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Abstract

The growth model at the Sala-i-Martin (1991 and 1992) fashion is revisited in order to take into account the interdependence of growth across countries based on the idea that outcomes are subject to mutual influence through a set of geographical, cultural, economic and financial determinants that are likely to condition growth propagation between economies through the world. A spatial lag like model is estimated for a sample of 146 countries from 1995 to 2009 in which the adjacency matrix is endogenous and set conditional of a set of bilateral variables describing the multidimensional aspect of the proximity between countries. MCMC estimation results show several prominent key feature of the growth propagation process through the countries' sample; as 17 MENA countries are in the sample, it was possible to characterize a network of spillover for these countries. One of the most important results is that trade and cultural proximity play a predominant role in growth spillover between countries. Clusters of high spillover effect are not only identified, but also their determinants are clearly assessed along with the importance of their impact. Distinction can be made between reciprocal spillover outcome propagation which identify a high performance cluster and asymmetric propagation witnessing the presence of a hotspot effect.

JEL Classification: C11, F63, O47.

Keywords: Growth model, Endogenous adjacency Matrix, Growth Spillover.

ملخص

نعيد النظر في نموذج النمو في سالا-أي مارتن (1991 و 1992) للأخذ في الاعتبار الترابط بين النمو في البلدان استنادا إلى فكرة أن النتائج تخضع للتأثير المتبادل من خلال مجموعة من المحددات الجغرافية والثقافية والاقتصادية والمالية التي من المرجح أن تشترط نشر النمو بين الاقتصاديات عبر العالم. ويقدر الفارق المكاني مثل نموذج لعينة من 146 بلدا للفترة 1995-2009 ومجموعة مشروطة من مجموعة من المتغيرات الثنائية واصفا الجانب متعدد الأبعاد من القرب بين البلدان. وأظهرت النتائج تقدير عدة سمة رئيسية بارزة من عملية نشر النمو من خلال عينة من البلدان. إلى 17 دول المنطقة موجودة في العينة، كان من الممكن أن تميز شبكة من امتداد لهذه البلدان. واحدة من أهم النتائج هو أن التجارة والقرب الثقافي يلعبا دورا بارزا في انتشار النمو بين البلدان. لم يتم تحديد مجموعات من تأثير امتداد مرتفع فقط، ولكن أيضا يتم تقييم المحددات بشكل واضح إلى جانب أهمية تأثيرها. ويمكن إجراء تمييز بين متبادل نشر نتائج امتداد التي تحدد مجموعة عالية الأداء ونشر غير متناظر لوجود تأثير قوى.

1. Introduction

Over the last two decades the determinants of economic growth have attracted increasing attention in both theoretical and applied research. Yet, the process underlying economic performance is inadequately conceptualized and poorly understood, something, which can be partly attributed to the lack of a generalized or unifying theory, and the myopic way conventional economics approach the issue (Artelaris et al, 2007).

Despite the lack of a unifying theory, there are several partial theories that discuss the role of various factors in determining economic growth. Two main components can be distinguished: the neoclassical theory, based on Solow's growth model, has emphasized the importance of investment and, the more recent theory of endogenous growth developed by Romer and Lucas has drawn attention to human capital and innovation capacity. Furthermore, important contributions on economic growth have been provided by Myrdal's cumulative causation theory, and by the New Economic Geography School. In addition, other explanations have highlighted the significant role non-economic (in the conventional sense) factors play on economic performance. These developments gave rise to a discussion that distinguishes between 'proximate' and 'fundamental' (or 'ultimate') sources of growth. The former refers to issues such as accumulation of capital, labor and technology while the latter to institutions, legal and political systems, socio-cultural factors, demography and geography.

A focus will be granted in the framework of this paper to fundamental factors that are likely to influence growth. Recently a considerable advent has been seen of new economic geography as a way of looking at the causes of regional concentration problems.

