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Neighborhood and Economic Spillovers

"Four essays on the role of culture, institutions and geography"

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GENERAL INTRODUCTION

Background

Nowadays, most of the data that economists have to deal with concerns a specific location such as a region or a country for instance. Moreover, the data they use is very often cross-sectional in nature. With this in mind, the main criticism raised by economists is that in most studies, the dependences between different locations are not taken into consideration. In order to take the potential dependences into account, they use spatial econometrics, a statistical field of economics that allows them to capture the influence a given location can have on other locations. This phenomenon is known as ‘spillover’. Spatial econometrics takes the spillover between entities into account by building a physical relationship which is generally represented by the relative geographical location of the given countries. It is indeed possible that both the growth and the productivity of a country are affected by neighboring countries. The statistical dependence between two observations in two different places is known as spatial autocorrelation and leads to a bias when estimating models in a classical econometrics framework. Spatial econometrics averts the presence of the bias and allows us to obtain consistent estimators despite the spatial interdependences present in the dataset.

During the last decade, a large number of authors have used spatial methods in empirical studies. Most of them considered the observations’ interdependence through the physical proximities of the entities studied, modeled using a weight matrix. A considerable contribution was made by Beck, Gleditsch and Beardsley in their paper “Space is more than Geography” (2006), who considered a political notion of distance such as relative trade or common dyad membership rather than the traditional relative geographic position. Their study raised great interest among researchers as there is no clear evidence that the physical link is the most effective way to account for the relationship between entities. No comparative test is as yet available to determine which matrix best captures the relationship between two countries.

The present thesis investigates the use of various weight matrices to model dependence between countries from different perspectives. Geographical weights are naturally used in the study for two reasons: first because acknowledging that other channels of spillover exist does not mean that the geographical link is no longer relevant, and second, the geographical relationship is used as a benchmark to compare non-physical relations. The approach is empirical and the following studies are all related to macroeconomic issues such as growth, productivity and poverty.

Geography

The geographical location of a country can affect its growth in different ways. First, the location itself may explain the country's growth performance. Countries that are close to one another may experience common shocks that can impact on their growth. For instance, many poor countries are located around the equator and countries in tropical regions have less fertile soils, unstable water supplies, a larger incidence of disease and other adverse conditions, all of which can impede their development. Second, a country's neighborhood can also play a role. For instance, war in one country may affect its neighbors because of migration or complicated access to some markets, or even potential 'collateral damage' from the war itself. Finally, location determines access to foreign markets as well as access to the domestic market by foreigners. Empirical evidence tends to show that trade and foreign direct investment (FDI) flows between countries depend on the distance separating them. This is a traditional feature of the "gravity equation" that seeks to explain bilateral trade (Bergstrand, 1985), but it is also increasingly recognized as an important feature of FDI flows (Eaton and Tamura, 1994). Trade and FDI are acknowledged as key channels of growth across countries (e.g. Grossman and Helpman, 1991 and Frankel and Romer, 1999). In addition to the traditional gains in terms of comparative advantages or scale economies, trade and FDI may foster the dissemination of technology, especially to less advanced economies. For instance, importers from poorer economies can benefit from training by suppliers from more technically advanced countries in the use of specialized equipment or the innovations embodied in imported equipment. Producers in less advanced countries may also improve their organization skills and best practice, and gain other spillover from foreign investors. Since the geographical distance appears to be an important determinant of trade and FDI, a country's location is likely to matter in terms of growth.

Empirical evidence seems to lend support to the impact of location on growth. Moreno and Trehan (1997) tested directly whether a country's long-term growth depends on what happens in neighboring countries, without seeking to identify the channel through which the effect operates. They showed that a country's growth rate is positively influenced by the growth rate of neighboring countries and that this reflects more than just the influence of common shocks to the region. Their results appear robust, and include a set of variables commonly used to predict growth rates. Interestingly, they also found that being near a large market (measured by the neighbor's total real output) is important to growth, while being near wealthy countries (measured by output per worker) is not.

Redding and Venables (2004) examined the influence of flows of goods, production factors, and ideas as channels of transmission between per capita incomes. They focused on two types of distance, distinguishing on the one hand the distance between a country and the markets in which its sells its output, and on the other, the distance between a country and its supplier of manufactured goods, capital equipment and intermediate goods. They found that geographical access to both markets and sources of supply is statistically significant and quantitatively important in explaining cross-country variation in per capita income. Their results also appear robust and include a number of other variables such as institutional, social, and political infrastructures.

Ades and Chua (1997) focused on political instability. They found that political instability in neighboring countries has a strong negative effect on a country's economic performance. The magnitude of this negative externality is similar in size to that of an equivalent increase in domestic political instability. One main channel through which neighbors' instability reduces economic performance is trade flows. The share of merchandise and manufactured trade are lower in countries with high neighborhood instability. This means that the gains from reducing neighbors' instability extend far beyond the welfare of the country experiencing political unrest.

Religion - Culture

The relationship between religion and economic performance is one of the oldest debates in economics. Adam Smith noted that participation in religious groups induces economic advantages for members because it acts as a reputation signal or provides extra-legal means of establishing trust and reducing uncertainty. In contrast, John Stuart Mill considered religion as a constraint that can hamper the pursuit of personal interests. Karl Marx even inverted the direction of causality between religion and economic performance. Rather than religion determining economic relations, he argued that the underlying technology determines the prevailing social structure and even the dominant culture (Guiso et al., 2006, p 26).

Subsequently, Max Weber developed a clearer and more provocative argument about religion and economic performance. While he produced works on Hinduism, Buddhism, and Confucianism, almost completed his essays on ancient Judaism, and was planning to work on Islam, it is his analysis of the relationship between Protestantism and capitalism that attracted most attention. Weber argued that the Protestant Reformation encouraged work and wealth accumulation, which gave individuals the moral strength to engage in production, investment and profit-seeking. In contrast, Catholicism glorifies monasticism, sin, repentance, atonement, and release. The result was the focus of Protestants on diligent, efficient economic activity, thrift, and non-ostentatious accumulation of wealth, which he saw as the bedrock of modern capitalism.[1]

The empirical evidence is mixed. Grier (1997) tested whether Protestantism is positively related to economic growth and development in a paper that focused on the growth performance of the Spanish, French and British ex-colonies. In a pooled sample of 63 ex-colonial states, the author found that the former Spanish and French colonies (mostly of Catholic tradition) performed significantly worse on average than former British colonies. The results also showed that the growth rate of Protestantism is positively and significantly correlated with real GDP growth, and that the level of Protestantism is significantly related to real per capita income levels, which suggests that there is a risk of spurious correlation. The author therefore controlled for the level and growth rate of Protestantism. This did not, however, eliminate the gap between the three sets of former colonies.

Barro, McCleary and Beardsley (2006) refined the analysis by focusing on religiosity instead of religion. Their study used international survey data on religiosity for a broad panel of countries to investigate the effects of church attendance and religious beliefs on economic growth. To isolate the direction of causation from religiosity to economic performance, the estimation relies on instrumental variables drawn from a regression in which church attendance and religious beliefs are the dependent variables. The results show that economic growth responds positively to religious beliefs, notably belief in heaven and hell, but negatively to church attendance. According to the authors, these results concur with a model in which religious beliefs influence individual traits that enhance economic performance. The

[1] For an alternative channel by which Protestantism affects economic growth, see Becker and Woessmann (2009).

beliefs are an output of the religious sector, and church attendance is an input of this sector. Hence, for given beliefs, higher church attendance means more resources used by the religious sector.

Noland (2005) investigated the relationship between religion and economic performance using both cross-country and within-country regressions. The null hypothesis that religious affiliation is uncorrelated with performance is rejected (i.e. religion matters). However, the results do not show any significant impact of a specific religion on economic growth. Since the impact of Islam on economic performance is increasingly subject to debate in professional circles, Noland addressed the issue using both cross-country and within-country data. The latter pertains to three multi-religious, multi-ethnic countries located in three different parts of the world: India, Malaysia, and Ghana. The results with respect to Islam do not support the notion that it is inimical to growth. On the contrary, in both the cross-country and the within-country regression, there are positive and statistically significant coefficients of the Muslim population shares on economic performance.

Effectively, religion is part of a broader concept, in other words, Culture. The latter can be defined as the system of shared beliefs, values, customs, behaviors and artifacts that members of a society use to cope with their world and with one another, and that are transmitted from generation to generation through learning. It appears from this definition that there are no clear factors which define the concept of culture with certainty. Of course, language or religion fit the definition well but cannot capture all the facets of the relations between individuals. However, the arguments in the literature used to justify the influence of religious beliefs on economic observations can also be applied to the influence of culture.

Institution

The role of political institutions in shaping differences in growth rates and incomes across countries is probably the most robust finding of the new growth empirics. According to North (1990), institutions “consist of formal rules, informal constraints - norms of behavior, conventions, and self-imposed codes of conduct - and their enforcement characteristics.” From an economic point of view, institutions aim at organizing and supporting market transactions. The general relation between institutions and efficiency can be traced back to the impact of political uncertainty on state policies and state behavior. Thus, inefficiencies may arise either as a direct consequence of government action, or indirectly if policies are introduced that disrupt the incentives available in the private sector.

Governments may also directly affect efficiency through the provision of public goods. Thus, a government that lacks checks and balances may be more tempted to finance inefficient investment projects, be it to please its constituency, to finance white elephants, or to obtain money from its members or supporters. The institutional environment also affects efficiency through its impact on the incentives available to private agents. The key characteristic of the institutional framework in this case lies in the definition and protection of property rights. Finally, institutions may hamper aggregate efficiency through the quality of private investments, either domestic or from abroad. To sum up, ill-functioning institutions can affect growth in its various determinants.

There is now rich empirical evidence supporting the above claim. Some researchers have focused directly on growth while others have examined the impact of institutions on the determinants of growth. Cross-section regressions which aim at explaining growth or its determinants now usually include at least one measure of institutional quality in their set of explanatory variables. Rodrik et al. (2004) investigated the impact of institutions on per capita income. They also included indicators of geography and trade among their regressors. Their results suggest the primacy of institution as a determinant of growth. Once institutions are controlled for, geographic indicators appear to have a weak direct effect on income, while trade indicators are almost always insignificant. Brunetti and Weder (1998), Mauro (1995) and Knack and Keefer (1995) examined the impact of different facets of governance, ranging from political stability to the control of graft, and showed that they tend to be associated with lower growth and investment when they deteriorate. Schneider and Frey (1985) found that political instability has a negative impact on Foreign Direct Investment (FDI) inflows. Gastanaga et al. (1998) showed that corruption, bureaucratic delays and poor contract enforcement are associated with lower FDI to GDP ratios, a result confirmed by Globerman and Shapiro (2002) and Wei (2000).

Besides the quantity of investment, other evidence concerns its quality. Tanzi and Davoodi (1997) observed that while corrupt governments tend to invest quantitatively more, they also tend to devote fewer resources to the maintenance of past projects, thereby reducing the quality of public infrastructures. Mauro (1998) showed that higher levels of corruption are associated with larger public investment in unproductive schemes. Finally, Kaufmann et al. (1999b) observed a significant negative relationship between the deterioration in the quality of governance and human capital.

Other studies have shown that low quality institutions have a negative impact on aggregate productivity (Hall and Jones, 1999), productivity growth (Olson et al., 2000) and international trade (Rodrik, 2000 and Anderson and Marcouiller, 2002), variables that economists consider as important drivers of economic growth.

