.390	0.01
Variance				Variance				Wx lnngd	0.011	1.100	0.272
lgt_theta	-2.745	-17.200	0.000	ln_phi	3.037***	10.750	0.000	Wx lnkhwdi	0.002	0.320	0.746
sigma2_e	6.36E-06***	4.980	0.000	sigma2_e	6.53E-06***	5.510	0.000	Wx lnfdistock	0.008***	3.670	0.000
								Wx lnexport	0.000	-0.080	0.939
R-sq:	within	0.890		R-sq:	within			Wx gover	-0.008	-1.560	0.119
	between	0.036			between						
	overall	0.317			overall			Spatial			
								rho	-0.087	-1.070	0.284
								Variance			
								lgt_theta	-2.48***	-11.000	0.000
								sigma2_e	5.47E-06***	12.210	0.000
								R-sq:	within	0.899	
									between	0.045	
									overall	0.447	

Notes: Wx: the spatially lagged variable. ***, **,* represent respectively statistical significance at 1, 5 and 10% level.

Table 8: Maximum Likelihood Spatial Regressions (SAR, SEM and SDM) with control variable in Asia, Period: 1996-2014, Sample: 23

	SAR				SEM				SDM		
Gr	**Coef**	**z**	**P>z**	**Gr**	**Coef.**	**z**	**P>z**	**Gr**	**Coef.**	**z**	**P>z**
lninitial	- 0.028***	-4.75	0.006	lninitial	-0.038***	-3.970	0.000	lninitial	-0.025***	-3.66	0.000
lnck	0.017***	8.35	0.001	lnck	0.025***	3.540	0.000	lnck	0.019***	7.36	0.000
lnngd	0.052***	8.21	0.006	lnngd	0.032	1.120	0.263	lnngd	0.054***	8.33	0.000
lnkhwdi	0.004	0.77	0.44	lnkhwdi	0.003	0.290	0.770	lnkhwdi	0.005	0.98	0.325
lnfdistock	0.003***	2.98	0.001	lnfdistock	0.009*	1.720	0.085	lnfdistock	0.001	1.15	0.251
lnexport	0.006***	6.00	0.001	lnexport	0.006*	1.660	0.097	lnexport	0.005***	5.26	0.000
gover	-0.001	-0.23	0.003	gover	-0.008	-1.030	0.303	gover	0.001	0.23	0.816
_cons	-0.084*	-1.85	0.06	_cons	-0.214***	-2.440	0.01	_cons	0.025	0.36	0.716
Spatial				*Spatial*				*Wx*			
rho	0.456	0.033	13.790	**lambda**	0.496	2.330	0.020	Wx_lninitial	-0.016**	-1.64	0.102
								Wx_lnck	0.005	1.39	0.165
Variance				Variance				Wx_lnngd	0.016	1.87	0.062
lgt_theta	-2.767	0.181	-15.270	ln_phi	3.323	7.950	0.000	Wx_lnkhwdi	-0.001	-0.16	0.874
sigma2_e	1.003E-05***	0.000	14.200	sigma2_e	1.19E-06***	4.740	0.000	Wx_lnfdistock	0.002	1.1	0.272
R-sq:	within	0.878		R-sq:	within	0.849		Wx_lnexport	-0.001	-0.88	0.378
	between	0.041			between	0.049		Wx_gover	0.018***	3.43	0.001
	overall	0.327			overall	0.165					
								Spatial			
								rho	0.38228	8.4	0.000
								Variance			
								lgt_theta	-2.78	-13.53	0.000
								sigma2_e	9.71E-05***	13.8	0.000
								R-sq:	within	0.8814	
									between	0.0211	
									overall	0.3034	

Notes: Wx: the spatially lagged variable. ***, **,* represent respectively statistical significance at 1, 5 and 10% level.

Table.9: Maximum Likelihood Spatial Regressions (SAR, SEM and SDM) with control variable in Europe, Period: 1996-2014, Sample: 33

	SAR				**SEM**				SDM		
Gr	Coef.	z	P>z	Gr	Coef.	z	P>z	Gr	Coef.	z	P>z
Main				**Main**				**Main**			
lninitial	-0.042***	-9.6	0.000	lninitial	-0.047***	-7.030	0.000	lninitial	-0.046***	-8.91	0.000
lnck	-0.006***	-3.81	0.000	lnck	-0.003	-0.350	0.728	lnck	-0.003*	-1.82	0.069
lnngd	0.007	1.35	0.176	lnngd	0.005	0.490	0.624	lnngd	0.009*	1.69	0.09
lnkhwdi	0.011***	2.49	0.01	lnkhwdi	0.009	1.100	0.271	lnkhwdi	0.012	2.61	0.009
lnfdistock	0.003***	5.11	0.000	lnfdistock	0.004***	2.240	0.025	lnfdistock	0.004	6.94	0.000
lnexport	0.032***	22.98	0.000	lnexport	0.034***	7.880	0.000	lnexport	0.033***	23.56	0.000
gover	0.005***	2.63	0.008	gover	0.003	0.490	0.624	gover	0.003	1.32	0.187
_cons	-0.359***	-7.48	0.000	_cons	-0.430***	-5.380	0.000	_cons	-0.052	-0.35	0.723
Spatial				***Spatial***				***Wx***			
rho	0.192	5.210	0.000	**lambda**	0.473***	5.190	0.000	Wx_lninitial	-0.010	-0.72	0.474
								Wx_lnck	-0.004	-1.18	0.238
Variance				Variance				Wx_lnkhwdi	-0.041***	-2.83	0.005
lgt_theta	-3.055***	-20.18	0.000	ln_phi	3.834***	9.710	0.000	Wx_lnfdistock	-0.004***	-3.43	0.001
sigma2_e	3.67E-06	17.130	0.000	sigma2_e	3.41E-06***	5.180	0.000	Wx_lnexport	0.000	0.08	0.937
								Wx_gover	0.001	0.09	0.930
R-sq:	within	0.93						**Spatial**			
	between	0.081		R-sq:	within	0.93		**rho**	0.31***	4.17	0.000
	overall	0.36			between	0.04		Variance			
					overall	0.24		lgt_theta	-3.27***	-21.46	0.000
								sigma2_e	3.35E-06***	17.02	0.000
								R-sq:	within	0.94	
									between	0.05	
									overall	0.29	

Notes: Wx: the spatially lagged variable. ***, **,* represent respectively statistical significance at 1, 5 and 10% level.