Following the seminal contribution by Baumol (1986) later refined by Barro and Sala-i- Martin (1991 and 1992), a large number of studies has made use of cross-sectional growth regressions to see whether regions are converging towards steady-state paths and, if so, at what speed (Magrini, 2004). For more than a decade, the study of the convergence process on the regional and international levels has been the center of interest of regional science and macroeconomic literature. For example, regional convergence processes have been examined for the U.S. experience (Barro and Sala-i-Martin, 1991; Crown and Wheat, 1995; Vohra, 1996; Rey and Montoury, 1999; Miller and Genk, 2005, among others), Canadian provinces (Coulombe and Lee, 1995), and European regions (EU-15) (López-Bazo et al, 1999; Carrington, 2003; Ramajo et al, 2005).

Different theoretical and empirical studies show that a nation growth rate is affected not only by its domestic conditions, but also by conditions of other countries, especially its neighbors and trade partners. To clarify, factors accumulations and technology improvements do not affect the economy of the very country. They also generate some externalities that spill across the frontiers of that economy.

Different theoretical and empirical works has tried to consider the impact of location on growth indirectly through regional dummies or directly by distant variable and spatial econometrics techniques. They find strong evidences that a (region) country's growth rate is positively influenced by the growth rate of (regions) countries nearby (for example see Arbia and Basil, 2005). There are different channels for contiguity spillovers. Countries that are close together may experience common shocks that affect growth as well. Another channel for spillovers is that residents of nearby countries are more likely to have some knowledge of, or have been influenced by, political or economic arrangements in a given country (Moreno and Trehan, 1997).

As Grossman and Helpman (1991) point out, international trade also is an important channel for the diffusion of technology, especially to less advanced small open economies. Recently, evidences have emerged that knowledge produced through R&D in developed countries can spill over through trade to other countries. It is accepted that trade embodying technological knowledge promotes higher growth. Coe et al. (1997) identify four channels through which trade may promote growth. First and the most important, a country can import intermediates which enhance productivity.

The problem with spatial empirical analysis ignores the influence of spatial location on the process of growth is that it may have produced biased results and hence misleading conclusions. To address this problem, some regional economists and economic geographers suggest accommodating spatial heterogeneity and dependence in regional growth specifications (Amstrong, 1995; Rey and Montouri, 1999; López-Bazo et al, 1999).

Their suggestions are broadly consistent with assumptions and predictions made from endogenous growth theory and new economic geography models, which stress the role of interactions across agents that, for instance, cause economic activity to agglomerate in some areas and not in others.

Spatial interdependence of outcomes across units of observation implies that outcomes are subject to mutual influence from units according to the nearest neighbor principle. As stated by Anselin (1988, 1995), this propagation mechanism is conditioned by what is called this contiguity matrix. This contiguity matrix is built mainly according to the physical proximity.

Bernat (1996) and Rey et al. (1999) were among the first to specifically include spatial effects in empirical growth exercises. Bernat (1996), for example, tested the simplest version of the so-called Kaldor's Laws in the set of US States, controlling for spatial dependence. Likewise Rey et al. (1999), checked for absolute β-convergence under spatial heterogeneity and spatial dependence. These early analyses precipitated a series of studies explicitly including spatial effects in growth specifications, mainly in the form of the spatial error model and the spatial lag model, although there has also been some estimation of the spatial model. The selection of one of these models is almost invariably based on a statistical criterion, basically the one proposed in Anselin et al. (1991) and in Florax et al. (1992). Hence, despite the broad agreement that interactions or externalities across regions are likely to be the major source of spatial dependence, they have been modelled in a rather ad hoc manner in most of the existing empirical studies. And what it is more surprising, the empirical evidence on the preferred spatial specification is mixed and seems to depend on the set of regions, time period, specification, etc (Armstrong, 1995; Bernat, 1996; Rey et al., 1999; Niebuhr, 2001; Kosfeld et al, 2002; Baumont et al, 2003; Arbia et al, 2003; Ying, 2003; Fingleton, 2001, 2004).