The contribution of this thesis

The above discussion suggests that geographical, institutional, religious and cultural links may be determinants of growth. We address a number of issues in this thesis. The starting point is naturally a study on growth, while the main focus is on the analysis of inequalities between countries with respect to their environment, and also on inequalities within countries.

The very first step of the study, presented in Chapter one, is to build such non-physical relations between countries. In this chapter, we present both the choices and methods used to model the institutional and cultural weights matrices. Chapter 1 also presents a comparative study between the different matrices built. The final aim of this chapter is to identify the differences between the geographical, institutional and cultural environment.

The following chapter incorporates these innovative new types of matrices in a study on growth. An externality growth model is therefore developed that takes proximities between entities into account, whether geographical, institutional or cultural. The purpose of the chapter is threefold. First, it compares the results obtained from spatial econometrics methods with classical regression, where observations of growth are considered as independent. Second, it examines whether the development of an externality model improves the quality of the estimation. Third, it investigates whether the institutional and cultural types of proximity make sense compared to the geographical one.

Chapter 3 narrows the analysis of countries' dependency with regard to their neighborhood, whether geographical, institutional or religious, and a quintile regression approach allows us to check whether the countries' wealth level matters. Do the poorest countries react in the same way as richer ones regarding the wealth of their geographical, institutional and religious neighbors? The gross impact of neighboring wealth on a country's wealth is then estimated, and some relative effects of the three matrices combined are also shown, as well as the robustness of the estimates.

Finally, Chapter 4 analyzes the dependence of poverty regarding neighborhood. The relative wealth and poverty of the neighborhood are examined as factors that can influence a country's poverty level. The poverty index used is the proportion of people living on less than one or two dollars a day. The study only considers the developing countries as data for the developed countries on the proportion of this variable is near zero. Once again, the final aim is to check whether a country's poverty is exacerbated by its geographical, institutional and religious neighborhood poverty or if it takes advantage of neighborhood wealth to manage its own poverty issues.

CHAPTER 1

NEIGHBORHOOD: CONCEPTS, MOTIVATIONS AND MEASURES

Abstract:

Several economic studies have employed spatial econometrics methods to identify the spillovers between entities and to control for spatial autocorrelation. Generally, space has been studied as a physical proximity between entities. This paper presents an exploratory study for building institutional or cultural proximities. The main questions of the study are: "How should we build such proximities?" And "Do institutional or cultural proximities differ from geographical ones?" After developing a methodology to obtain relational matrices for institutions and culture, the paper suggests that such proximities do diverge from geographical relationships. The paper therefore concludes that these factors could be used in a comprehensive economic study on growth and production for instance.

1. Introduction

Spatial econometrics aims to consider the effects of neighborhood in its estimations. This consideration is usually made through methods that channel the neighbor effect via explanatory variables or through the error term of a model. Nevertheless, spatial studies as a whole rely on the definition of neighborhood itself. The way the entities studied are connected impacts directly on the results of the estimates. Spatial econometricians have therefore focused on the weight matrix that defines the interdependence between entities. Many ways of defining geographical proximity have been investigated, from simple contiguity to the metric distance between the different centers. Other authors have even introduced the concept of a friction parameter in order to give more value to the better connected entities. However, no testing methods have as yet clearly shown how to model the best weight matrix for a spatial econometric study. The issue of the best fitting relationship between countries, regions or geographical entities is the starting point of this thesis while, in parallel, we ask: "Why choose geographical rather than cultural or institutional links?" There is no straightforward answer to this question but some empirical experiments can be conducted in order to decide whether it should be rejected it or not.

Assuming that geographical connections could be replaced by other interdependence factors, we explored some institutional and cultural proximity factors to define the relationship between places. As institutional and cultural matters tend to be related to macroeconomic data, we chose to concentrate on country level. The main goal of this thesis is therefore to study whether institutional and cultural neighborhoods are as significant as geographical neighborhood. Before interpreting the results of such proximities within economics models, we needed to conduct an exploratory study of these institutional and cultural dimensions. The following chapter investigates the opportunity to create institutional and cultural neighborhoods before comparing the dimensions obtained.

Section 2 and 3 argue respectively for the importance of neighborhood in economics and the various concepts of neighborhood already defined in the literature. Section 4 shows how the connection matrices are generally built. Section 5, 6 and 7 explain why the data used for the construction of the geographical, institutional and cultural connection was adopted in the following chapters of this thesis. Finally, section 8 compares the three dimensions and section 9 concludes.

2. The importance of neighborhood in economics

In many empirical studies, economists have used data that concerns a specific location such as a country, a region or a city. Indeed, it is generally admitted that cross-sectional observations are independent from one another, even without testing or discussing the interdependence between the entities studied. Historically, the work by Cliff and Ord (1973), which shows the state-of-the-art spatial methods for statistics, has raised the interest of economists in spatial analysis. Since then, many authors have contributed to this literature, mainly through the development of testing methods for spatial data (see Ord (1975), Paelinck and Klassen (1979) and Anselin (1980)).

Thanks to the advances in spatial data testing theory, economists are now able to check whether observation sets suffer from spatial autocorrelation. Anselin and Berra (1998) gave a broad definition of this: “Spatial autocorrelation can be loosely defined as the coincidence of value similarity with locational similarity.” Tobler (1979) already stipulated that geographic distance is just that: “Everything is related to everything, but closer things more so.” More specifically, spatial autocorrelation may have two sources. On the one hand, it can be due to the fact that the data are affected by the same effects that link locations within a specific organization of space. The strength of interaction indeed defines the way in which a specific shock in one place could affect economic observations in other places. On the other hand, spatial autocorrelation may be due to a misspecification of the model. Spatially correlated omitted variables, misspecification of the relationship function, or measurement errors may hide a spatial relationship. In this case, spatial autocorrelation may be used as a diagnostic tool for misspecification.

The development of testing theory alone does not explain the sudden interest in the use of spatial econometrics over the last few years. Anselin (2000) gives two main reasons for the upsurge in the use of spatial treatment in economics. First, the development of economics theory linked to geography, such as industrial and international theories, which include the concepts of interactions and/or externalities in agents’ decisions, have increased. Second, it appears that economists are now more likely to use spatial datasets for empirical studies. Both the development of theories and datasets give economists greater incentive to consider spatial effects.

3. Concepts of neighborhood

The definition of the neighborhood between the entities studied defines the structure of their relationship. Generally, this relationship is structured through a physical relation represented by the relative geographical position between the regions. While there are several ways to define this physical relationship (see next section), the geographical dimension has been used and discussed by several authors.

Durlauf, Johnson and Temple (2005) argued that there could be many reasons for the presence of spatial correlation in error terms. Akerlof (1997) stated 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 the issue of long-term development can be dissociated from historical and cultural factors, while Beck, Gleditsch and Beardsley (2006) considered the political notion of distance, such as relative trade or common dyad membership.

An interesting study by Hall and Jones (1999) takes social infrastructure into account to explain differences between countries' productivity per capita. In their study, the authors consider that institutions and government policies provide individuals and firms in an economy with incentives. In this paper, the social infrastructure is formally considered as institutions or informally as culture. Our paper integrates the formal and standard aspects of social infrastructure defined by institutions, as well as a more informal approach by integrating the concept of ‘culture’ into the analysis. The proximity or distance between pairs of countries with respect to these concepts can indeed have an impact on the transmission of productivity and thus, growth.

So far, no consensus has emerged from the literature regarding the notion that geographic proximities provide an optimal way to set neighborhoods. Furthermore, no testing methods exist to determine the optimal spatial weights to use. A valuable generalization of spillover treatment is still being investigated.

The present thesis analyzes the opportunity to build a qualitative relational structure such as cultural or institutional proximities between the entities studied. The following sections will therefore present the different measures of neighborhood with respect to the idea formulated by Beck, Gleditsch and Beardsley (2006), namely, “Space is more than geography.”

4. Measures of neighborhood

The most important step in a spatial econometric study is to define the type of dependence between localities so that the dependence matrix W can be defined (NxN matrix). The first proposition was made by Moran (1948) and Geary (1954). Their method was based on a contiguity relationship between all the geographic entities considered in the study. The notion of neighborhood was defined through a binary relationship. Since then, other notions of spatial dependence have been used. Some remain based on a contiguity relationship while others take the geographic distances between entities into account as well as exportation flows between countries.

Spatial contiguity can be defined by a binary relationship between two countries. Let S be the set of N countries considered in the study and let i and j denote two countries from this set. A relationship between two countries can be defined as follows:

$$c_{ij} = \begin{cases} 1 & If\ i\ and\ j\ are\ contiguous \\ 0 & Otherwise \end{cases}$$

with $c_{ii} = 0, \forall\ i \in S$ by convention.

This specification implies that only direct neighborhood is involved in the relationship between two geographical entities. For instance, the relationship between the Netherlands and France would be set to zero in a contiguous weight matrix and therefore no interdependence would be considered between these two countries. All the interdependence is imputed to Belgium that is situated between the two countries.

The contiguous weight matrix W can then be defined as the contiguity matrix where all lines are normalized in the following way:

$$w_{ij} = \frac{c_{ij}}{\sum_{j=1}^{N} c_{ij}} \qquad \forall\ i, j \in S$$

Another way of defining the interaction between both entity $i$and j is to consider the physical distances between their respective centers. This specification of neighborhood would put a closer relationship between France and Belgium than between France and Spain due to the distance between their capitals, if we consider the centers as the capitals.

A real distance connection matrix D (with elements $d_{ij}, \forall\, i,j \in S$) is defined as the distance between the centers of i and j. Hence, the weight matrix W can be written as follows:

$$w_{ij} = \frac{\frac{1}{d_{ij}}}{\sum_{j=1}^{N} \frac{1}{d_{ij}}} \qquad \forall\, i,j \in S$$

with $w_{ii} = 0, \forall\, i \in S$.

Taking the inverse of each distance d_{ij} transforms the observation into a proximity between the entities i and j. In effect, the weight has to be greater for entities that are close to each other in order to relate the power of interaction between them.

The empirical reason for considering the inverse distance is that it defines a more global relation between all the entities studied. The relationship previously presented with the Netherlands and France would differ from zero. While the simple contiguity between France and Belgium takes into account all the spillover effects, the proximities computed from the physical distances between centers puts each pair of countries into relation, and therefore gives a value between the Netherlands and France.

In general, any decreasing function of distance that can yield a stronger relationship to entities that are close to each other can be used:

$$w_{ij} = \frac{f(d_{ij})}{\sum_{j=1}^{N} f(d_{ij})} \qquad \forall\, i,j \in S$$

with $w_{ii} = 0, \forall\, i \in S$ and $f'(d_{ij}) < 0$.

5. **Geographic neighborhood**

The main goal of this thesis is to determine whether spatial autocorrelation is only due to physical proximity or if it can result from the qualitative interaction between countries or entities. In order to have a benchmark to compare our results, we need to use a geographical weight matrix in the empirical analyses that follows.

The geographical matrix used in the thesis is constructed from the method of inverted distances. These distances are computed using the great circle formula[2] which considers the latitudes and longitudes of the largest cities or agglomerations (in terms of population).

This matrix will be used throughout the thesis in order to compare both the institutional and the cultural matrice outputs in the empirical studies within a spatial context.

