Exploratory study on the presence of cultural and institutional growth spillovers

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Abstract

This paper shows an exploratory study on the use of institutional or cultural proximities on growth model. The justification dealing with spillovers problems in growth models with such connection matrices is detailed. The empirical study answers two questions. First, do institutional and cultural weights are really different to geographical ones? Second, do these proximities have an impact on growth estimation? Analyze concludes that institutional and cultural proximities do differs from geographical proximities. Furthermore, both show autocorrelation with growth. The spatial exploratory study shows that geographical and institutional weights have a great positive impact on growth when cultural similarities show slight but significant effects.

1 Introduction

Empirical studies about growth and convergence processes have been the topic of many great authors' studies. Barro and Sala-i-Martin (1992), Mankiw, Romer and Weil (1992) or Nazrul (1995), among others, have made some of the greatest contributions in this literature. All of these studies have pointed out many differences in the production and the growth values amoung countries. The models are explaining those variations by two sources: physical and human capital. Nevertheless the variation of the residuals may suggest omitted variables in the specification. Indeed, estimations made in the mentioned studies have all

considered countries as being isolated the one from the others. However, the reality is that interactions exist between observations made in different places. In other words, border countries are not impervious to economic performance of one another. The treatment of spillovers is still an unresolved issue in growth econometrics and cross-section correlation are important to determine the estimates.

Since the works of MRW and Nazrul, spatial econometrics methods appeared in economic studies. The idea that growth observations on different localizations are mutually dependant has been modelized in estimations. Ertur and Thiaw (2000) showed that Mankiw, Romer and Weil cross sections data's were biased by a spatial autocorrelation problem. Other studies on growth or productivity have used spatial econometrics methods (Baumont, Ertur and Le Gallo (2000), Beck and Gleditsh (2004), Arbia, de Dominicis and Piras (2005)). All of them have defined spatial dependence with respect to geographic distances or contiguity. Durlauf, Johnson and Temple (2005) argued that one can imagine many reasons for presence of spatial correlation in the error terms. Akerlof (1997) said that countries are perhaps best thought of as occupying some general socio-economic-political space defined by a range of factors. Durlauf and Al. (2005) pointed out that nothing in the empirical growth literature suggests that issue of long term development can be dissociated from the historical and cultural factors. So far, no consensus has emerged from the literature about the fact that geographic distance or contiguity constitutes the optimal way to weight observations. No testing methods exist yet to determine which spatial weights methods are optimal. A valuable generalization of the spillovers treatment is still under investigation.

Interesting works from Hall and Jones (1999) are taking into account the social infrastructure in order to explain differences among countries' productivity per capita. In their work they used the institutions and government policies that provide the incentives for individuals and firms in an economy. In this paper, the social infrastructure will take a formal definition as institutions or informal as culture. This paper will integrate formal and standard aspects of the social infrastructure defined by institutions as well as a more informal approach by integrating the concept of "culture" in the analysis. Indeed the proximity or the distance for countries pair with respect to these concepts can have an impact to the transmission of productivity and thus, growth.

Some empirical studies have already tried to determine the impacts of cultural behavior on the economic performance. Duane Swank (1996)

starts from the idea that communitarian policies countries should have a better economic growth than non communitarian policies countries. The statistical analyze suggests that human capital investment and communitarian policies is empirically more powerful than the alternative. Marcus Noland (2003) has studied the relationship between culture, religion and economic performance. He finds correlations between religious affiliations, the intensity of religious belief and cultural tendencies. Unfortunately, in his study there were no correlations between cultural measures and economic performance but religion is always correlated with economic performance in panel and cross-section estimates. Easterly and Levine (1997), Alesina and al. (2003), Masters and McMillan (2001) have showed that ethno-linguistic fractionalization has a negative impact on economic growth. Barro and McCleary (2004) have shown a strong relationship between economic growth and religiosity. They found out that religious beliefs stimulate growth but that church attendance tends to reduce it. Their interpretation is that religious beliefs may help to sustain aspect of individual behavior. The theoretical literature agrees with the hypothesis of cultural behaviors influencing a country's economic growth. Indeed cultural contents of a country are strongly related to the social organization, the networks and the trust of a population. Languages, religions, origin of law and G. Hofstede indexes (individualism, uncertainty avoidance, distance to power and masculinity) are determining the culture in this work. They are vectors of social rules and trust that can increase the organization of common action.

Acemoglu, Johnson and Robinson (2004) as well as Hall and Jones (1999) though that cross countries differences in output can be explained by the presence of different institutional system. They argue that the way the government affects physical and human capital accumulation by taxes and rules has an indirect impact on economic productivity per capita. The way that redistributions are made affects as well the economic performance. Another channel for the State to insure productivity of individuals and firm is the way it guarantees the security inside the country. Indeed, crime level affects human and physical capital accumulation. Another stylized fact over institutions is that democracy appears as a precondition for prosperity. Indeed, all the developed countries are running from democracy system. A few poor countries, as India does, sustain a democracy in a long run period. All emerging countries have chosen a democratic system as Chili, South Africa and South Korea. Indeed, living in an autocracy cannot insure individuals and firms the private property and represents a capital accumulation-proof fence. Acemoglu, Johnson and Robinson (2004) founding suggests that low growth countries have chosen poor institutions as well, considering institutions

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as endogenous. Giving for example east and West Germany, North and South Korea, China, Taiwan and Hong-Kong, all of these have started with same health level and have grown differently by choosing different institutions. Anyway, this question is still under investigation, and this work will consider institutions as exogenous factor that could help to provide explanation on the variability of error terms in growth estimations.

Another justification of using cultural and institutional matrices of weights is the importance of such distances on trade and foreign direct investments (FDI). Indeed, these features can be seen as factors of capital accumulation. Trade effects on growth level have been pointed out by several authors as Dollar and Kraay (2002) that are showing cross-country estimations that show out a great impact of trade level on growth. Romer and Frankel (1999) had large and robust effects of trade on growth but slightly significant. Other authors as Beugelsdijk, de Groot, Linders and Slangen (2007) or Linders, Burger and Van Oort (2008) have shown the importance of institutional and cultural distances in trade using gravity models. The social infrastructure distance are considering as a cost of trade and invest. Culture may have a positive role on trade and FDI as it stays at low level of differences. But up to a certain level it increases the cost of trade and FDI by complicating interactions, make them prone to fail and hinder the development of trust. They point out that the cost of employees' managing increases as well because of the interactions with local stakeholders as employees, unions, suppliers, government agencies. Institutions by legal, political and administrative systems determine the international attractiveness of a location.