A turning point of the geographic school in dealing with purely special growth model was the work of Attfield et al. (2000) who attempted to assess any spatial influence between regions and countries. They have found that physical (unidimensional) distance between economies has little role to play in explaining the spatial correlation of growth rate. Definitely distance, as a proxy of a more complicated concept that is proximity is a relatively poor tool to assess the full complexity between regions or units in terms of spill over. Since the early 70's, Cliff et al. (1973) have moved beyond crude measures of between-group spatial distance, such as the simple notions of proximity and contiguity, and brought a slightly more elaborate specifications which nonetheless are still based on the physical features of geographical units. They have combined in their paper distance and length of the common border between contiguous spatial units. Bodson et al. (1975) use a general accessibility weight which combines in a logistic function several channels of communication between regions such as railways, motorways, etc. These measures are less useful when the spatial interaction is determined by purely economic variables which may have little to do with spatial configuration of boundaries or geographical distance per se. This introduces the notion of economic distance, and developments in the conceptualization of economic distance have been surveyed in Greenhut et al. (1987). According to Fingleton et al. (2008) "the spillover between areas will not simply be a function of spatial propinquity, to the exclusion of other effects, and it is more realistic to base it on relative economic distance".

Relative economic distance has been considered by, among others, Fingleton (2001), Fingleton (2008), LeSage et al. (2008) and Fingleton et al. (2008).

As a result of all the body literature described above the conclusion is the following: on the purely theoretical point of view, it is widely accepted and well argued that "proximity" ought to be a multidimensional issue when used to control spatial mutual influence especially when growth theory is assessed. Proximity between economies can be physical, economic, cultural, political, historical, etc. However, we can point out a substantial luck of fully addressing the issue of multidimensional proximity when dealing with growth models. In order to obtain a closer representation of the spatial interaction process, Anselin (2010) suggests greater focus on modelling agents involved in social and economic interaction. Looking back in this context, Patuelli et al. (2007) consider network interaction modelling with reference to earlier work on spatial interaction and discrete choice behavior. Treating the connection between observations as nodes within a whole network seems to be a proper manner to tackle the issue of this multidimensional distance. In this issue a comprehensive body of literature is available with applications dedicated exclusively for network constitutions, social connections friendship network structure assessment. We can cite the spatial autoregressive (SAR) model with different-sized groups in Lee (2007, 2010) or network structures in Lin (2010), Bramoullé et al. (2009) and Lee et al. (2010). The reasons led papers dealing with such an issue focusing on estimating endogenous association between pairs is the fact that physical proximity in its pure definition has little effect on network constitution. The most important factors for pairs association is rather tastes, psychological affinity, cultural, ethnic and historical similarities. Apart from attempts cited above to embed some economic variables in an ad hoc manner to assess this concept of multidimensional distance between units, no research has been conducted up to my knowledge to understand ad assess the full complexity of the channels enhancing growth propagation between countries or regions based on a network like model.

The paper is organized as follow: After a body literature being reviewed in a non-exhaustive manner in the Introduction, Section 2 will be dedicated to the implementation of a network model to assess growth propagation between countries based on an endogenous proximity matrix. Principal results are discussed in the framework of Section 3 with a focus on the MENA region. Section 4 concludes.