6. **Institutional neighborhood**

Many economists have focused on the impact of institutions on economic development. One of the main questions raised in the literature on the topic is how to allocate quantitative measures to the institutions in the models. Looking back at the most contributive papers can help us to decide on the best indicators to take into account for the computation of an institutional distance between countries. North (1990) defined institutions as follows: "Institutions are the rules of the game in a society or, more formally, are the humanly devised constraints that shape human interactions. (...) In consequence, they structure incentives in human exchange, whether political, social or economic." While there may be consensus on the definition of the role of institutions, the indicators to be used for quantifying these institutions are numerous.

Institutional indicators that can be found in the literature include the governance indicators of Kaufmann et al. (2004), Acemoglu and Robinson’s (2001) approach to colonization, the set of indicators used by Glaeser et al. (2004), and finally the corruption perception index (CPI) published by Transparency International since 1995.

[2] 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.

Acemoglu and Robinson (2001) considered institutions as related first to the way the colonizers exploited the colonized territories and second to the risk of expropriation. An incentive to create good institutions or not in the colonies depended on whether the conditions were good enough to settle in the territory, or whether the conditions were too tough to live in the colony. There are thus different ways of considering colonies: simply extracting the resources or emigrating to exploit the resources themselves. Favorable settlement conditions are indicated as the mortality rate of the settlers, which is considered as an index of the level of the institutions created during the colonization. In their study, the authors assume that the differences in the level of the institutions created at the time are still apparent today. In order to have a contemporaneous measure of institutions, they add the Risk of expropriation index from the Political Risk Services. While these indices tend to give good results, there are three main reasons for not using them in the computation of an institutional distance. First, the countries that are taken into consideration are de facto colonized countries. It is therefore impossible to include the colonizing countries in the study or countries that have never been colonized. Second, there is a huge difference between introducing an index as a dependent or an independent variable in the model and building an interaction matrix based on just one dimension. Third, the hypothesis of non-evolution of the institutions since their colonial past appears to be too strong.

Glaeser et al. (2004) studied the impact of the quality of institutions on the evaluation of growth. They consider three sets of indices for the evaluation of institutions. The first set includes the indicators used by authors like Knach and Keefer (1995), Hall and Jones (1999), and Acemoglu, Johnson and Robinson (2001). The second set is the Government effectiveness index from the governance indicator by Kaufmann et al. (2003). The third set represents the measures of the limits of executive power (Jagger and Marshall, 2000). The conclusion is that most institutional quality indicators used are constructed to be conceptually unsuitable for their purpose.

There are two reasons why we will not use the same techniques for computing institutional relations. First, they used single dimension indices to determine the quality of an institution. Reducing the institutional problematic to the risk of expropriation or to the single government effectiveness index implies a significant simplification of the role of institutions. Second, the aim of the other studies was to introduce the institutional indices into the models to explain or control variables, while our aim is to model institutional interactions. The difference between their purpose and ours de facto implies a different approach.

Another well-known indicator for institutions is the annual Corruption Perception Index from Transparency International. The CPI considers corruption as a misuse of public power for private benefit. The index is computed through experts' assessment and opinion surveys. Once again, the main criticism we can formulate about this index is that only one dimension is considered for the institutions' evaluation. Furthermore, computing distances based on a single dimension only may be considered a radical consideration of the institutional space.

The indicators we use to build our institutional weight matrix are the Kaufmann et al (2003) governance indicators. Some advantages of the governance indicators are the availability for a large set of countries (186 in 2002) and the consideration of 6 dimensions to define the institutions. Moreover, a large consensus of opinion considers that the six governance indicators give a pretty good sketch of the countries' institutions. The following section details the definition of the six governance indicators, the sources used and the computation methodology, as well as their limits. These indices have already been used by Linders et al. (2005) to model institutional distances between countries. The distances were constructed to be applied to a gravity model that analyses trade and FDI between countries. Such methods can easily be extended to a spatial analysis with respect to institutional proximities.

6.1.*Indicators of institutions: the Kaufmann et al. governance indexes*

Kaufmann et al. (2004) constructed six governance indices based on a broad definition of the traditions and institutions through which authority is exercised. These broad definitions can be summarized in the following three categories:[3]

- The process by which governments are selected, monitored and replaced;
- The capacity of the government to effectively formulate and implement sound policies;
- Respect for citizens and the state of the institutions that govern economic and social interactions among them.

[3] 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

They then build six governance indices that are related to the broad categories defined[4] below:

- **Voice and accountability**: measures 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.
- **Political stability and the absence of violence**: measures 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**: measures 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**: measures 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**: measures 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**: measures perceptions of the extent to which public power is exercised for private gain, including both petty and rife corruption, as well as the 'capture' of the state by the elite and private interests.

Where "voice and accountability" and "political stability" are linked to the process by which governments are selected, monitored and replaced, "Governments' effectiveness" and "Regulatory quality" designate the government's capacity to formulate and implement sound policies, and "Rule of law" and "Control of corruption" designate respect for institutions.

The governance indices are built on various observations that come from different sources according to the country. For the 2002 indices, for instance, the authors have used 250 individual measures taken from 25 different publications and produced by 18 different institutions (see table 1 of the appendices).

[4] Ibid.

They distinguish whether sources are from an experts' poll or from surveys. The reason for this distinction is that an experts' poll is usually built to allow cross-country comparison, even if its reliability depends on the experts' ability to express an objective and accurate assessment of the governance.

In contrast, surveys are designed for a large number of local respondents from different cultural or socio-economical backgrounds. It can therefore be difficult to make cross-country comparisons. The different sources will be taken into account when computing the indices.

Furthermore, some sources cover very large samples of countries, whilst others are very narrowly focused. In addition, most of the smallest and/or the poorest countries are not covered by commercially-oriented polls because of their unattractive characteristics. However, the methodology used to construct aggregate governance indices takes these differences in country coverage into account.

The method used by Kaufmann et al. (2002) to compute the indices is an extension of the standard unobserved components model. This model expresses the observed data in each cluster as a linear expression of the unobserved common components of governance plus a disturbance term capturing perception errors and/or sampling variations:

$$y_{j,k} = \propto_k + \beta_k\left(g_j + \varepsilon_{j,k}\right) \qquad \forall j \in S \text{ } and \text{ } k \in I$$

where I is the set of indicators, $y_{j,k}$ is the score of a country j on indicator k, g_j is the unobserved governance, $\varepsilon_{j,k}$ is a disturbance for country j , and indicator k and α_k and β_k are unknown parameters that are specific to an indicator.

Kaufmann et al. assume that the error term $\varepsilon_{j,k}$ has a zero mean and the same variance across countries but differs across indicators. Finally, they assume that the errors are independent across sources, i.e. $E\left[\varepsilon_{j,k}.\varepsilon_{j,l}\right] = 0, \forall k \neq l \text{ } et \text{ } \forall k,l \in I$. This assumption means that the only reason why two sources might be correlated with one another is because they both measure the same underlying, unobserved governance dimension.

Given the estimates of the model, α_k and β_k, it is possible to compute governance estimates for each country as well as a measure of precision for this estimate. Formally, the governance estimate for a country produced by an unobserved component model is given by the distribution mean of the unobserved governance conditional on the K_j observed data for the country *j*, where K_j represents the number of indicators used by country *j*:

$$E\left(g_j | y_{j,1}, y_{j,2}, \dots, y_{j,K_j}\right) = \sum_{k=1}^{K_j} w_k \frac{y_{jk} - \alpha_k}{\beta_k}$$

where $w_k = \frac{\sigma_\varepsilon(k)^{-2}}{1+\sum_{k=1}^{K_j} \sigma_{\varepsilon}.(k)^{-2}}, \forall k \in I.$

The standard deviation of the conditional distribution is an indicator of the confidence factor of this estimate and is given by:

$$SD\left(g_j | y_{j,1}, y_{j,2}, \dots, y_{j,K_j}\right) = \left(1 + \sum_{k=1}^{K_j} \sigma_{\varepsilon}.(k)^{-2}\right)^{1/2}$$

This standard deviation declines in *k*. This means that the more indicator sources are used for the estimation, the more precise the estimate is.

Kaufmann et al. finally use all the estimated parameters of the unobserved component model to construct the final set of governance estimates. After subtracting the mean across countries and dividing by the standard deviation across countries for each country, they obtain a result with a mean equal to zero and a standard deviation of one. This implies that all scores lie between -2.5 and 2.5, with higher scores corresponding to better outcomes in terms of governance.

Kaufmann et al. have written many papers in which they respond to criticism about their indexes. The main criticisms have come from Langbein and Knack (2008, 2010) who examine the discrimination capacity among the six indices. Their results lead to the conclusion that each of the indices merely reflects the perception of the governance quality more broadly. Kaufmann et al. (2010) replied that their results come from the fact that the six governance dimensions are highly correlated. However, this does not mean that they measure the same aspect of governance.

The following section summarizes other limitations and criticisms, as well as the responses Kaufmann et al. gave in a replying paper (2003).

The first criticism made of their indices concerns what it measures exactly. Regardless of the indicators or the indices used, they are built on the respondents' perception and this may have an impact on its interpretation. In fact, it is extremely complex to obtain uniformity in the definition of a concept among nations. The subjective perception of governance often matters as much as its legal reality.

Another difficulty regarding indicators is to isolate exactly what it measures. In effect, it is relatively difficult to find an indicator that measures just one dimension of governance. Corruption for instance is often observed through the number of press investigations on the matter. This kind of indicator could however be more adapted to represent the level of freedom of the press. Another indicator of corruption could be the number of cases convicted for corruption. But this can hide a problem of government efficiency or liberty of justice.

Another criticism made of indices in general is that they should be useful to investigate the extent to which the differences in assessment across sources are related to unobservable measures of the ideology of the government in power in each country. Kaufmann et al. controlled for this issue with a regression of the differences between the percentile rank of a country in a specific source and its rank in the World Bank Business Environment Survey (WBS) on the indicator variable measuring the ideology of the government in the country in question. They only found one source which appears to have a consistent ideological bias. They therefore concluded that this ideological bias is fairly modest in magnitude.

It is also important to note that the substantial margins of error that are associated with governance estimates mean that it is difficult to assign many countries to a definitive performance category. An "in-or-out" rule presents a major risk of misclassification for some countries. To counter this problem, the authors computed the probability that a country's true unobserved level of governance falls into the top half of the sample of developing countries. Not surprisingly, the worst rated countries got a misclassification probability of close to zero while the best rated ones got a probability close to one. However, 25 of the 74 countries in the sample cannot be clearly classified in the top or the bottom half. In short, caution is needed when the indices are used to classify countries into groups, and even more so when only using a single dimension of the governance indices.

A final criticism of governance indicators is that they do not provide a global governance trend. In fact, governance indicators have a mean equal to zero and a variance equal to one for each time period. It is therefore impossible to have a true idea of the trend. To overcome this problem, the authors summarized the information available on the potential trend in average world governance within the various dimensions of governance by source. They finally concluded that there was no clear evidence of any significant improvement in governance worldwide.

To conclude with the limits of Kaufmann et al.'s governance indicators in the frame of this study which aims to build institution proximities between countries, we are not really concerned about the global indicator trends or whether there could be some misclassification using an "in-or-out" method. Furthermore, the authors controlled for ideological bias and concluded that its existence is fairly modest. Using these indicators to build our connection matrices does not therefore pose a problem. Finally, the subjectivity linked to governance indicators is a problem that can lead to all kinds of institutional perception indexes.