The aim of this work is to determine a cultural and a institutional weights matrices and to answer two questions : Does cultural and institutional proximities really differ from geographical ones? Does those type of proximities have an impact on growth estimations ? The first chapter presents the empirical growth model from Mankiw, Romer and Weil (1992). Then, an overview of spatial econometrics is showed. Second chapter present how cultural and institional matrices are build. Finaly, third chapter will show a exploratory study which point out that differences between all notions of proximities really differ.

2 The empirical model

2.1 Economic model

This paper is based on the neo-classical model of growth, called the Solow-Cass model. In this section, the development of the augmented model made by Mankiw, Romer and Weil (1992) by including human capital will be explained in detail. The aims of this study are to determine if a cultural proximity application of spatial distance could improve the MRW estimates and if there is a spillover of productivity per capita or growth due to a cultural proximity.

The production function of a Solow-Cass model including human capital is

$$Y(t) = K(t)^\alpha H(t)^\beta (A(t)L(t))^{1-\alpha-\beta}, \tag{1}$$

where Y is output, K is capital, L is labor and A the level of technology. H is the stock of human capital. MRW assumes that a constant part s_k of capital and a constant fraction s_h of human capital are invested. Following MRW's paper (1992, pp 416-418), the evolution of the economy is determined by

$$\dot{k}(t) = s_k y(t) - (n + g + \delta)k(t), \tag{2}$$
$$\text{and } \dot{h}(t) = s_h y(t) - (n + g + \delta)h(t), \tag{3}$$

where $y = Y/AL$, $k = K/AL$, and $h = H/AL$. And δ, n and g are respectively the capital depreciation rate, the population growth rate and the rate of technology.

The economy converges to a steady state defined by

$$k^* = \left(\frac{s_k^{1-\beta} s_h^{\beta}}{n + g + \delta} \right)^{1/(1-\alpha-\beta)} \tag{4}$$

$$\text{and } h^* = \left(\frac{s_k^{\alpha} s_h^{1-\alpha}}{n + g + \delta} \right)^{1/(1-\alpha-\beta)}. \tag{5}$$

Substituting those results in the production function and taking the log provides the equation below :

$$\ln\left[y(t)\right] = \ln A(0) + gt - \frac{\alpha + \beta}{1 - \alpha - \beta} \ln\left(n + g + \delta\right)$$

$$+ \frac{\alpha}{1 - \alpha - \beta} \ln\left(s_k\right) + \frac{\beta}{1 - \alpha - \beta} \ln\left(s_h\right). \tag{6}$$

This equation developped by MRW shows how income per capita depends on population growth and accumulation of physical and human capital.

In addition to the Solow-Cass model, MRW (1992, pp 422-423) developped an endogeneous growth equation. y^* is the steady state level of income per effective worker and its level is given by equation (6). Approximating around the steady state, the speed of convergence is given by

$$\frac{d\ln\left(y(t)\right)}{dt} = \lambda\left[\ln(y^*) - \ln(y(t))\right], \tag{7}$$

where $\lambda = (n + g + \delta)(1 - \alpha - \beta)$ is the convergence rate. Equation (7) suggests a natural regression to study the convergence rate and implies that

$$\ln(y(t)) = (1 - e^{-\lambda t})\ln(y^*) + e^{-\lambda t}\ln(y(0)), \tag{8}$$

where $y(0)$ is the income per effective worker at an initial date. Substracting $\ln(y(0))$ from both sides of equation (8) gives

$$\ln(y(t)) - \ln(y(0)) = (1 - e^{-\lambda t})\ln(y^*) - (1 - e^{-\lambda t})\ln(y(0)). \tag{9}$$

By equation (6), it is possible to replace $\ln(y^*)$ and to obtain

$$\ln(y(t)) - \ln(y(0)) = (1 - e^{-\lambda t})\frac{\alpha}{1 - \alpha - \beta} \ln\left(s_k\right) \tag{10}$$

$$+ (1 - e^{-\lambda t})\frac{\beta}{1 - \alpha - \beta} \ln\left(s_h\right)$$

$$- (1 - e^{-\lambda t})\frac{\alpha + \beta}{1 - \alpha - \beta} \ln\left(n + g + \delta\right) \tag{11}$$

$$- (1 - e^{-\lambda t})\ln(y(0)). \tag{12}$$

Equation (11) lead us to a classical estimation equation :

$$Y = X\beta + \varepsilon, \tag{13}$$

$$\text{That is} \quad y_i = \beta_1 x_{i1} + \beta_2 x_{i2} + \ldots + \beta_k x_{ik} + \varepsilon_i \tag{14}$$

where $i = 1, .., N$ is the number of spatial units, $\beta = \left(\beta_1, \beta_2, ..., \beta_k\right)'$ is the vector of parameters, and the ε_i's are the *iid* error terms with expectation equal to zero and variance equal to σ^2.

2.2 Estimation methods

Observations over economic growth has oftenly been considered as independant from each others. In fact, those observations have 'spillovers' problems : a problem of propagation. Indeed, good economic results in a country could have repercussions on its neighbours. Those spillovers are results of spatial autocorrelation between data taken in different places. In order to resolve those problems, we use statistical technics called spatial econometric. The aim of this method is to weight, by a function of proximity, observations in order to take into account those spillovers. In this section, I will present the two most used models and the way to interpret them. Those model are taken from Anselin (2003) and from Ertur and Thiaw (2005).

2.2.1 Spatial lag

The principle of the spatial lag model is to introduce a spatial lag on the dependant variable :

$$Y = \rho WY + X\beta + \varepsilon, \tag{15}$$

where W is a NxN matrix representing a spatial relation between each entities, with the diagonal elements equal to zero and lines normalized to 1. ε is the the *iid* error terms with expectation equals to zero and variance equal to σ^2. By reducing we obtain

$$Y = (I - \rho W)^{-1} X\beta + (I - \rho W)^{-1} \varepsilon. \tag{16}$$

The presence of $(I - \rho W)^{-1}$ with $X\beta$ and the error term in equation (14) implies two spatial effects. Firstly, there is a spatial multiplyer effect which means that for every localisation, Y depends on the explaining variables from its own localities but also from observations in the other localities. Secondly, there is a spatial diffusion effect such that every exogen shock from a localisation affects its own dependent observation (y_i) but also all dependent observations in the other localisations.