2. A Network Model with Endogenous Proximity Matrix

One of the most used growth models is the Barro and Sala-I-Martin (1992) Model, based on Solow-Swan (1956), which tests the convergence hypothesis, and related growth rate of each economy to its socio-economic conditions. This growth model is based on the assumption that the economies are fundamentally closed. Due to this assumption, each country has been viewed as an independent entity. As a result, the potential interactions across countries have been ignored. On the contrary, regarding to the existence role of factor mobility, trade relations and technological diffusion (or knowledge spillovers), the openness assumption should come into consideration. Spillovers are generated through such ways as contiguity; the growth model is reshaped in order to assess any spillover effect between the countries in the sample, ie.

$$y_{it} = X_{it}\beta + \lambda WY + \varepsilon_{it} \tag{1}$$

where y_{it} stands for the GDP growth rate for country i at the period t with respect to the GDP at the initial period and Y the NT vector of y_{it}. $X_{it}\beta$ is the amount of growth explained by the traditional determinant such as investment, labor, labor quality, infrastructure, governance quality, institutional features and political features[1]. W is a contingency matrix where the w_{ij}'s depict the existence of any growth propagation between countries i and j. In the traditional spatial models (Anselin, 1988 and 1995) the w_{ij}'s are known and represent either contiguity indexes ($w_{ij} = 1$ if countries are neighbors and $w_{ij} = 0$ if not) or a distance-based penalty function (the inverse of the distance between countries i and j for example). λ has different interpretation depending on the shape of W. With the row normalization on W, each element of WY summarizes the weighted average outcomes of connected pairs and may be interpreted as average growth propagation intensity. When W is not row-normalized and each entry is either 0 or 1, the coefficient should be interpreted as the spillover from one single connection.

In this article, a prototypical new model is proposed in which w_{ij}'s are endogenous and represent a more general interpretation of the distance separating two counties; indeed, w_{ij}'s are set conditional to a set of covariates, ie. $w_{ij} = G(\Psi_{ij}\alpha)$

Where Ψ is a matrix of bilateral variable representing each a shape of primary connection between countries i and j such as physical distance, cultural distance or ethnic distance between i and j.

Note that there is a problem of a selection bias on the endogenous interactions effect on outcomes. To overcome this problem, number of authors has integrated a distance like variable between observations concerning a set of measured and non-measured characteristics. When these variables are integrated into the model as explanatory variables outside W and inside it as a distance between pairs problem of endogeneity can be weakened (but not completely fixed). The idea behind is that correlation between links is straightforward due to the fact that interactions between countries taking the form of "homophily" and "transitivity". Introducing distance between countries in terms of some characteristics will capture, at least partly, if not completely such correlations through specified individual characteristics.

The design of the model introduces two main innovations: it permits the spillover effect λ to vary through pairs conditional on a multidimensional set of bilateral variables describing their trade and financial integration. The spillover index is modelled as a logistic function of bilateral variables, ie.

$$\lambda_{ij} = \frac{e^{z_{ij}\delta}}{1+e^{z_{ij}\delta}} \tag{2}$$

where z_{ij} is the set of bilateral variables and δ is a vector of parameters to be estimated. As mentioned above the proximity matrix is endogenous and depends on a set of variables describing characteristics of pairs that are likely to condition whether they are likely to interact or not. Let w_{ij} be a dummy variable depicting if counties i and j interact if it's equal to 1 and 0 if not. w_{ij} is considered as a latent variable depicted through its probability of occurrence, ie.

$$P\left(w_{ij} = 1 \middle| X, Z_{ij}, \Psi_{ij}\right) = \Phi\left(\frac{\Psi_{ij}\alpha}{s_1}\right) \tag{3}$$

Where Φ stands for the standard normal cdf and Ψ_{ij} is a N(N-1) row matrix of bilateral characteristics of pairs. Equation (3) implies that the manifest index for w_{ij} is a probit function. s_1 stands for a scale factor (the standard deviation of w_{ij})

The model described in (1), (2) and (3) assumes that λ_{ij} is observed only if $w_{ij} = 1$. That is the spillover or growth propagation index is only observed for pairs that show prerequisite to

[1] Data used in the empirical assessment will be discussed earlier.

permit any growth propagation. The sample selection bias induced by the conditioning of λ_{ij} by w_{ij} is addressed by making use of a Heckman (1979) bias correction treatment. In order to correct the estimation of $logit(\lambda_{ij})$[2] from selection bias this latter is expressed as a conditional expectation, i.e.