6.2. *Building the institutional weight matrix*

A simple formula giving distance between quantitative vectors as, for instance, the Kogut and Singh index (1988), is given by:

$$ID_{ij} = \frac{1}{6}\left[\sum_{k=1}^{6} \frac{\left(I_{ki} - I_{kj}\right)^2}{V_k}\right] \qquad \forall\, i,j\ \in S$$

Where I_{ki} is the k^{th} institutional index for the country i, V_k is the variance of the k^{th} institutional index. Let us note that $ID_{ij} = ID_{ji},\ \forall\, i,j\ \in S$. The index varies from 1 to 6 with respect to the six dimensions of governance used to compute the institutional distances.

As this formula gives us distances, we need to invert the result to reach a value that represents the proximity between two entities i and j. Hence, the proximity can be defined as follows:

$$c_{ij}^{Inst.} = \frac{1}{ID_{ij}} \qquad \forall\, i,j \in S$$

with $c_{ii} = 0, \forall\, i \in S$.

Finally, this weight matrix must be normalized for each row to fit into the spatial econometrics methods.

$$w_{ij}^{Inst.} = \frac{c_{ij}^{Inst.}}{\sum_{j=1}^{N} c_{ij}^{Inst.}} \qquad \forall\, i,j\ \in S$$

This method of computing institutional proximities allows us to take the relative proximity of each of Kaufmann et al.'s (2002) governance dimensions into account to shape the institutional proximities. In practical terms, the more the various countries have similar values in several dimensions of governance, the more they are considered as having similar institutions.

6.3. *Institutional dimensions analyses*

This section aims to justify the use of the Governance indices in the construction of the institutional weight matrix. It also gives a first indication of the institutional neighborhood. The statistical tool used in this section is the Principal Component Analysis (PCA). This method identifies patterns in data and expresses data in such a way as to highlight their similarities and differences.

PCA is mathematically defined as an orthogonal linear transformation that transforms the data to a new coordinate system such that the greatest variance by any projection of the data comes to lie on the first coordinate (called the first principal component), the second greatest variance comes to lies on the second coordinate (i.e. component), and so on.

In practice, the proportion of the initial variance of the data attributable to each component is given by the eigenvalue of the eigenvectors obtained from the covariance matrix of the raw dataset. In fact, the highest eigenvalue is linked to the first principal component; the second highest eigenvalue is linked to the second principal component, and so on.

In practical terms, a good interpretation of the PCA transformation is made through several tools:

- The eigenvalue gives the proportion of the initial variance from each principal component;

- The correlation map gives the relation between the original dimensions and the principal components obtained. This helps to interpret each component.
- A scatter map plots the individuals on the first two principal components. This outcome provides the projection of a multidimensional relation on a plan.

Applied to the six governance indicators, the PCA allows us to check which indicator is relevant in differentiating between the countries. It also gives a better understanding of the institutional distances or proximities between the countries considered in the study.

Table 1 shows the correlation matrix from which the eigenvalues of the PCA are computed. It appears that all six indices are highly correlated, which means that when a country gets a high score in one of the six institutional dimensions, it usually has a high score in the five other dimensions as well.

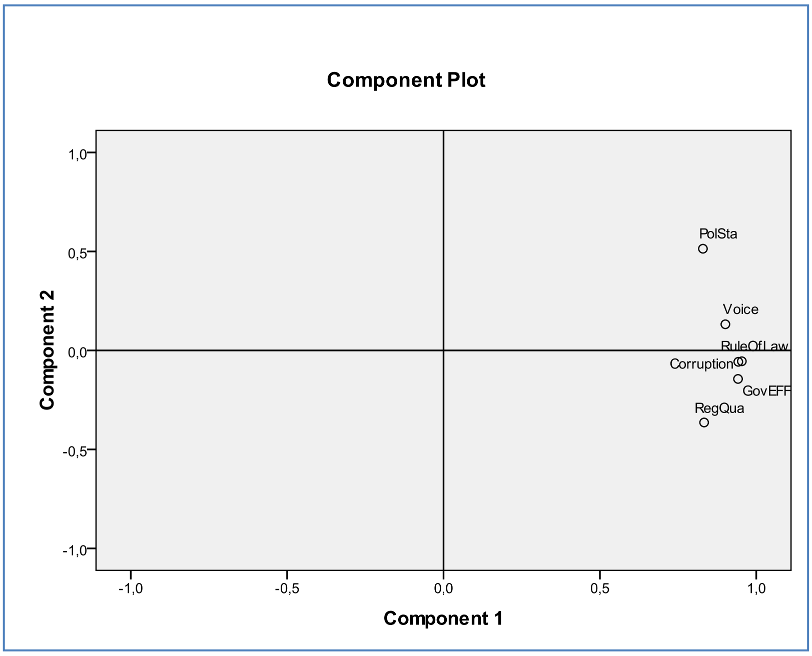
Table 1: The correlation matrix for the 6 governance indicators

	VA	RoL	RQ	PS	GE	CC
VA	1,000					
RoL	0,808	1,000				
RQ	0,757	0,736	1,000			
PS	0,778	0,736	0,570	1,000		
GE	0,758	0,924	0,756	0,700	1,000	
CC	0,781	0,933	0,704	0,721	0,932	1,000

VA for Voice Accountability, RoL for Rule of Law, RQ for Regulatory Quality, PS for Political Stability, GE for Government Effectiveness and CC for Control of Corruption.

Due to the high correlation between the six original dimensions, these will be highly correlated with the first principal component. This is confirmed by the correlation map illustrated in Figure 1. Indeed, the 6 indices have a correlation with the first component that is higher than 0,80. The only index that shows a slightly higher correlation with the second component is the Political Stability index with a coefficient of 0,55. Furthermore, the eigenvalue linked to the first principal component represents 81% of the total sum of the eigenvalues. This implies that 81% of the initial variance is explained by the first principal component. Hence, the first principal component could be interpreted as a general index of governance.

Figure 1: Correlation map of the PCA with all the countries

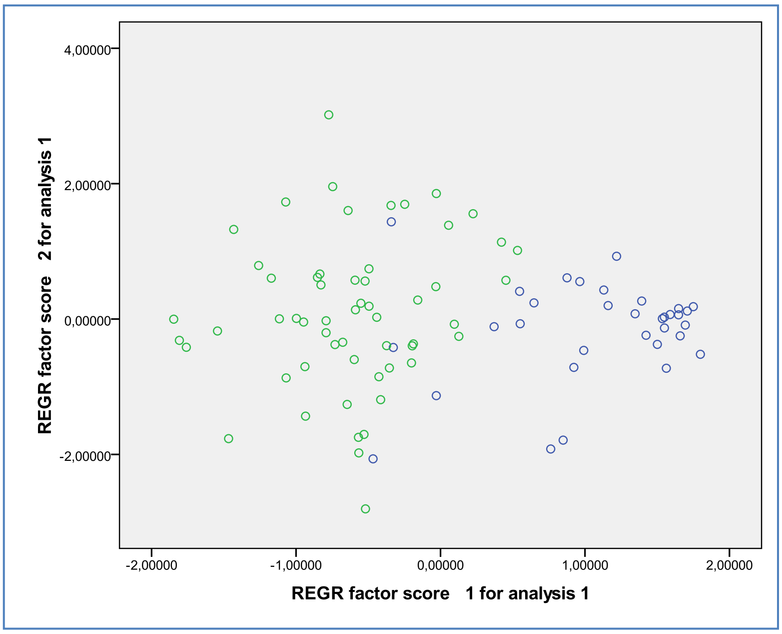


These results could raise some critical question about the use of the governance indices: why should we consider 6 dimensions to compute institutional distances while a single dimension can summarize most of the information? Why can we not compute institutional distances from the scores obtained on the first principal components, which capture a total of 81% of the initial variance? These questions have already been raised by Langbein and Knack (2008) who applied the PCA to Kaufmann et al.'s dataset and got the same outcomes. Technically speaking, the result mainly comes from the high level of positive correlation between the six dimensions of governance.

Part of the answer can be found in the scatterplot of the countries on the biplane formed by the first two principal components. At first sight, Figure 1 appears to show that the more a country is located on the right-hand side of the plot, the better its institutions are. On closer examination, it turns out that the countries on the right-hand side are considered as developed countries while the left-hand side is occupied by developing countries.

In order to illustrate this more clearly on Figure 2, different colors have been associated with the developed countries (in green) and the developing countries (in blue). The bipolarity of the first principal component now becomes obvious. We therefore conclude that doing a PCA with the countries together just allows us to differentiate the good and the poor level of the institutions which are themselves highly correlated with economic performance. Furthermore, it seems that the countries on the right-hand of the plot (i.e. developed countries) tend to narrow around the first component, while the left-hand side countries (i.e. developing countries) are spread off the first axis.

Figure 2: Differentiating developed and developing countries on the biplane of the PCA



In order to detect the effects of the six governance indices for the computation of distances/proximities between countries, it seems natural to separate the developed from the developing countries before applying the PCA.[5]

Looking at the cluster of developed countries, we first find that the correlation matrix (Table 2) gives similar levels of correlation, even if they are slightly lower than those obtained with the full sample of countries. This is almost certainly due to the high homogeneity of institutions in the developed countries.

The results of the PCA with the developed countries alone are quite similar to the previous one. The first principal component captures 80% of initial variance while the second principal component captures 10%. The six governance indicators are highly correlated with the first principal component. Once again, this first principal component discriminates between countries with a higher level of institutions and countries with a lower level of institutions.

[5] The separation has been quite obvious for most of the country set. Nevertheless, some emerging countries are difficult to sort between the categories of developing and developed countries. Regarding the results obtained in the following chapter, countries like South Africa, Brazil, Chile and South Korea are considered as developed while India and Argentina are considered as developing.

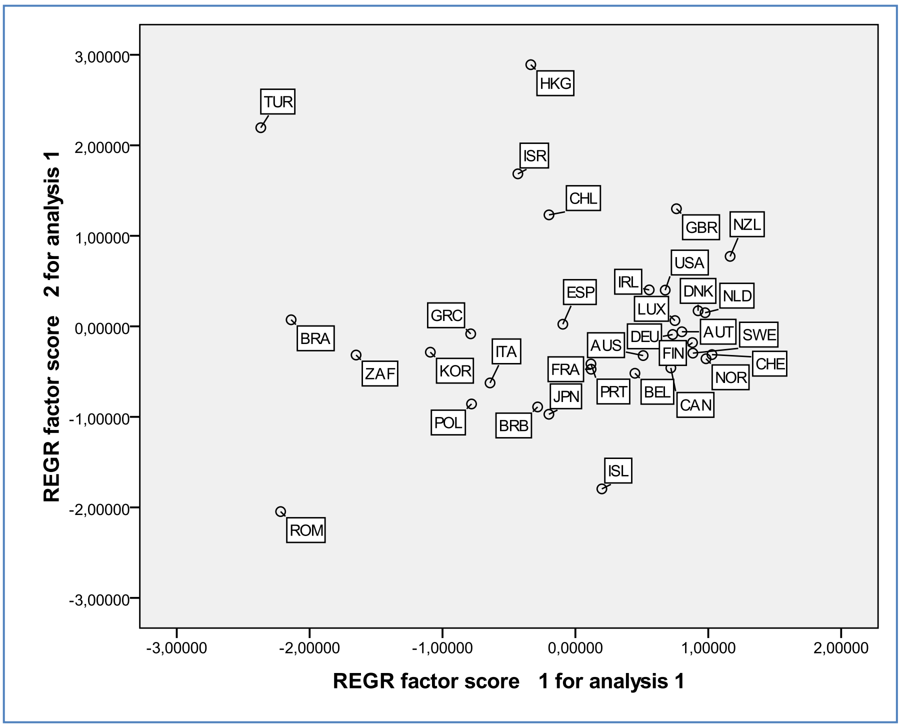
The second principal component is slightly positively correlated (i.e. a coefficient of 0,55) with the Regulatory Quality index.