2.2.2 Spatial error

In this model, spatial autocorrelation is defined by the correlation between the interest variable's value and the spatial units proximity where such variable is observed. The spatial model is based on the adoption of a spatial process in the error term ε:

$$Y = X\beta + \varepsilon \quad \text{whith} \quad \varepsilon = \lambda W\varepsilon + \mu, \tag{17}$$

where λ is the autoregressive coefficient of the error term ε and μ is the *iid* error term with expectation equal to zero and variance equal to $\sigma^2 I$.

By reducing this specification :

$$Y = X\beta + (I - \lambda W)^{-1}\mu. \tag{18}$$

The presence of $(I - \lambda W)^{-1}$ is related only to the error term. That means that only an exogeneous shock in a spatial unit of the model has some repercussion on Y in all spatial units. Those repercussions are bigger when spatial units are close and smaller if spatial units are far from each other.

2.2.3 Weight matrices

The most important step in a spatial econometric study is to define the dependence between localities. The first proposition have been made by Moran (1948) and Geary (1954). The methods were based on a contiguity relation between all the geographic entities present in the study. The notion of neighborhood was defined by a binary relation. Since that, other notions of spatial dependence have been used. Some are still based on a contiguity relation, other are taking into account the geographic distances between entities or exportation flux between countries.

Spatial contiguity is a binary relation between countries i and j. A relation between two localisations can be defined as

$$c_{ij} = \begin{cases} 1 & \text{if } i \text{ and } j \text{ are contigue} \\ 0 & \text{otherwise,} \end{cases} \tag{19}$$

and $c_{ij} = 0$ if $i = j$.

This specification implies that only neighborhood is important in the relation between two geographical entities. The weight matrix W is then defined as the matrix of contiguity where lines are normalized:

$$w_{ij} = \frac{c_{ij}}{\sum_{j=1}^{N} c_{ij}}. \tag{20}$$

Another way to define interaction between entities i and j is to take the real distances between theirs centers. Define d_{ij} as the distance between i and j. Then, the weight matrix W can be written with

$$w_{ij} = \frac{\frac{1}{d_{ij}}}{\frac{1}{\sum_{j=1}^{N} d_{ij}}}, \tag{21}$$

with $w_{ij} = 0$ for $i = j$.

The inverse distance is taken in order to define a bigger relation for entities near to each other. In general, every decreasing function of distance which gives a bigger relation to close entities can be used :

$$w_{ij} = \frac{f(d_{ij})}{\sum_{j=1}^{N} f(d_{ij})} \ ,$$

(22)

with $w_{ij} = 0$ for $i = j$ and $f'(d_{ij}) < 0$.

3   Weights matrices

Most of the studies are based on geographical spatial dependence. The consideration of this type of dependence has provided good results in many of them but none of them has brought the proof that geographical distances are optimal. Furthermore, it could be interesting to test the impact of other type of interdependence on growth estimation. It is indeed possible that spillovers of growth or productivity can be channeled by social, cultural or political proximities. The problem is how to modelize such qualitative distances by the use of a weight matrix W in order to introduce it in spatial dependence econometrics estimations.

3.1   Geographical weights

The geographical matrix computed with the inverse of distances. Those distances are computed following the great circle formula[1] which uses latitudes and longitudes of the most important cities or agglomerations (in terms of population).

3.2   Cultural Weights

The modelization of cultural weights is build with a tool called proximities between objects[2]. Let us compare two vectors of observations relative to two entities i and j : x_i, x_j where $x_i = (x_{i1},\ x_{i2},\ ...\ ,x_{ik})'$ and $x_j = (x_{j1},\ x_{j2},\ ...,\ x_{jk})'$ with x_{ik} and $x_{jk} \in \{0,1\}$ for all k. Then four cases can appear :

$$x_{ik} = x_{jk} = 1,$$
$$x_{ik} = x_{jk} = 0,$$
$$x_{ik} = 0\ ,\ x_{jk} = 1,$$
$$x_{ik} = 1\ ,\ x_{jk} = 0.$$

Then, we can define :

$$a_1 = \sum_{k=1}^{P} I(x_{ik} = x_{jk} = 1),$$
$$a_2 = \sum_{k=1}^{P} I(x_{ik} = 0, x_{jk} = 1),$$
$$a_3 = \sum_{k=1}^{P} I(x_{ik} = 1, x_{jk} = 0),$$
$$a_4 = \sum_{k=1}^{P} I(x_{ik} = x_{jk} = 0).$$

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[1]The great-circle distance is the shortest distance between any two points on the surface of a sphere measured along a path on the surface of the sphere .

[2]W.Härdle, L.Simar, "Applied Multivariate Statistical Analysis", Lehrstuhl für statistik wirtschaftswissenschafliche fakultät Humboldt, Universität zu Berlin, 2004.

Finally, proximity between objects can be computed as

$$d_{ij} = \frac{a_1 + \upsilon a_4}{a_1 + \upsilon a_4 + (a_2 + a_3)\tau}, \qquad (23)$$

where υ and τ are weight factors which can take different values. υ gives more weight to zero similiraties and τ gives more weight to disimilarities. In this work, Jaccard specification with $\upsilon = 0$ and $\tau = 1$ and Tanimoto's with $\upsilon = 1$ and $\tau = 2$ will be used[3]. Finally, the elements of the weight matrix W are the proximities with lines normalized to 1 :

$$w_{ij} = \frac{d_{ij}}{\sum_{j=1}^{N} d_{ij}} \quad \text{with} \quad w_{ii} = 0 \qquad (24)$$

The last point is how to build binary vectors of comparison between countries with qualitative or quantitative variables ? Let z_{ik} be a quantitative variable of comparison. An element of t_{ik} can be computed by

$$t_{ik} = \begin{cases} 1 & \text{if } z_{ik} > \bar{z}_{.k} \\ 0 & \text{Otherwise} \end{cases}. \qquad (25)$$

Let z_{ik} be a qualitative variable with n modalities. Then, n binary variables can be created indicating the presence or absence of each modality.

The vectors of comparison have been built with variables of religions, languages, legal origin and the Hofstede's four dimensions of culturality for each country of the study.

The religion variable had four modalities: percentage of Catholics, Protestant, Muslim or percentage of other religions. Each one of these modalities had been transformed in a binary variable.

The legal system origin has been divided in five binary variables: British, French, socialist, German or origin.

Languages were divided in seven categories: the six languages officially spoken at the ONU (English, French, Spanish, Arabic, Russian, Chinese) and a category of other languages. Each country could only have one legal system origin but it is possible to have several variables of official languages equal to one.