$$E\{logit(\lambda_{ij})|w_{ij}=1\} = z_{ij}\delta + \frac{s_2}{s_1^2}\frac{\varphi(\Psi_{ij}\alpha/s_1)}{\phi(\Psi_{ij}\alpha/s_1)} \quad (4)$$

where $s_1 = \sigma_w$ and $s_2 = \rho\sigma_\lambda$ based on Cholesky decomposition of the covariance between error terms of the Odds ratios of w_{ij} and λ_{ij}. Note that (5) is linked to (4) through the standard deviation s_1.

The complexity of the model being elaborated and the presence of a latent variable leads to the use of Bayesian method.

The estimation is based on block Gibbs sampling following sequential steps as preconized by Hsieh et al. (2015):

Step 1 $(\alpha, s_2) \backsim P\{s_2|W,Y,X,Z,\Psi,\beta,\delta,s_1\}$

Step 2 $\delta \backsim P\{\delta|W,Y,X,Z,\Psi,\alpha,\beta,s_1,s_2\}$

Step 3 $s_1 \backsim P\{s_1|W,Y,X,Z,\Psi,\alpha,\beta,\delta,s_2\}$

Step 4 $\beta \backsim P\{\beta|W,Y,X,Z,\Psi,\alpha,\delta,s_1,s_2\}$

Priors used for the parameters are multivariate normal density for α, β , δ and s_2 and truncated normal density for s_1.

Except for β, other conditional posterior distributions are not available in a closed form. In place, Metropolis-Hastings (M-H) algorithm is used to draw from their conditional distributions. The procedure of MCMC sampling starts with arbitrary initial values of parameters and then sampling sequentially from the above set of conditional posterior distributions. To improve the efficiency of the M-H algorithm, an Adaptive Metropolis (AM) algorithm introduced by Haario et al. (2001) is used. The advantage of AM is that parameters' updates are done based partially on previous draws instead of being completely based on a random walk process[3].

3. Empirical Results

The model described in (1), (3) and (4) is estimated for a panel data of 146 countries between 1995 and 2009. Growth is set conditional on the GDP per capita at 1995, and two production factors that are Labor (Total active population) and capital (Gross formation of fixed capital) as proximate factors of growth. In order to assess the internal capacity for a country to enhance GDP by its fundamentals, a set of supplementary variables is added: The first stream of variables give information about the governance effectivity within a country. Variables are a score for control of corruption, a score for Rule of law, regulatory quality and government expenditure as a share of GDP. Proportion of students at the university is added to control the impact of skilled labor and, more generally the degree of education of a country. The degree of technological development is proxied by the proportion of the population equipped by a telephone. Even some of these variables are poor proxies of more global intended variables, they are useful in the sense that they will purge the residual (Total factors productivity

[2] *Logit* stands for the natural logarithm of the odds ratio.

[3] Further technical details are avoided but can be provided upon request.

according to Solow) of the model from a part of the country's own ability to enhance the GDP growth apart from using more inputs.

Linkage is estimated through the MCMC process by making use of the following variables: dgdp: The absolute logarithmic difference between pairs GDP per capita. duniv: The absolute logarithmic difference between pairs' total enrollment in tertiary education.

comleg: a dummy variable equal to 1 if pairs have common legal origin

Dist: Distance separating the capitals of the countries pairs in kilometers.

lang: an index equal to 0 if pairs have no linguistic link, 1 for common official of primary language and 2 if a language is spoken by at least 9% of the population in both countries.

mig: the number of migrants national of one country and living in the other permanently.

trd: the trade of goods between pairs.