Table 2 : Correlation matrix for the 6 governance indices for the developed countries

	VA	RoL	RQ	PS	GE	CC
VA	1					
RoL	0,761	1				
RQ	0,507	0,69	1			
PS	0,812	0,701	0,487	1		
GE	0,857	0,886	0,747	0,746	1	
CC	0,817	0,865	0,764	0,713	0,921	1

The biplan of the developed countries (see figure 3) shows that most countries are located along the first axis which differentiates between the general level of institutions. Not surprisingly, the left-hand side of the plot is occupied by the emergent countries such as Brazil, South Africa and Korea, but also by Turkey, Romania and Poland. Once again, these results correlate with Langbein and Knack's (2008) conclusions.

Figure 3: Biplan of the developed countries with respect to the two first principal components



The Scandinavian countries, Switzerland, the United States, Australia and New Zealand lie on the right-hand side of the plot.

The countries which do not get a zero score on the second principal component are Turkey, Hong Kong, Israel, Chile, Great-Britain and New Zealand at the top of the plot, and Romania and Iceland at the bottom of the plot. This opposition is mainly due to the Regulatory Quality Index.

In conclusion, developed countries show homogenous institutions. The main opposition is between emergent countries or eastern European countries and the most developed countries such as the old European, North American and Oceanic countries.

Finally, the Principal Component Analysis (PCA) with respect to developing countries gives very different outcomes. First, the correlations between the governance indices are much lower than those obtained when taking all the countries together or even when only taking the developed countries into account (see Table 3). This implies that a high score on one of the institutional dimensions does not systematically imply a high score on the other 5 dimensions. A direct consequence of this result is that the first axis of the PCA with developing countries is likely to be less important than for the set of developed countries.

Table 3: Correlation matrix for the 6 governance indices for the developed countries

	VA	RoL	RQ	PS	GE	CC
VA	1					
RoL	0,496	1				
RQ	0,566	0,417	1			
PS	0,593	0,489	0,274	1		
GE	0,246	0,69	0,488	0,314	1	
CC	0,356	0,75	0,268	0,43	0,595	1

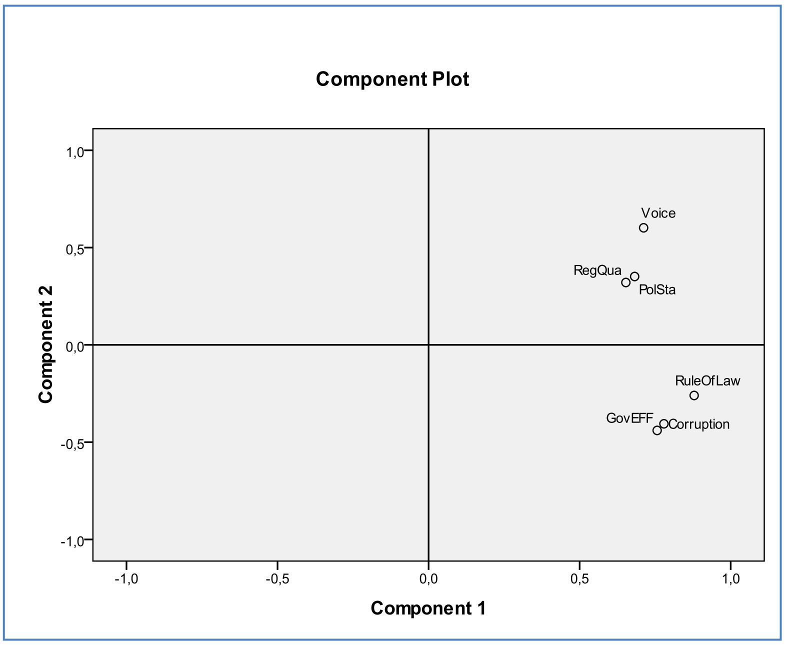
Indeed, as can be observed in Table 4, this difference in correlations decreases the importance of the first principal component in the PCA. The cluster of developing countries is still opposed to the first principal component which can be interpreted as the general quality of the institution (see Figure 4). This first dimension only captures 56% of the initial variance however. In consequence, the other principal components take far more of the initial variance; 16% for the second, 13% for the third and 6%, 4% and 2% for the next principal components (see Table 4).

Table 4: The percentage of variance explained by component for the developing countries PCA

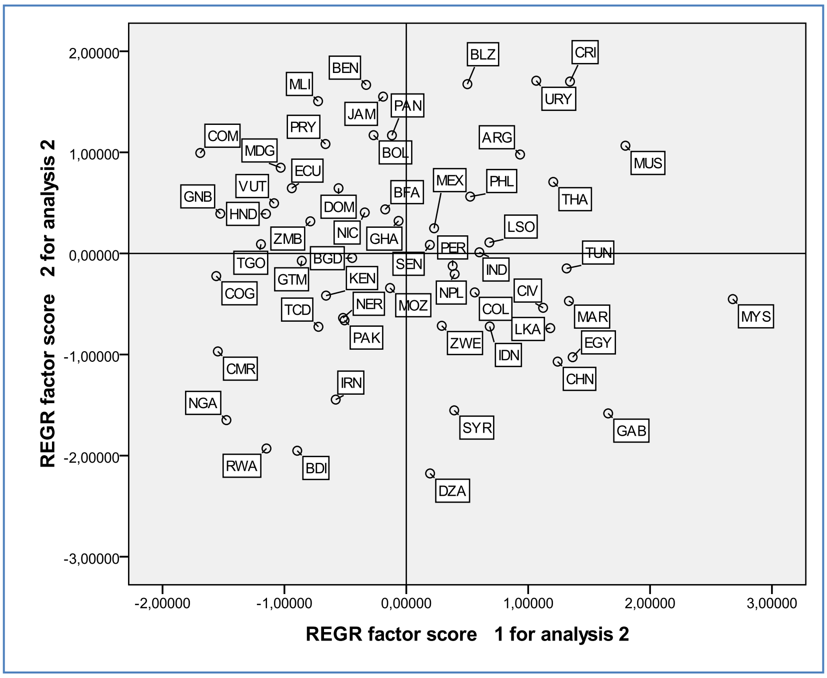
Component	Percentage of variance explained
1	55,84
2	16,89
3	13,48
4	6,66
5	4,14
6	2,99

Looking at the correlation map (fig. 4), the second component opposes countries according to their score in the Voice and Accountability dimension. On the one hand, the biplane (fig. 5) which plots the countries on the map shows the countries with lower institutional levels on the left-hand side and the better performers on the right-hand side of the plot. On the other hand, the countries located on the upper-side of the plot have a better Voice and Accountability Index while those in the down-side of the plot have a lower score for this index. It may be noted that the developing countries are totally spread around on the biplan.

Figure 4: Correlation map of the PCA for developing countries



<u>Figure 5</u>: Biplan of the developing countries with respect to the first two principal components



Overall, the first two principal components capture 72% of the total initial variance while the other four dimensions capture the remaining 28% of the initial variance that could be used to discriminate between the countries for a computation of the institutional distances.

All in all, we can say that the PCA of the governance indices clearly oppose countries with better and lower institutional levels on the first principal component regardless of the sample of countries used. Nevertheless, developed and developing countries are differently mapped. Developed countries show significant homogeneity in their institutional levels and are mainly differentiated by the first principal component. On the other hand, the first principal component does not have enough information to discriminate between the developing countries. Furthermore, the other principal components do not contain the same proportion of information in the two clusters. Finally, these results show how important it is to consider the six governance indices to compute institutional proximities between countries. In fact, developed countries are very homogenous and thus are all close to one another with regard to each of the 6 indices, while the developing countries cluster requires all six dimensions in order to fully capture the distance computation.

7. Cultural neighborhood

As explained in the previous sections, most studies are based on geographical spatial dependence. Taking this type of dependence into consideration has achieved positive results in many papers, but none of them has formally proved that geographical distances are optimal. The main idea of the thesis is to introduce non-physical relationship structures which will take the form of weight matrices. In this section, we explore the opportunity to compute a cultural weight matrix that will capture the interdependence between the countries studied. The main issue in this section is the modeling of such qualitative distances into a weight matrix W.

While geographical relationship is relatively simple to implement, cultural proximities are less straightforward to define. Which variables can define a qualitative relationship such as culture? How can a qualitative relationship be transformed into a distance and then into a proximity? The following sections will first present the variables used in the computation of cultural proximities and, second, the computation techniques.

7.1. *The indices*

The first difficulty in building such a cultural matrix was to select the different dimensions that could define culture. A large number of authors have attempted to give a clear definition of exactly what culture is but no consensus has emerged to date. References in the economic literature to the 'cultural' dimensions that impact on economic development are numerous. Nevertheless a first paper by Easterly and Levine (1997) on ethno-linguistic fractionalization identifies the importance of a common culture to ensure economic development within a country. In the latter, the common culture is characterized by the spoken language. Interesting studies by Barro (2003, 2005), among others, have shown the impact of religion in the development of nations.

More generally, Baba (1996) classifies cultural differences into three broad categories:

- The traditional organization structure, in which language and religion are included
- Managerial differences

- Differences in fundamental concepts and philosophy that contracts and laws are based on.

The traditional organization structure is represented by language and religion. Languages are divided into seven categories: the six official UN languages (English, French, Spanish, Arabic, Russian and Chinese) and a last category called 'Other languages'. Regarding religion, we have four variables which take into account the proportion of Catholics, Protestants, Muslims and other religions in a country.

The differences in fundamental concepts and philosophy are represented by the origin of the law of the countries. Furthermore, this variable gives insights that include an historical link that could define the basis of the legal concept, and therefore the rules on which contracts are based. In order to explore this relationship, the origin of the legal system has been used as a proxy for a cultural historical dependence. The origin of the legal system has been divided into five binary variables: British, French, socialist, German or Scandinavian origin.

The observations on religious and legal system origins stem from data from the World Bank's Global Development Finance & World Development Indicators (GDF & WDI) database. Data on languages represent all the official languages for each country.

The second category of Baba (1996) points to managerial differences as a broad category of culture. The four dimensions of culture by Hofstede (1980) offer a good picture of managerial issues.

Hofstede (1980) built his indices on the fact that a society's culture is based on mental programs experienced by each individual. After analyzing answers to a given questionnaire, he concluded that these mental programs can be classified into four broad dimensions or indices. These four dimensions are based on the fundamental issues that each society needs to respond to.

- **Power Distance Index** (PDI) which is the extent to which the less powerful members of organizations and institutions (like family for instance) accept and expect that power is distributed unequally.
- **Individualism** (IDV) versus its opposite: collectivism, which is the degree to which individuals are integrated into groups.