Finally, the four dimension of Hofstede estimations on cultural indexes were added[4] :

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[3]W.Härdle, L.Simar, "Applied Multivariate Statistical Analysis", Lehrstuhl für statistik wirtschaftswissenschafliche fakultät Humboldt, Universität zu Berlin, 2004.

[4]Hofstede G., (2001), "Culture's consequences: Comparing values, Behaviors, Institutions and Organizations across Nations", Second edition, Thousand Oaks: Sage publications

- Power Distance Index (PDI) that is the extent to which the less powerful members of organizations and institutions (like the family) accept and expect that power is distributed unequally.

- Individualism (IDV) on the one side versus its opposite, collectivism, that is the degree to which individuals are integrated into groups.

- Masculinity (MAS) versus its opposite, femininity, refers to the distribution of roles between the genders which is another fundamental issue for any society to which a range of solutions are found.

- Uncertainty Avoidance Index (UAI) deals with a society's tolerance for uncertainty and ambiguity; it ultimately refers to man's search for Truth. It indicates to what extent a culture programs its members to feel either uncomfortable or comfortable in unstructured situations.

Comparing each country score to the average, these ones were changed to binary data.

After doing this work, 90 countries were still used in the estimations for cultural weight. The cultural weights gives an equal ponderation to similar 1 in the vector of comparison and to disimilarities. No weight are given to similar 0 in the vectors ($\upsilon = 0$ and $\tau = 1$).

3.3 Institutional weights

Institutional weights are build with the observations of Kaufmann and al. (2002) of governance indexes. The worldwide governance indicators are provided as a World Bank database for the years 1996-2007. For this study, only the observations of this index for the year 1996 were used. Kaufmann and al. identified six dimensions of governance and defined them as[5] :

- Voice and accountability : measuring perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media.

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[5]Kaufmann, Daniel, Kraay, Aart and Mastruzzi, Massimo,Governance Matters VII: Aggregate and Individual Governance Indicators, 1996-2007(June 24, 2008). World Bank Policy Research Working Paper No. 4654

- Political stability and the absence of violence : measuring perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism.

- Government effectiveness : measuring perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.

- Regulatory quality : measuring perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.

- Rule of law : measuring perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.

- Control of corruption : measuring perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.

These indicators were constructs on the basis of factor analyses and give a pretty good description of all the matters related to institutionalism. In this paper, our interest is to build some institutional proximity in order to have a new weight matrix in spatial analyses. Firstly, it is necessary to compute an institutional distance for each country pair i and j. The Kogut and Singh index (1988) gives a tool to compute distances between the two vectors of indexes:

$$ID_{ij} = \frac{1}{6} \left[\sum_{k=1}^{6} \frac{(I_{ki} - I_{kj})^2}{V_k} \right]$$

Where I_{ki} is the kth institutional index for the country i and V_k is te variance of the kth institutional index.

As these formula gives us distances, we need to inverse the result to reach a value of proximities beetwen two entities i and j. Then :

$$w_{ij}^{Inst} = \frac{1}{ID_{ij}}$$

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Finally, this weight matrix has to be row normalized to run into the spatial econometrics methods.

4   Results

4.1   Exploratory analysis

The aim of the exploratory study is to answer to several questions and justify the estimations using spatial methods. As the use of geographical weights has already been documented in literature, this paper will focus on the utilization of institutional and cultural weights. Thus, two question have to find an answer in this exploratory analyze, firstly, does institutional and cultural weights really differ from geographical weights? Secondly, does the use of such matrices is justified in growth estimations? The next section will show descriptive analyze of different weight type in order to be able to differentiate geographical proximities and institutional or cultural ones. To answer the second question, an analyze of global and local autocorrelation on growth will be detailed before going to spatial estimates.

4.1.1   Matrices analyses

In order to see if institutional or cultural proximities are different from geographical ones, we have to compare which countries are institutionally or culturally near to a precise location. Figure 1 shows in green the 44 nearest countries to Spain and the red colored ones are the 45 countries under the median.
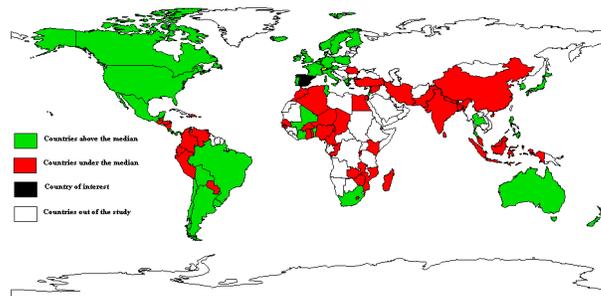
Fig. 1 **Institutional proximities compare to Spain median**

The map clearly shows that nearest countries from Spain are Europeans ones but also a great part of North, Central and South America. Some countries of Africa are considering as near from Spain and Asian countries as South Korea, Japan, Malaysia or Philippines. Australia and

New Zealand complete the list of countries above the median of prox-
imities from Spain. Do the nearest ones geographically are the nearest
ones institutionally? Figure 2 shows the Spain quartiles distribution and
Figure 3. These standing compare to Spanish's institutional proximity
average.
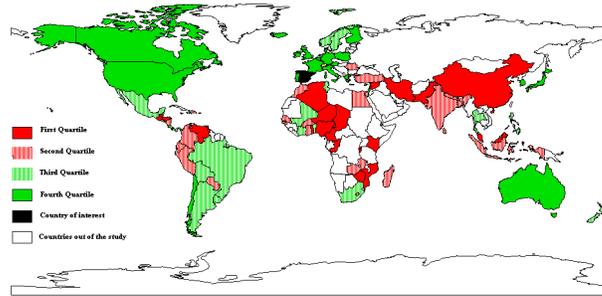

Fig. 2 **Quartiles of Spain's institutional proximities**
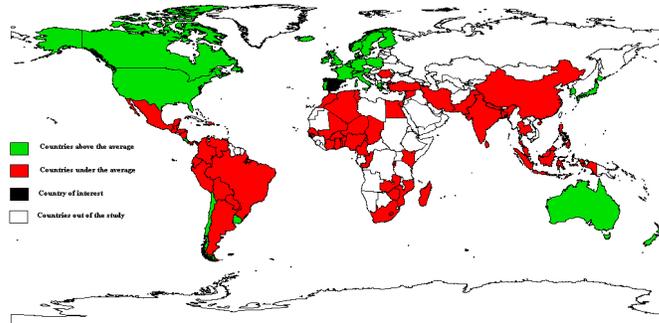
Fig. 3 **Instutional proximities compare to Spain Average**