Spillover intensity estimated by the λ_{ij} *s* is based on another set of variables that are:

x: exports from i to j in 2000 Million USD

m: imports of i from j in 2000 Millions USD

fdiij: Foreign Direct Investment stock from i to j in 2000 Million USD

fdiji: Foreign Direct Investment stock from j to i in 2000 Million USD

Dist: Distance separating the capitals of the countries pairs in kilometers.

migij: number of migrant from country i to country j

migji: number of migrant from country j to country i

tariff_x: average tariff barriers encountered by country i when exporting goods to country j

tariff_m: average tariff barriers encountered by country j when exporting goods to country i

Linkage and Spillover estimation is based on variables' averages between 1995 and 2009.

Two raisons are behind the use of averages instead of a panel data: the first raison is the number of non-available observations through time which will reduce dramatically the sample size. The second raison is to avoid any lagged effect when dealing with the temporal dimension; using averaged observation is assuming that effects are averaged through the sample period. Since most of the data are structural and stock variables the average should be considered as a structural level which is assumed to be (quasi) fixed in the short and medium term.

Table.1 exposes at a glance the distribution of variables governing connectivity between countries that are used in the model. As stated above, the paper will zoom on the MENA region that's why descriptive statistics are provided for the whole sample (146 countries) and for 17 MMENA countries which are Algeria, Bahrain, Egypt, Iran, Jordan, Kuwait, Lebanon,

Libya, Mauritania, Morocco, Oman, Qatar, Saudi Arabia, Tunisia, Turkey, United Arab Emirates and Yemen. The discrepancy between MENA region and the whole sample is twofold: on the first level one can notice the cultural, legal and ethnic proximity of MENA countries compared to the whole sample. However, when it comes to the economic and financial linkage, the tendency is completely inverted. Average Trade between pairs among the total sample is 347 Million USD while it doesn't reach the half of this amount between MENA countries. FDI stock in MENA countries reaches 241 Million USD on the average while this amount is almost doubled when dealing with the total sample.

The difference between MENA countries and the rest of the sample is depicted through trade barriers proxied by the average tariffs barriers on trade of goods. The average through the whole sample is 14% while it's 17% within MENA countries.

The MCMC estimation results are presented in Table.2. The Gibbs Sampling algorithm, as described above is repeated 80000 times. In order to insure the convergence of the Markov Chain a burn-in is practiced on the first 30000 values. Point estimates of the parameters were estimated by the means of iteration results. The standard deviation is retrieved by calculating the sample standard deviation of the iteration results. Since the values of parameters in a probit or a Logit function have no meaningful interpretation marginal effects are calculated instead for both sets of estimates in order to depict the marginal effect of each variable on its relative index. Marginal effects are presented in Table.2 column 3.

The analysis will be focused on the sets of linkage and spillover estimates. All the parameters of the linkage index were found to be significant (based on the asymptotic Normal distribution assumption). First of all the negative sign of the parameter associated with the distance implies that the distance between pairs still has an important role to play in determining any possibility their growth link. However, the impact of the distance is not the highest among the variables integrated into the model. This statement is confirmed by the value of its marginal effect which comes after the impact of the migration, trade and both common official and ethnic languages. The result implies that an increase of 1% in the distance between two countries will result in a decrease by about 0.06 points in the probability of these countries being linked by a growth spillover relationship. Migration was found to have the largest effect on the probability a pair can be linked. Common languages (both official and ethnic language) along with a common legal origin have a positive impact on the linkage probability. Trade between pairs is an important determinant in linking growth between countries since 1% increase in trade between a pair will result in an increase by 0.066 point in the probability of their linkage. The gap between countries in terms of average wealth proxied by the GDP per capita has a negative impact of the linkage probability implying that the more there is a revenue gap between a pair less will be the chance of a growth spillover between them. The human capital gap between a pair proxied by their absolute logarithmic difference of total enrollment in tertiary education seems to have a positive effect on the linkage probability. These two results keep the contention in the body literature about spillover possibilities between countries being at different levels of economic and/or human development. Nevertheless Results implies that educational differences between pairs is likely to enhance the possibilities of spillover by taking advantage of the technological advance of one country embedded in the physical flow (trade) and financial flow (FDI) and the impact of financial returns from the other country due to its exports and direct investment. Estimates results of spillover intensity will give more clarification about the issue.