- **Masculinity** (MAS) versus its opposite: femininity i.e. the distribution of roles between genders. This is a critical issue for any society for which many solutions have been devised.
- **Uncertainty Avoidance Index** (UAI) deals with a society's tolerance of uncertainty and ambiguity; it ultimately refers to the individual's search for Truth. It indicates to what extent a culture programs its members to feel either uncomfortable or comfortable with unstructured situations.

The questionnaire prepared by Hofstede contained a mainly five-point answer scale. Most of them used an ordinal scale which means that there was clear ranking between the answers given by the respondents. A few questions were not ordinal but nominal and therefore had no natural ranking order for all answers.

Hofstede (1980) computed the Power Distance Index (PDI) on the basis of country mean scores for the following questions:

- Non managerial employees' perception that employees are afraid to disagree with their manager (ordinal scale).
- The subordinates' perception that their boss tends to make decisions in an autocratic or persuasively paternalistic way (nominal).
- The subordinates' preference for anything but a consultative style of decision-making, in other words for either an autocratic, persuasive paternalistic or democratic style (nominal).

Finally Hofstede (1980) computed the PDI as follows:

$$\begin{aligned} PDI = 135 - [25 \times (Mean\ score\ of\ afraid\ employees)] \\ + (Percentage\ of\ perceived\ manager\ as\ autocratic\ or\ paternalistic) \\ - (percentage\ of\ preferred\ decision - making\ as\ non - consultative) \end{aligned}$$

The Uncertainty Avoidance Index (UAI) can be computed on the basis of the country mean scores for the following questions:

- Rule orientation: agreement with the statement: *"Company rules should not be broken, even when the employee thinks it is in the company's best interest"*
- Employee stability: employees' statement that they intend to continue with the company for 2 years at most or for 2 to 5 years as against more than 5 years.

- Stress: the mean score of the question: *"How often do you feel nervous or tense at work?"*

Hence,

$$\begin{aligned} UAI = 300 - {} & [30 \times (mean\ of\ the\ score\ of\ the\ rule\ orientation\ question)] \\ & - (percentage\ of\ employee\ intending\ to\ stay\ less\ than\ 2\ years) \\ & - [40 \times (the\ mean\ of\ score\ of\ stress)] \end{aligned}$$

The Individualism Index (IDV) and the Masculinity Index (MAS) were computed based on the standardized scores of 15 work goal questions. Using a factor analysis, Hofstede found that almost one-half of the variance mean score from these questions could be summarized by just two factors. Hofstede called the first: "Individual vs. collective" and the second: "masculinity vs. femininity." Finally, Hofstede used the country factor scores on the two axes as a basis for IDV and MAS.

7.2. ***Building the cultural weight matrix***

We consider several ways of dealing with qualitative distances in this study. The first is proximity between objects, which allows us to compute distances between binary vectors and is perfect for qualitative observations (presence=1 vs. no presence=0). The second is Mahalanobis distance, which gives more weight to the dimensions that discriminate significantly between individuals. After testing the two matrices in the models, we found no differences in the results obtained. Only the results for the cultural matrix obtained by means of the proximity between objects approach will therefore be presented. Nevertheless, this section explains how to obtain the qualitative proximities with respect to both methods.

7.2.1. Proximity between objects

The cultural values are built using a tool called proximities between objects.[6] This method works by computing proximity between binary vectors. Let us compare two vectors of observations relative to two entities i and j: x_i, x_j where $x_i = (x_{i1}, x_{i2}, \ldots, x_{iP})'$ and $x_j = (x_{j1}, x_{j2}, \ldots, x_{jP})'$ with x_{ik} and $x_{ik} \in \{0,1\}$ for all k. Three cases can thus appear:

$$\begin{cases} x_{ik} = x_{jk} = 1 \\ x_{ik} = x_{jk} = 0 \\ x_{ik} \neq x_{jk} \end{cases}$$

Hence, we can define:

$$\begin{cases} a_1 = \sum_{k=1}^{P} (x_{ik} = x_{jk} = 1) \\ a_2 = \sum_{k=1}^{P} (x_{ik} = x_{jk} = 0) \\ a_3 = \sum_{k=1}^{P} (x_{ik} \neq x_{jk}) \end{cases}$$

Finally, proximity between objects can be computed as follows:

$$d_{ij} = \frac{a_1 + \nu a_2}{a_1 + \nu a_2 + \tau a_3} \qquad \forall i, j \in S$$

Where $\nu$and $\tau$are weight factors which can take different values. νgives more weight to similar zeros in the comparison vector and τgives more weight to cases without any similarities between objects. Finally, the elements of the weight matrix $W$are the proximities with each line being normalized to 1:

$$w_{ij} = \frac{d_{ij}}{\sum_{j=1}^{N} d_{ij}} \qquad \text{with } w_{ii} = 0 \text{ and } \forall i, j \in S$$

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

The last point of this method is to build binary vectors of comparison between countries with qualitative or quantitative variables. Let z_{ik} be a quantitative variable.

An element t_{ik}can be computed as follows:

$$t_{ik} = \begin{cases} 1 & \text{if } z_{ik} > \bar{z}_{.k} \\ 0 & \text{Otherwise} \end{cases} \qquad \forall i \in S$$

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 main advantage of this method is that it provides a comparison between countries using qualitative variables. Indeed, language or the origins of the legal system are easy to transform into a series of binary variables. However, this transformation leads to a loss of precision about how religion is actually distributed within a country. A country like Belgium, for example, will be considered as a Catholic country even if this religion does not represent the beliefs of 100% of the population. It is important to stress that our interest is to shape the cultural fractionalization between countries and not within countries. In this sense, we can consider that the dominant religion in a country provides a good indication of the cultural tendency in the countries in question.

The second advantage of proximity between objects is the possibility to measure the similarities of zero in the comparison vector and to measure the dissimilarities differently. This is really useful for variables; the legal system origin, for example, has 5 modalities and can be transformed into 5 binary variables. When a country is given a value of 1 for a social system origin, for instance, then it implies a zero for all the other related binary variables. Therefore, a similarity of 1 implies four similarities of 0 in this case. Thus, it is important to be able to attribute a zero weight to similar zeros. Consequently, this study will use the Jaccard specification of proximity between objects that gives null value to similar zeros (ν=0) and a 1 value for dissimilarities (τ=1).[7] However, several combinations of $\nu$and τhave been applied in order to check the shape of the relationship regarding these two values of similarities. As expected, the weight of similar zeros gives too great a proximity between

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

countries that are not meant to be similar. For instance, Mexico and Morocco do not have a similar weight for their religion, respectively Catholic and Muslim, but they do have similar zeros for the two other modalities, Protestantism and other religions, that result in a religious similarity between the two countries.

7.2.2. Mahalanobis distances

The use of binary variables could also result in some problems. Indeed, the quantitative variables are also transformed into binary information, which leads to a loss of information. A second disadvantage to proximity between objects is that all the dimensions of the vectors have the same weighting. It could be interesting to give more importance to variables that really discriminate between countries. The Mahalanobis distance between two vectors allows us to take all the quantitative information into account without transforming it into binary information. Furthermore, it gives more weight to variables with low covariance or, in other words, to variables that differentiate the countries even further in the multidimensional space.

The Mahalanobis distance is usually used to compute the distance of an individual with respect to the centroid of the multidimensional space. This distance is given by:

$$DM(x) = \sqrt{(x-\mu)'\Sigma^{-1}(x-\mu)}$$

With $x = (x_1, x_2, \dots, x_p)'$, $\mu = (\mu_1, \mu_2, \dots, \mu_p)'$ and Σ is the covariance matrix ($p \times p$).

This formulation can be used as a computation of dissimilarities between two vectors $x_i = (x_{i1}, x_{i2}, \dots, x_{ip})'$ and $x_j = (x_{j1}, x_{j2}, \dots, x_{jp})'$:

$$d_{ij} = \sqrt{(x_i - x_j)'\Sigma^{-1}(x_i - x_j)} \qquad \forall i,j \in S$$

If $\Sigma$is the covariance matrix, this formula is equivalent to the Euclidian distance. If $\Sigma$is a diagonal matrix, it computes a normalized distance. If covariance exists, then it weights the dissimilarities by putting more weight on variables that are really differentiating individuals (e.g. small covariance).

After computing dissimilarities between both country $i$and j, we have to take the inverse of the distance to create the weight matrix Wwhich represents the proximity between countries. Each row has again been normalized in order to enter it into spatial models. As some countries have more than half of the country above the average weight, we add a friction parameter in order to differentiate the nearby countries more precisely.

$$w_{ij} = \frac{1}{d_{ij}^2} \qquad \forall i, j \in S$$

Finally, the normalization of each row is performed in order to apply spatial methods.

7.3. *Cultural dimensions analyses*

This section aims to give a picture of the raw data used for the computation of the cultural proximities. As we showed previously, several cultural matrices have been built with the aim of testing different methods for the computation of distance based on qualitative data. Nevertheless, the various matrices obtained did not give very different outcomes in the study. The results presented below are therefore those obtained with the cultural matrix obtained from the proximity between objects method using the weighted Jaccard metric.

Each binary vector used for proximity between object computations represents the information available on the culture of a country and includes 4 dimensions which are:

- Official language
- Religion
- Origin of the legal system
- Hofstede's cultural dimensions

Table 5: Description of the binary vectors by modality and cultural dimension

Languages		**Religions**		**Origin of the legal system**		**Hofstede's cultural dimension**	
English	23	Catholic	35	French	51	Power distance	58
Arabic	9	Islam	22	British	26	Individualism	36
Chinese	2	Protestant	25	Socialist	3	Masculinity	38
Spanish	19	Others	33	German	5	UAI	41
Russian	0			Scandinavian	5		
French	21						
Others	44						
Total	**118**		**115**		**90**		**173**

Table 5 shows the number of '1' given to each modality for each dimension. The first remark is that for three of the four dimensions it is possible to get a '1' on several modalities. It is indeed possible to have several official languages, to have a religious proportion higher than the country mean in more than one religion or to have a high score on several of Hofstede's dimensions. The only dimension that totals 90 (the number of studied countries) is the origin of the legal system which cannot take more than one modality at the same time.

We can first note that we have a similar number of countries where the three main languages are English, French and Spanish. Arabic is the official language in 9 of the 90 countries in the study, while Chinese is the official language in only 2 of them (China and Hong Kong). There are no countries where Russian is spoken in our study and there are 44 countries where other languages are spoken, explained by the fact that a large number of countries have several official languages. In a country like India, for instance, the official language is English, but many other local languages are also considered as official.

The 4 modalities concerning religion have a more balanced distribution. The three main religions of Catholicism, Islam and Protestantism respectively show 35, 22 and 25 countries with a proportion higher than the mean of the 90 countries. In fact, some countries can be represented in two of the three categories. Switzerland, the Netherlands, Lesotho and Canada are above average for Catholicism and Protestantism, while Nigeria and Cameroon are above average for Catholicism and Islam. The countries ranked as 'Other religion' are from three different clusters: first the countries that have very specific religions such as Israel or Greece, second, countries that have various local beliefs (generally animists) such as Togo or Benin, and finally the cluster of religions specific to Asia with Buddhism and Hinduism.

The distribution of the legal system's origin is very unbalanced. Most of the countries have a system of French origin (51) while 26 have a British system origin. Only three countries have a socialist origin (China, Poland and Romania), 5 have a German origin (Germany, Austria, Japan, Korea and Switzerland), and 5 have a Scandinavian origin (Denmark, Finland, Norway, Sweden and Iceland).