The fourth quartile represent Canada, United States, Chili and Costa
Rica for America, All European countries except Norway and Sweden,
then Korea, Japan and Australia are composing the nearest institutional
neighbors from Spain. Figure 3 shows that fourth quartile countries
adding to New Zealand, Norway, Sweden, Costa Rica and Paraguay are
above the average of institutional proximities. Figure 4, 5 and 6 are
showing the same maps for institutional proximities from India.
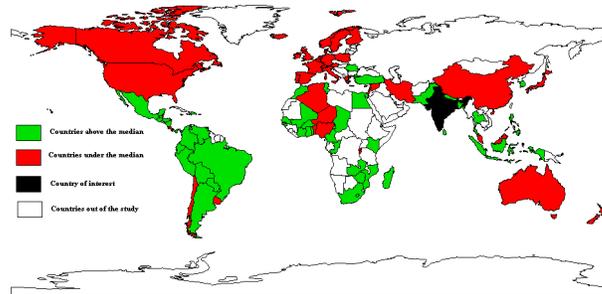
Fig. 4 **Institutional proximities compare to Indian median**
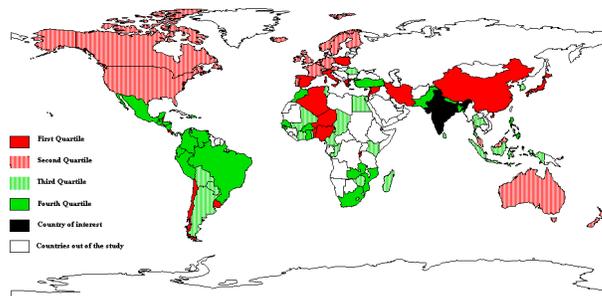
Fig. 5 **Institutional proximities - Indian quartiles**
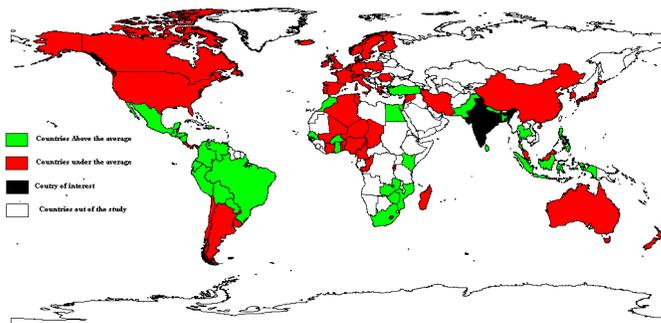
Fig. 6 **Institutional proximities compare to Indian average**

The same results are obtained with India: the countries above the average are those of the fourth quartile of the institutional proximities with India. Looking further to explain this fact, Figure 7 shows the box plots for several countries in different continent in order to see the institutional proximity distribution shape.
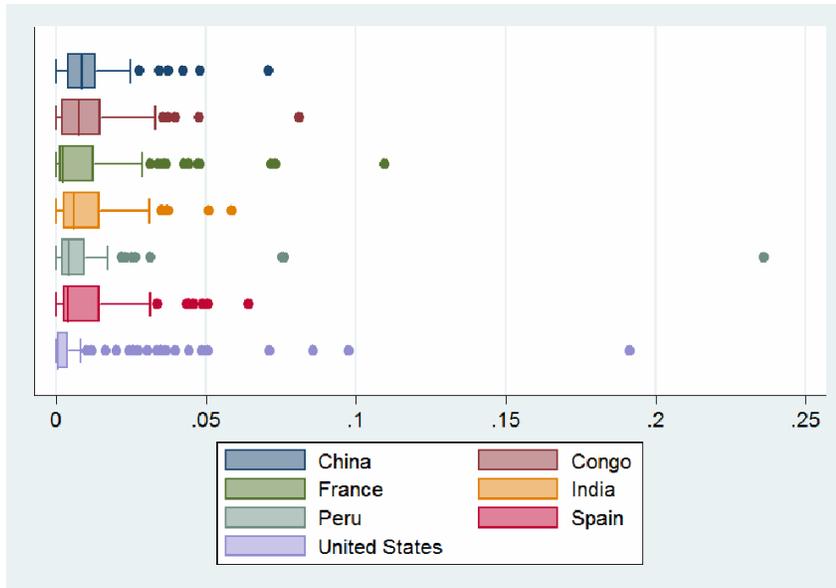
Fig. 7 **Box plot - Institutional proximities**

All countries' box plots have a very asymmetric shape. Furthermore, they do have outboxes high values. These values have a great impact on average that becomes really high compare to the median. It points out that one country have strong institutional relations with few countries. For example Spain main relations are Barbados, Japan and France. Peru has a really strong link with Turkey, Columbia, Mexico and India. The most influent neighbors of India are Ecuador, Nicaragua, Brazil and Bangladesh.

Do these conclusion are the same for cultural proximities? Figure 8 and 9 shows cultural proximities compare to the average for Spain and France respectively. The connections from cultural point of view are different from institutional ones. Indeed, France and Spain are well connected to South and Central America but North America stands under the average for both. France has good cultural connection with Africa (Fig. 9) and Spain.
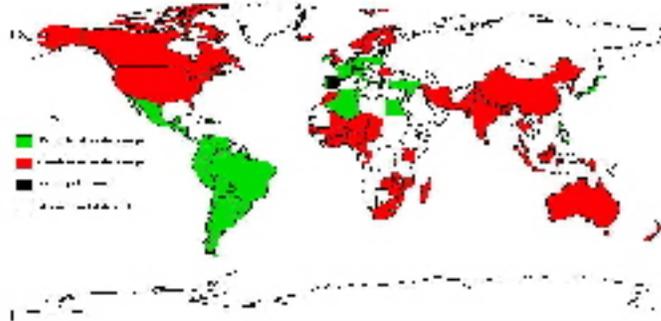
Fig. 8 **Cultural proximities compare to Spain average**
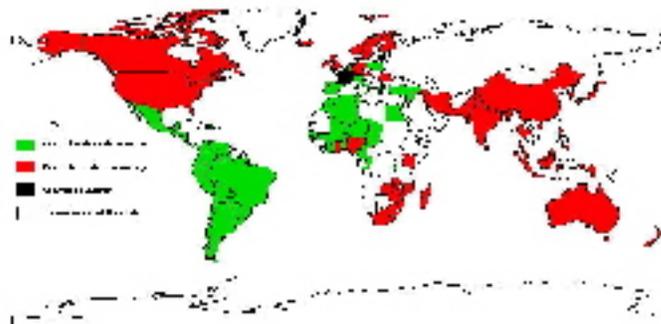
Fig. 9 **Cultural proximities compare to French average**