In the spillover intensity estimates trade, investment and migration are split in order to distinguish between the sides of the relationship. This modelling permits the proximity matrix to be non-symmetric. The results imply that the FDI stock in the host country has no significant effect in the origin country in terms of spillover. The remaining parameters were found to be significant at least at the 10%. Imports of goods seem to play against the spillovers for the host country.

Besides Exports play a major role in terms of spillover implying that a 1% increase in the exports of a country i to j will lead to an increase of 0.005 points in the growth spillover intensity coefficient λ_{ij} for country i. Here again distance between pair has an important impact in determining the magnitude of the spillover. Tariff barriers play a determinant role in greasing and sanding spillover dynamics between countries. For a country i, increasing by 1% tariffs on goods imported from a country j will increase by 0.005 points the spillover effect in terms of growth induced by the growth of country i (taking the form of customs revenue and procompetitive effect of the domestic supply).

Besides an increase by 1% in the tariffs barriers on export of goods to country j will lead to decrease by 0.019 points in the spillover coefficient for the exporter i. This result come in concordance with the results on exports and imports variable and arguing that exports are the significant vectors of spillover and protectionism tends to alleviate this trade effect.

Results on migration show a symmetric marginal side implying that an increase by 1% of the number of migrants from country i in country j will lead to an increase by 0.004 point in the spillover effect (taking the form of remittances) and a decrease by almost the same magnitude in the spillover effect of country j.

After the principal estimation results being discussed, a focus on the MENA region will be hereafter undertaken in by making a comparison between this region and five other geographic regions distributed on the five continents and showing more or less a significant process of economic, political and cultural integration. The regions are Europe 15 (EU15), MERCOSUR countries, some countries of the northern and central America, Countries of the southeastern Asia and countries of West Africa. The comparison is conducted through two indices. The first index is the density indices: Density and Relative Intensity.

Density as defined by Hanneman et al. (2005) as the average strength of ties across all possible (not all actual) ties. Where the data are symmetric or un-directed, which is the case for the linkage matrix, density is calculated relative to the number of unique pairs (N*(N- 1)/2); where the data are directed, density is calculated across the total number of pairs. Density lies between 0 and 1. The null value implies that there are no ties in the network and 1 implies that all possible ties are verified.

Relative Intensity is a new concept that I have introduced (since no such an index has been implemented at the time being on my knowledge) and based on the connectivity matrix in which terms are λ_{ij}s. The Relative Intensity is the average value of the non-null nodes (existence of spillovers) within a subgroup of the network divided by the value of the non-null nodes in the whole network.

Based on the density of the subnetwork of MENA region, results show that this region performs better than West Africa and Southeastern Asia with an index value of 0.75. However, compared to EU15, MERCOSUR or AMERICA regions, density is substantially week within MENA region. As an example, in the EU15 region 93% of all possible ties are significant implying that 93% of connections in term of growth spillover are significant. In the MERCOSUR region 89% of possible connections between the region's countries are significant.

Based on the Relative Intensity Index, MENA region performs better that all the rest of the regions except EU15. The spillover intensity, when there is a spillover effect, is almost 4.5 times the average of all the sample countries. The spillover effect is more the 8 times the sample average for EU15.

4. Concluding Remarks

The main idea in this article was to assess vectors that are likely to condition growth propagation between economies through the world. A spatial lag like model is estimated for a classical growth model (Solow and Swan, 1956). The contiguity matrix elements here are endogenous and set conditional on variables indicating the different shapes of proximity. A Monte Carlo Markov Chain Bayesian procedure was used in order to estimate both the growth model's parameters and the influence of proximity covariates. Based on the literature dealing with social network constitution process, the growth spillover effect was assessed through two steps; assessing the existence of any possible linkage between countries' pairs based on a set of bilateral structural connectivity variables and then account for the spillover among pairs who showed significant linkage. This procedure is likely to identify subnetworks among countries in the sample and avoid any problem of sample selection bias due to practicing an ad hoc partition of the sample.