The cultural indices indicate different numbers of countries which are above the average of the 90 countries.

In fact, the possibility to have several modalities for the same dimensions allows us to avoid using complex methods to analyze the interactions between the four dimensions. It is indeed impossible to lead a Factorial Correspondence Analysis. The qualitative nature of the variables makes the application of a Principal Component analysis impossible as well.

Therefore, the following descriptive results and cross tabs are presented to better understand the topology of the cultural dimensions.

Table 6 shows the cross-tabulation between religion and official language. We should keep in mind that a country can appear in the table several times as it may possess several official languages.

Table 6: Number of countries by religion and by official spoken language

	Catholicism	Islam	Protestantism	Others
English	6	4	15	12
Arabic	0	8	0	1
Chinese	0	0	0	2
Spanish	19	0	0	1
French	8	9	5	6
Others	16	6	14	20

15 of the 23 English-speaking countries have a high level of Protestantism while only 4 and 6 countries have more Catholics and Muslims respectively. For 12 countries, religions other than these three are present. The French-speaking countries are spread among the different religions: 8 out of 21 are Catholic, 9 are Muslim and 5 Protestant, while 6 are in the cluster of other religions. The most interesting interaction between language and religion concerns the Spanish-speaking and Arabic-speaking countries. Nearly all the Spanish-speaking countries in the sample are Catholics. Uruguay is the only country that has a different religion. The Arabic-speaking countries encompass 8 out of 9 Islamic countries. The Arabic-speaking country that is not an Islamic country is Israel. Hong Kong and China are of course in the cluster of other religions.

Table 7 shows the same interactions between language and the origin of the legal system. Of course, English-speaking countries mainly have a British legal system while French-speaking countries mainly have a French legal system. Once again, the Spanish-speaking countries are homogenous concerning the legal system origin which is French. The only Spanish-speaking country with a British legal system is Belize. The same remark stands for the Arabic-speaking countries where only Israel has a British legal system. For the Chinese-speaking countries, China has a socialist legal system while Hong-Kong naturally has a British legal system.

<u>Table 7:</u> Number of countries by origin of legal system and official spoken language

	French	British	Socialist	German	Scandinavian
English	5	18	0	0	0
Arabic	8	1	0	0	0
Chinese	0	1	1	0	0
Spanish	18	1	0	0	0
French	19	1	0	1	0
Others	18	14	2	5	5

So far, we can conclude that the Hispanic and Arabic countries display relatively homogenous clusters. Countries from these two clusters generally have the same religion and the same legal system origin. The other linguistic clusters do not show any clear similarities. The French and English-speaking countries naturally have a French and British legal system respectively, but are not that homogenous regarding religion. Finally, the cluster of countries ranked as “Other official language” is heterogeneous. This is mainly due to the fact that this cluster of 44 countries is composed, on the one hand, of countries that have only one official language that is not taken into consideration as an official UN language (such as Brazil and Portugal, for instance, where Portuguese, which is not one of the seven UN official languages, is the official language), and on the other hand, countries that are already in an official UN language cluster (such as Belgium, which is both in the French-speaking cluster and in the other official language group due to its Dutch-speaking population).

Countries that are different in terms of religion and legal system origin but that share the same official language are interesting in the sense that their similarities can be studied via Hofstede’s cultural dimension. Table 8 presents the number of countries for which the score is higher than the average score for each cultural dimension with respect to each cluster of official language.

<u>Table 8</u>: Number of countries by Hofstede’s cultural dimension and by official spoken language

	Distance to power	Individuality	Masculinity	Uncertainty avoidance
English	12	10	12	3
Arabic	7	7	5	6
Chinese	2	0	2	0
Spanish	14	6	2	18
French	17	6	5	4
Others	21	23	21	19

The 23 English-speaking countries are divided into two sections according to the ‘distance to power’, ‘individuality’ and ‘masculinity’ indices: half of them have a score that is above average and the other half one that is lower than average. The ‘Uncertainty avoidance’ is higher than average for only three English-speaking countries: Pakistan, Barbados and Belize.

Most of the French-speaking countries have a high score on the ‘Distance to Power’ index and a few of them on the three other cultural dimensions. These low figures are mainly due to the African countries which have low score on the ‘Individuality’, ‘Masculinity’ and ‘Uncertainty avoidance’ indices.

Arabic countries and all Chinese countries are relatively homogeneous. Most of the Arabic countries have high scores for the 4 cultural dimensions except for Chad and Iran which systematically have a lower score. The Chinese are very homogeneous and score well on both the ‘Distance to power’ and the ‘Masculinity’ indices.

Finally, the clusters of ‘Other official languages’ is well balanced in each cultural dimension.

8. Comparative analysis of neighborhood measures

The aim of this section is to study the differences between the three spatial notions considered in order to justify the use of the different weight matrices in the models. As the use of geographical weights has already been reviewed in the literature, this paper will focus on the use of institutional and cultural weightings. Thus, the main question is: Do institutional and cultural weights really differ from geographical weights? Our thesis analyzes both the institutional and the cultural dimension by looking at all the nearest institutional or cultural neighbors, making maps to visualize the neighborhood and comparing the weight distribution for all countries.

8.1. *Institution vs. Geography*

It is quite difficult to develop a comparative analysis of institutional and geographical dimensions. Indeed, while everybody knows what a geographical neighborhood looks like, making a similar representation of the institutional neighborhood is not so straightforward.

In this section we first try to pinpoint whether a country's neighbors are similar in both dimensions by looking at its five closest institutional neighbors and then compare the distribution of weights in both dimensions.

The main issue is to consider both dimensions (i.e. institutions and geography) at the same time. Table 4 shows the five nearest institutional neighbors for the European countries. In order to clearly show the institutional neighbors that are also in the geographical environment, a color scheme has been used as follows:

- Green for institutional neighbors that are geographically contiguous;
- Orange for institutional neighbors present on the same continent;
- Red for institutional neighbors from another continent.

Looking at Table 9, we first observe that most European countries have their institutional neighbors on the same continent rather than outside. The countries with a geographically contiguous institutional neighborhood are the Scandinavians countries (Finland, Denmark, Sweden and Norway) that are always close to one another. This institutional homogeneous core within Europe can be extended to other countries which can be considered as the institutional neighbors of the Scandinavian countries: Germany, Austria and the Netherlands. This cluster of countries appears natural as their institutions are relatively similar.

Moreover, it can be noted that some European countries such as Poland and Romania do not have their institutional neighbors in the geographical environment. Poland, for instance, has its most direct neighbors in Europe (Italy and Greece) but the others are outside Europe (Mauritius, Korea and Uruguay). It is perfectly normal to find Poland's neighbors outside Europe, given that the indices are for institutional levels in 2000 when Poland was not yet a member of the EU. However, one may legitimately be skeptical about the fact that the institutional neighbors of Poland are Mauritius and the Korean Republic. Furthermore, these two countries are also in the neighborhood of Italy and Greece, which are also neighbors of Poland. Looking more closely at the raw data, it may be noted that this set of countries share similar values regarding the six dimensions of governance apart from the Regulatory Quality index that is much lower in Mauritius, and the Voice and Accountability index of the Korean Republic, which is also lower. This leaves us with five of the six dimensions which are really similar.

Table 9: The five nearest institutional neighbors of the European countries

Countries	First	Second	Third	Fourth	Fifth
Austria	Germany	Luxembourg	Sweden	Finland	The Netherlands
Belgium	United States	France	Luxembourg	Ireland	Barbados
Denmark	The Netherlands	Finland	Norway	Sweden	Luxembourg
Finland	Sweden	Norway	Germany	Denmark	The Netherlands
France	Barbados	Japan	Belgium	Ireland	Australia
Germany	Austria	Finland	Sweden	Luxembourg	Norway
Greece	Italy	Poland	Korea, Rep.	Argentina	Mauritius
Iceland	France	Barbados	Japan	Australia	Canada
Ireland	United States	Austria	Germany	Australia	Luxembourg
Italy	Poland	Greece	Korea, Rep.	Mauritius	Japan
Luxembourg	Austria	Germany	United States	The Netherlands	Denmark
The Netherlands	Denmark	Sweden	Finland	Norway	Luxembourg
Norway	Sweden	Finland	Denmark	The Netherlands	Switzerland
Poland	Italy	Greece	Mauritius	Korea, Rep.	Uruguay
Portugal	Australia	Barbados	Ireland	France	Belgium
Romania	Madagascar	Burkina Faso	Mali	Senegal	Ghana
Spain	France	Japan	Barbados	Belgium	Chile
Sweden	Finland	Norway	Germany	Denmark	The Netherlands
Switzerland	Sweden	Norway	Finland	The Netherlands	Germany
United Kingdom	Ireland	United States	Denmark	Luxembourg	Germany

Other institutional neighbors can also be surprising. France for instance has Barbados and then Japan as nearest neighbors. The Principal Component Analysis that was performed in section 6.3 can help us to better understand this outcome. Figure 5 (Section 6.3) shows the projection of the developed countries on a biplane where the first axis represents the general level of the institutions and captures 80% of the initial variance. In this figure, France, Japan and Barbados have similar scores on the first axis as well as on the second one. Looking at their governance indices, we notice that they have exactly the same values on at least five of the six governance dimension indices. France and Japan have very similar scores on the 'Rule of law' and 'Political stability' index, and France and Barbados share the same 'Control of corruption' value. The same conclusions can be made regarding Belgium and the USA.

Table 10: The five nearest institutional neighbors of the American countries (North, South and Central America with the Caribbean included)

Countries	First	Second	Third	Fourth	Fifth
Argentina	Thailand	Korea, Rep.	Panama	Greece	Jamaica
Barbados	Portugal	France	Australia	Belgium	Ireland
Belize	Mali	Benin	Jamaica	Mauritius	Costa Rica
Bolivia	Panama	Philippines	Argentina	Thailand	Jamaica
Brazil	Philippines	Dominican Rep.	Mexico	India	Ghana
Canada	Finland	Norway	Germany	Sweden	Denmark
Chile	Hong Kong, China	Spain	Portugal	Greece	Barbados
Colombia	Peru	Turkey	Mexico	Sri Lanka	Egypt, Arab Rep.
Costa Rica	Uruguay	Poland	Mauritius	Italy	Belize
Dominican Rep.	Nicaragua	Venezuela	Ecuador	Brazil	Bangladesh
Ecuador	Venezuela	Dominican Rep.	Guinea-Bissau	Nicaragua	Bangladesh
Guatemala	Pakistan	India	Colombia	Ecuador	Bangladesh
Honduras	Venezuela	Guinea-Bissau	Bangladesh	Dominican Rep.	Ecuador
Jamaica	Panama	Argentina	Thailand	Belize	Bolivia
Mexico	Philippines	Peru	Brazil	Colombia	Turkey
Nicaragua	Dominican Rep.	Venezuela	Bangladesh	Ecuador	Brazil
Panama	Jamaica	Bolivia	Paraguay	Thailand	Argentina
Paraguay	Panama	Philippines	Brazil	Bolivia	Mexico
Peru	Turkey	Mexico	Colombia	India	Egypt, Rep.
United States	Luxembourg	Ireland	Austria	Germany	Belgium
Uruguay	Costa Rica	Poland	Jamaica	Greece	Italy
Venezuela	Ecuador	Bangladesh	Honduras	Nicaragua	Dominican Rep.