For cultural connections, median's separation is quite similar to average one due to a more symmetric shape of cultural proximities distribution as shown in figure 10. These facts have two meanings, first connections are above the average for half of the countries present in the study and second they do not have really strong connection with some countries.
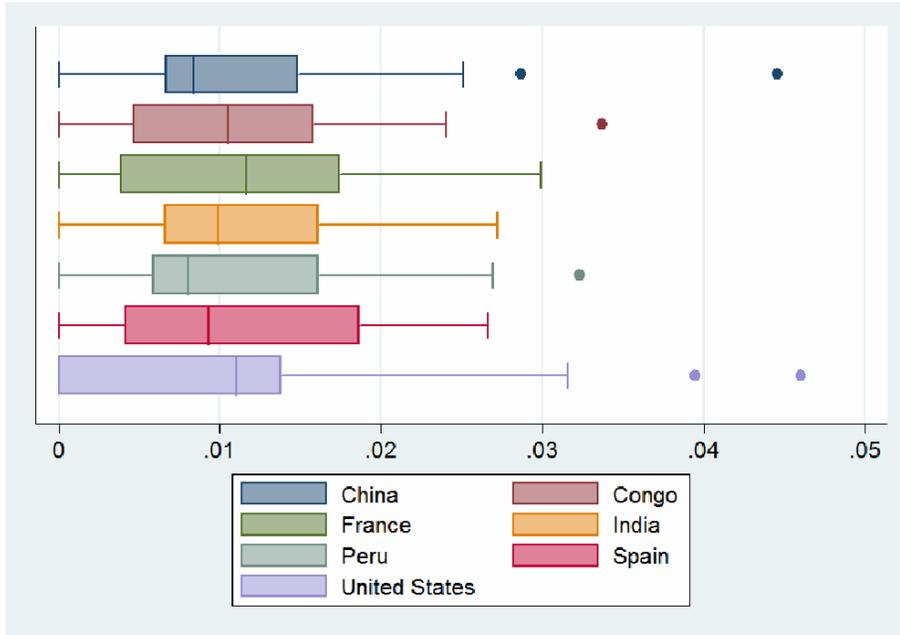
Fig. 10 **Cultural proximities box plots**

All the maps are showing connections quite different from geographical ones from institutional and cultural point of view. Indeed, those weights are connecting countries that would not be looking only from geographical distances. Furthermore, institutional and cultural weights do not reject connections for countries near from each other but does not connect systematically countries from the same regions. A last step to ensure that the three matrices are really different with each other's is to compute correlation between average vectors for each type of distances. Taking weights matrices in absolute value and doing a average of weights for each line gives a vector with one average weight value for all the countries in the study.

$$Average_i^{G,I,C} = \frac{1}{N-1} \sum_{k=1}^{N} w_{ik}^{G,I,C}$$

Table 1 gives the correlation matrix between the three average vectors. Correlation between vectors is really low. Furthermore, correlation between institutional and cultural vectors is low and negative. Even if these correlations are made with countries' average values for each type of proximities, it is possible to conclude that the different weights do not have similar variation on their value. It means that when a country has a great amount of connection from one point of view, he could have very low level of connections from another one. This ensures even more that

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the three ways to ponderate the spatial estimations are different to each other and will influence results on their own way.

Table 1 : Correlation between average weights vectors

Correlations	Geography	Institution	Culture
Geography	1	-	-
Institutional	0,267	1	-
Cultural	0,232	-0,223	1

4.1.2 Impact on growth

The last step of the explorative study is to determine if the weights really have an impact on growth. These part show a global and local autocorrelation analyse.

In order to tell if the is a presence of global autocorrelation over growth datas, two tests will be made : Moran's I test of global autocorrelation and Geary's C test of global autocorrelation. Moran's I is testing the nul hypothesis of no global autocorrelation over a variable.

$$
I = \frac{N}{S_0} \frac{\sum\limits_{i,j=1}^{N} w_{ij} \left(x_i - \bar{x}\right) \left(x_j - \bar{x}\right)}{\sum\limits_{i=1}^{N} \left(x_i - \bar{x}\right)^2} \qquad \text{With } i \neq j
$$

Where $S_0 = \sum_i \sum_j w_{ij}$. The Moran's I value has to be compare to its expected value $E\left(I\right) = -1/\left(n - 1\right)$. Above these value, x has a positive autocorrelation due to spatial weight that means that neighbours have a similar value on x. Under, x has a negative global autocorrelation and neighbouring countries have unsimilar value. Moran's I statistic follow a $N\left(0, 1\right)$ and it is then possible to test I compare to its expected value. If it is significant, it means that the nul hypothesis of no global autocorrelation is rejected. Table 2 shows the result of global autocorrelation Moran's I tests for the Geographic, Institutional and cultural weights matrices.

Table 2 : Moran's I global autocorrelation tests

	Geography	Institution	Culture
Moran's I	0,215	0,173	0,087
$E\left(I\right)$	-0,011	-0,011	-0,011
p-value	0,000	0,000	0,000

The results show that the three tests have a highly significant positive global autocorrelation. That means that one country's geographical, institutional or cultural neighbors have similar growth value. Comparing the Moran's I value, Geographical en institutional weights have a best positive autocorrelation on growth values.

Geary's C is the second global autocorrelation test on x and has the following expression:

$$C = \frac{N-1}{2S_0} \frac{\sum\limits_{i,j=1}^{N} w_{ij}(x_i - x_j)}{\sum\limits_{i=1}^{N} (x_i - \bar{x})^2} \qquad \text{With } i \neq j$$

where the definition of the elements are the same as the Moran's I expression. Geary's C has to be compared to its expected value $E(C) = 1$. A significant test on Geary's C value means a positive global autocorrelation if $C < 1$ and negative global autocorrelation if $C > 1$. Table 3 shows the results for Geary's C global autocorrelation test with geographical, institutional and cultural weights.

Table 3 : Geary's C global autocorrelation tests

	Geography	Institution	Culture
Geary's C	0,767	0,789	0,878
$E(C)$	1,000	1,000	1,000
p-value	0,000	0,000	0,000

Geary's C result confirm exactly those obtained with Moran's I global autocorrelation tests. The three weights matrices have a positive autocorrelation impact on growth. Geographical and institutional connections seem to have the best impact on growth.