One of the most important results is that trade and cultural proximity play a predominant role in growth spillover between countries. Exporting goods and hosting Foreign Direct Investment have a significant effect of accelerating the spillover of a country. For the MENA region linkage between pairs is mainly due to the cultural, legal and linguistic similarities. Geographical proximity still remains an important vector of linkage not only for this region but also for the whole sample. These similarities offer a fantastic chance, as pre-requisites, to these countries to undertake an integration process by enhancing trade and financial integration in order to take advantage of the growth spillover within the Region. It's worth mentioning that the performance of the MENA region in terms of both network density and intensity is mainly due to the wonderful integration assessed within the GCC countries with a density equal to 0.8 and a Relative Intensity Equal to 19.32.

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Table 1: Descriptive Statistics of the Proximity and Connection Variables

	Total Sample				MENA			
	mean	**sd**	**min**	**max**	**mean**	**sd**	**min**	**max**
Trade (in M USD)	347	3640	0	232838	166	396	0	3559
FDI (in M USD)	453	7670	0	519317	241	889	0	10223
dist (in km)	7447	4302	60	19812	2786	1829	139	7696
Mig (number)	8025	122699	0	8220588	14465	70446	0	943147
Tariffs (%)	14	11	0	89	17	15	0	79
comleg	0.31	0.46	0	1	0.69	0.46	0	1
lang	0.26	0.63	0	2	1.46	0.83	0	2
dGDPpc	1.15	1.21	0.00	6.09	1.04	1.01	0.01	4.28
duniv	1.01	1.00	0.00	7.28	0.81	0.52	0.06	2.86

Source: own elaboration

Table 2: Estimation Results

	Estimates	s.d	Marginal Effects
gdp0	-0.0719	0.0068	-
Ink	0.1696	0.0163	-
Inl	-0.1565	0.0244	-
Ink2	-0.0067	0.0015	-
Inl2	0.0082	0.0006	-
Ink1	-0.0002	0.0012	-
cor1	0.0151	0.0139	-
law1	0.0551	0.0166	-
regul1	0.0315	0.0120	-
gov	-0.5450	0.0800	-
uni	0.0016	0.0003	-
tel	0.0033	0.0005	-
Linkage			
intercept	9.8827	0.0030	-
dgdp	-1.0945	0.0002	-0.035
duniv	0.1316	0.0019	0.004
comleg	0.9273	0.0028	0.029
dist	-1.8824	0.0007	-0.061
lang	1.0322	0.0322	0.033
mig	2.2270	0.0013	0.072
trd	2.0450	0.0034	0.066
Spillover Intensity			
intercept	1.5216	1.3889	-
x	0.2264	0.0301	0.005
m	-0.4762	0.0703	-0.011
fdi_{ij}	0.0439	0.0601	0.001
fdi_{ji}	0.1421	0.0480	0.003
dist	-0.5851	0.1561	-0.013
mig_{ij}	0.1810	0.0134	0.004
mig_{ji}	-0.2304	0.0195	-0.005
tariff_x	-0.8325	0.1521	-0.019
tariff_m	0.2041	0.0879	0.005
$sigma^2$	0.0442	0.0013	-
s_1	0.9554	0.1301	-
s_2	1.0324	0.4284	-

Table 3 Density and Intensity of Spillover: A Regional Comparison

	Density	Intensity
MENA	0.75	4.41
EU15	0.93	8.13
MERCOSUR	0.89	0.94
America	0.86	2.17
SE Asia	0.70	2.94
W Africa	0.54	3.36
World	0.30	1.00

Source: Own elaboration