A way to visualize the relation between one country growth and neighboring growth is to draw the Moran's scatterplot for each of the connection matrix made for this study. Moran's scatterplot (Anselin, 1996) plots the spatial lag of centered dependant observations Wz with the centered values z in order to detect stability. The dependent values are centered. The plot is divided in four quadrants: the upside right called HH, the downside left LL, the upside left HL and finally the downside right LH. The quadrant HH is the one in which the both values of z and Wz are positives and refers to the cluster of countries with positive

spatial interaction. The quadrant LL is the one in which the both values are negative and refers to the cluster of countries with negative spatial interaction. The others two quadrants refer to atypical localization: a high value surrounded by low values or the inverse. Furthermore the slope of the regression line has the value of the Moran's I statistic.

Figure 11 shows the geographical weights Moran's scatterplot. As showed, the scatterplot has a good positive shape and regression slope points out a real positive impact of geographical proximities on growth. Indeed, a majority of the scatters is in the HH and the LL quadrant and means that high (low) growth countries are surrounded by high (low) growth countries.
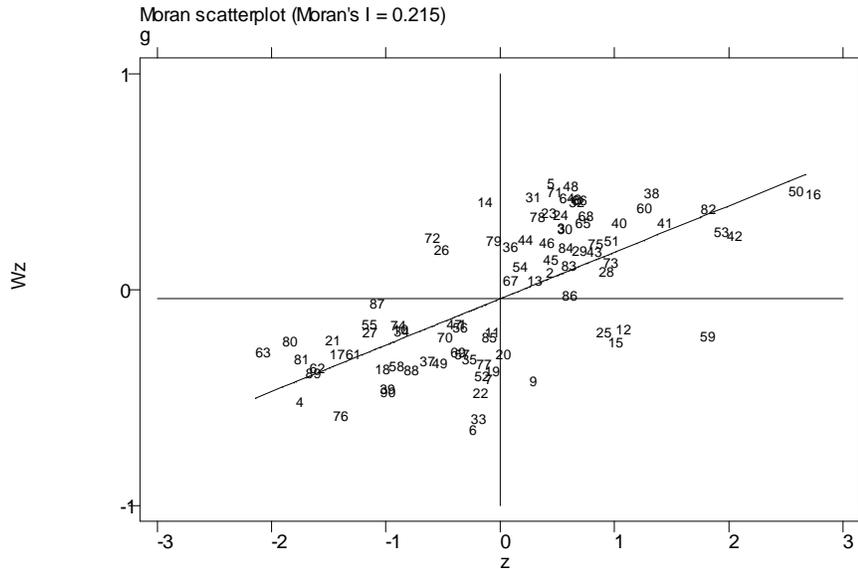

Fig. 11 **Geographical weights Moran's scatterplot**

Figure 12 and 13 show the Moran's scatterplot for the institutional and cultural weights, respectively. Both have a good positive relation and scatter positioned for the most of them in the HH and LL quadrants. It means that the institutional and cultural neighbors of high (low) growth countries are high (low) growth countries. Nevertheless, regression's slope shows a different impact of cultural weights on growth. As institutional weights have the same impact level on growth, cultural one seems to be slight. These observations confirm the results obtained with global autocorrelation tests.

Moran scatterplot (Moran's I = 0.173)

Fig 12 **Instutional weights Moran's scatterplot**
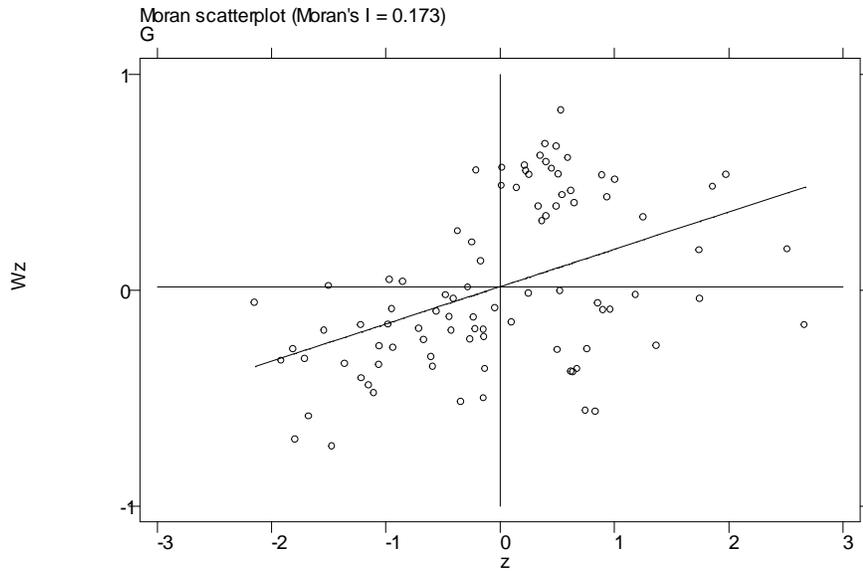
Moran scatterplot (Moran's I = 0.087)
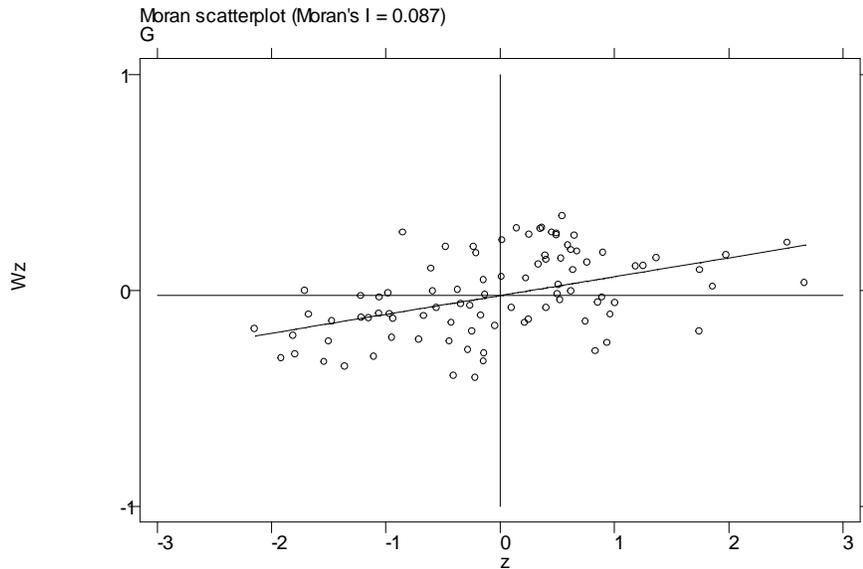
Fig. 13 **Cultural weights Moran's scatterplot**

Finally, a last way to analyse the clusters of countries with growth is to make a Moran's I local analyse. The expression of a local Moran's I_i is :

$$I_i = \frac{z_i}{\sum\limits_{i=1}^{N} z_i^2 / N} \sum\limits_{j \in J_i} w_{ij} z_j$$

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where z_i is normalized value of the interest variable (growth) for country i and J_i the connections with i's neighbors. A positive (negative) value of I_i means that country i is in a clusters of similar (dissimilar) countries. A local Moran's I is calculated for each countries and then tested at 10% significance level. In our case, a map would not help to visualize the clusters as neighbors are not only geographical but also institutional and cultural. Table 4 and 5 show a list of countries by continents that have a significant value of local Moran's I. Normal font countries are significant for institutional (cultural) proximities only, Italic font are only for geographical weights and bold font countries are significant for both.

Table 4 : Countries with significant Moran's I test for institutional weights compare to geographical weights

Europe	America	Africa	Asia
Romania	**Dominican republic**	**Madagascar**	China
Belgium	**Guatemala**	**Kenya**	**Iran**
United kingdom	**Paraguay**	Algeria	**India**
Luxembourg	United states	**Zimbabwe**	**Pakistan**
Spain	**Ecuador**	**Mauritius**	**Bangladesh**
Portugal	Venezuela	Gambia	**Nepal**
Ireland	**Barbados**	**Zambia**	**Malaysia**
Norway	**Honduras**	**Comoros**	Israel
Poland	*Peru*	**Togo**	**Japan**
	Bolivia	**Cameroon**	**Korea**
	Nicaragua	**Rwanda**	**Hong-Kong**
	Chile	**Niger**	*Philippines*
		Chad	*Sri Lanka*
		Burundi	*Indonesia*
		Nigeria	*Thailand*
		South Africa	Australia
		Mozambique	
		Côte d'ivoire	

Most of the countries that are significant with institutional weights are also with geographical ones. Very few countries have a significant negative local test but those who have are different from geographical or institutional point of view. Countries that are in a cluster of dissimilar geographical neighbors are Chile, Barbados, Dominican Republic, Paraguay and Mauritius. Some are high growth countries surrounded by low growth neighbors as Chile. Others are low growth countries

that are near enough from United States to say that neighbors are high growth countries as Dominican Republic. Countries that have a negative local test from institutional weights are China, Iran, India, Dominican Republic, Pakistan, Bangladesh, Romania, Nepal and Malaysia. All of those countries are countries with growth level above the average with institutional connections with lower average growth countries.

Table 5 : Countries with significant Moran's I test for cultural weights compare to geographical weights

Europe	America	Africa	Asia
Poland	**Mauritius**	**South Africa**	**Indonesia**
Norway	**Dominican Republic**	Gambia	**China**
Germany	**Chile**	Mali	**Nepal**
Austria	**Paraguay**	**Chad**	**Hong-Kong**
Romania	Panama	**Burundi**	Israel
Ireland	**Peru**	**Nigeria**	**Malaysia**
Luxembourg	**Honduras**	**Rwanda**	**Pakistan**
United Kingdom	**Venezuela**	**Ivory Coast**	**Sri Lanka**
	Guatemala	**Togo**	**Korea**
	Ecuador	**Niger**	**Japan**
	Bolivia	**Cameroon**	**Thailand**
	Nicaragua	**Comoros**	**India**
	Barbados	*Kenya*	*Philippines*
		Madagascar	*Iran*
		Mozambique	*Bangladesh*
		Zimbabwe	
		Zambia	

For cultural proximities, very few countries have a negative local Moran's I value. Mauritius, Dominican Republic, South Africa, Chile and Indonesia are countries that are clustered with culturally dissimilar countries. All these results confirm that geographical, institutional and cultural weights are different from each other. Even if 36 countries have a locally significant value in both, institutional and geographical or cultural and geographical, they do not have the same clusters.

As proximities differ from the point view and as growth values show an autocorrelation either with geographical than institutional or cultural weights, it is interesting to go through a spatial analyze of growth models with those three type of ponderation.

5 Conclusion

Countries are not isolated from each other. The most obvious way of connection between them is naturally geographical situation. Indeed, the economic literature agreed that growth spillovers are due to physical proximity between entities. This study has showed other connections between countries, taking into account cultural and institutional similarities. Those types of proximities could indeed have an important role to play for growth propagation. Two countries that have similar institution or cultural behavior reduce the cost and the barriers to trade, FDI and economic collaboration. Thus, non physical proximity has a role to play in economic spillovers.

This paper has showed how to build institutional and cultural proximities. The obtained weight matrices are really different from each other's and mainly from the geographical one. The most interesting results are the way those matrices are connecting countries. Indeed, it appears new clusters of countries due to their common institution, common language or religion and common behaviors. From institution proximities, it appears that linked countries are more developed ones: whole Europe, North America, Japan and South Korea are closed institutionally speaking. For cultural proximities, many clusters tend to appear. Naturally, countries with same language and religion are getting closed. Furthermore, the historical links from colonial relation get out the results: France is linked to a great part of French speaking African countries and Spain is linked with a great part of South America.

The spatial exploratory analyze have also showed that growth is suffering global spatial autocorrelation problems with respect to geographical, institutional and cultural spatiality. Growth observation of one country depends on growth observation of its neighbors, institutional neighbors and cultural neighbors. The way that proximity affects growth is positive for all weights matrices. Even in a local study, a very few countries are clustered with non similar countries. The spatial exploratory study shows that geographical and institutional weights have a great positive impact on growth when cultural similarities show slight but significant effects.

To conclude, this paper shows that geographical and institutional proximities are different and both are channel of growth spillovers. Cultural weights do not seem to play an important role in growth propagation or maybe it may contain ambiguity in the way to influence propagation. Institutional differences seem to be a higher constraint for growth propagation. These results are opening new research perspectives as choosing the best spatial models for each spatial weights,

geographical analyses of growth or production diffusion, estimating relative importance of different weight matrices, going further by including geographical, institutional and cultural externalities on growth. Finally, the new found clusters of countries can be studied as convergence club.

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