Table 10 shows the same results as Table 9 but this time for the American countries, North, South and Central America, including the Caribbean countries. The first conclusion we can draw is that when comparing this table to one of the European countries, there are far more orange and red boxes and only a few green boxes, i.e. institutional neighbors that are geographically contiguous. This first observation reflects less institutional homogeneity inside America.

Looking further at Table 10, we can see that 10 out of 22 countries have their first institutional neighbors outside the continent. This is obvious for countries such as Canada that has its main neighbors located in Scandinavia, and the USA whose neighborhood is located in Europe. Not surprisingly, Chile and Barbados have their main institutional neighborhood in the cluster of developed countries as well.

However, other proximities such as the one between Peru and Turkey or between Mexico and the Philippines seem less natural. In fact, Mexico has very similar values in its governance indices compared to the Philippines. Furthermore, when looking at the Principal Component Analysis of point 6.3, we find that these countries are very close to each other on the biplan. Here again, it is not because Turkey is the closest country to Peru regarding the six governance dimensions that they are institutional neighbors, but because Peru and Turkey are constantly close to each other with regard to the six indices.

Table 11 shows the five nearest institutional neighbors of the African countries. It appears that while every African country has a neighbor outside the African continent, the majority of them have most of their institutional neighbors on the continent.

For 6 of the 29 African countries, their main neighbor is geographically contiguous. We first find a strong bilateral institutional proximity between Rwanda and Burundi, and Ghana and Burkina Faso. A second cluster of countries is made up of Cameroon, Chad and Nigeria.

On the other hand, only 9 countries have their nearest institutional neighbor outside the continent. Several types of institutional relationship are represented. First, the institutional shape of the emergent countries, with countries such as South Africa, Egypt, and Mauritius, has its proximity with countries from the other continents with a similar level of institutions. Second, we find some surprising proximities between countries, such as Benin with Belize or Mali with Belize. Here again, the principal analytical component and the similarities among the six governance indices go a long way to explaining these institutional relations. Indeed, the three countries have similar scores for the second component to which they contribute significantly. Similar interpretations can be made for the other countries.

Table 11: The five nearest institutional neighbors of the African countries

Countries	First	Second	Third	Fourth	Fifth
Algeria	Burundi	Rwanda	Cameroon	Pakistan	Nigeria
Benin	Belize	Mali	Jamaica	Panama	Mauritius
Burkina Faso	Ghana	Romania	Senegal	Dominican Rep.	Madagascar
Burundi	Rwanda	Nigeria	Cameroon	Algeria	Iran,.
Cameroon	Nigeria	Chad	Pakistan	Congo	Syrian Rep.
Chad	Congo	Kenya	Zimbabwe	Cameroon	Syrian Rep.
Comoros	Lesotho	Romania	Madagascar	Mali	Burkina Faso
Congo	Chad	Honduras	Cameroon	Zimbabwe	Bangladesh
Cote d'Ivoire	Morocco	Tunisia	Ghana	China	Senegal
Egypt, Arab Rep.	Indonesia	Turkey	Morocco	Peru	Colombia
Gambia	Niger	Iran	Zimbabwe	Syrian Rep.	Chad
Ghana	Burkina Faso	Senegal	Guinea-Bissau	Zambia	Brazil
Guinea-Bissau	Zambia	Ecuador	Venezuela	Honduras	Ghana
Kenya	Chad	Pakistan	Guinea-Bissau	Honduras	Bangladesh
Lesotho	Senegal	Romania	Burkina Faso	Nepal	Ghana
Madagascar	Romania	Burkina Faso	Dominican Rep.	Mali	Nicaragua
Mali	Belize	Romania	Benin	Madagascar	Jamaica
Mauritius	Poland	Italy	Costa Rica	Korea, Rep.	Greece
Morocco	Cote d'Ivoire	Egypt, Arab Rep.	Ghana	Indonesia	Mexico
Mozambique	Nepal	Zimbabwe	Senegal	Bangladesh	Congo
Niger	Chad	Zimbabwe	Iran.	Congo	Gambia
Nigeria	Burundi	Cameroon	Rwanda	Iran, Islamic Rep.	Syrian Arab Rep.
Rwanda	Burundi	Nigeria	Cameroon	Iran, Islamic Rep.	Algeria
Senegal	Nepal	Ghana	Burkina Faso	Bangladesh	Honduras
South Africa	India	Brazil	Philippines	Peru	Korea, Rep.
Togo	Zambia	Guinea-Bissau	Indonesia	Ghana	Kenya
Tunisia	Cote d'Ivoire	Morocco	China	Indonesia	Thailand
Zambia	Guinea-Bissau	Togo	Ghana	Ecuador	Kenya
Zimbabwe	Nepal	Mozambique	Chad	Senegal	Bangladesh

Finally, most of the African countries have their main institutional neighbors within the continent. Two things have to be taken into consideration in the interpretation. First, the general low level of institutions in Africa increases proximity among African countries. Second, the huge size of the African continent has to be taken into consideration. Indeed, strong institutional proximity between Zambia (Southeast of the continent) and Guinea-Bissau (Northwest) cannot be considered as a geographical link, even if they are located on the same continent.

Table 12 shows the five nearest institutional neighbors of the Asian and Oceanic countries. The first observation we can make from this table is the high number of red boxes. In fact, most of the institutional neighbors come from outside the two continents. It is quite evident that countries such as Japan, Korea, Australia, Israel, New Zealand and Hong Kong are part of the cluster of developed countries and therefore will have their main neighbors in this cluster.

As in the previous analysis, the cluster of developing countries shows expected results as well as surprising ones for institutional environments. The principal analytical component for point 6.3 shows that the developing countries have high heterogeneity in their institutional levels and in the covariance of their governance indices. Thus, when there are some similarities in the general level of institutions as well as similar scores for one or two of the six institutional dimensions, a strong proximity between countries will be noted.

Table 12: The five nearest institutional neighbors of the Asian and Oceanic countries

Countries	First	Second	Third	Fourth	Fifth
Australia	Portugal	Ireland	Barbados	Austria	Germany
Bangladesh	Venezuela	Nicaragua	India	Honduras	Dominican Rep.
China	Indonesia	Cote d'Ivoire	Tunisia	Morocco	Egypt, Arab Rep.
Hong Kong, China	Chile	Israel	Spain	Greece	Ireland
India	Bangladesh	Brazil	Nicaragua	Ecuador	Venezuela
Indonesia	Egypt, Arab Rep.	China	Morocco	Togo	Colombia
Iran, Islamic Rep.	Chad	Niger	Syrian Arab Rep.	Cameroon	Rwanda
Israel	Hong Kong, China	Spain	Chile	Greece	Korea, Rep.
Japan	France	Barbados	Italy	Spain	Iceland
Korea, Rep.	Greece	Italy	Poland	Thailand	Argentina
Malaysia	Lesotho	Cote d'Ivoire	Senegal	Comoros	Zimbabwe
Nepal	Mozambique	Senegal	Zimbabwe	Bangladesh	Honduras
New Zealand	Netherlands	Denmark	Luxembourg	Norway	Finland
Pakistan	Kenya	Guatemala	Bangladesh	Cameroon	Chad
Philippines	Brazil	Mexico	Thailand	Bolivia	Panama
Sri Lanka	Colombia	Turkey	Peru	Guatemala	Egypt, Arab Rep.
Syrian Arab Rep.	Chad	Kenya	Iran, Islamic Rep.	Cameroon	Zimbabwe
Thailand	Argentina	Philippines	Korea, Rep.	Panama	Bolivia
Turkey	Peru	Colombia	Egypt, Arab Rep.	Mexico	Sri Lanka

The analysis of the different tables leads us to the conclusion that an institutional neighborhood generally differs from a geographical one. The homogeneity of European institutions and the general low level for African countries naturally implies institutional links inside the continents. However, countries do not always have the same environment with regard to both the institutional and geographical dimensions.

All in all, the institutional proximities drawn from this method are generally coherent. However, a few cases appear very surprising such as the proximities between Mauritius and Poland, Italy and Greece, Peru and Turkey, or Mexico and the Philippines. The main source of these results is the indices themselves. Indeed, in each case, the indices relating to the six dimension of governance appear to be constantly close and this leads to greater proximity between the countries. Another factor that could influence the outcome is the set of countries taken into consideration in the study. Poland, for instance, find its institutional neighborhood with countries such as Mauritius, the Republic of Korea or Uruguay. Ideally, a country such as Poland would have had its neighborhood with the former soviet countries. In fact, our study does not take many of these countries into account as they experienced major institutional changes between 1980 and 2000. Consequently, the required data are not available. Furthermore, as the institutions in this type of country have changed dramatically, it is better not to take them into consideration in the study so as to assume a pre-determination of the institutions at a future stage of the study.[8]

To get a better idea of the neighbors, Figure 6 shows the 44 nearest countries that are above the median weight of Spain in green. Red-colored countries are the 45 countries that are under the median of Spain. As weights represent proximities, the 44 countries above the median can be considered as the nearest countries to Spain.

The map clearly shows that the nearest countries to Spain are European ones as well as many countries in North, Central and South America. Some African and Asian countries such as South Korea, Japan, Malaysia and the Philippines are considered to be near Spain. Australia and New Zealand are also countries that are above the median of proximity to Spain.

[8] Spatial estimation requires a spatial matrix considered as exogenous in the models. While Geography clearly has this property, it is not the case for institutional or cultural weight matrices. This study makes the assumption that both institution and culture can be considered as pre-determined. It is thus worth excluding countries that have experienced great changes in the decades under study.

Figure 6: Institutional proximities compared to the weight median of Spain.

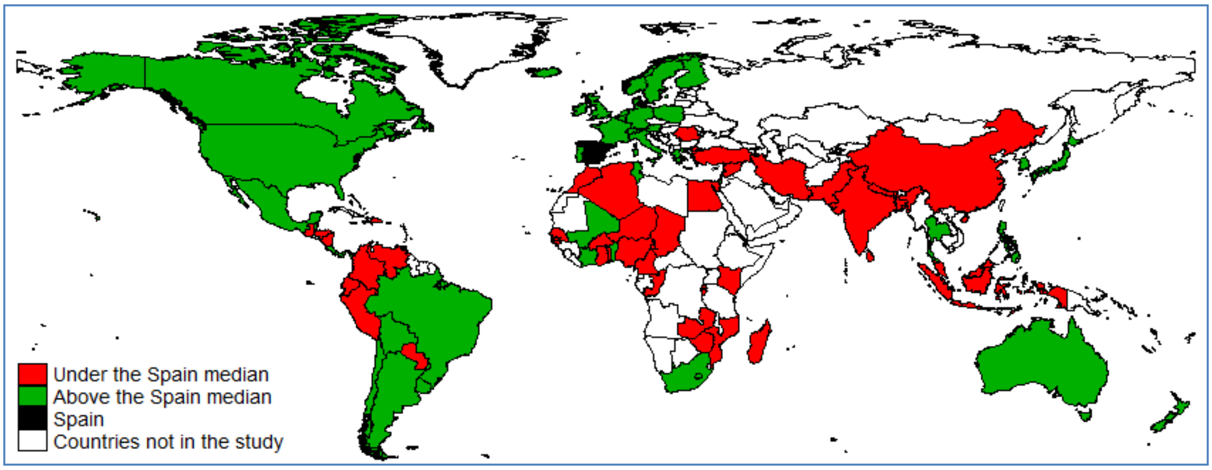
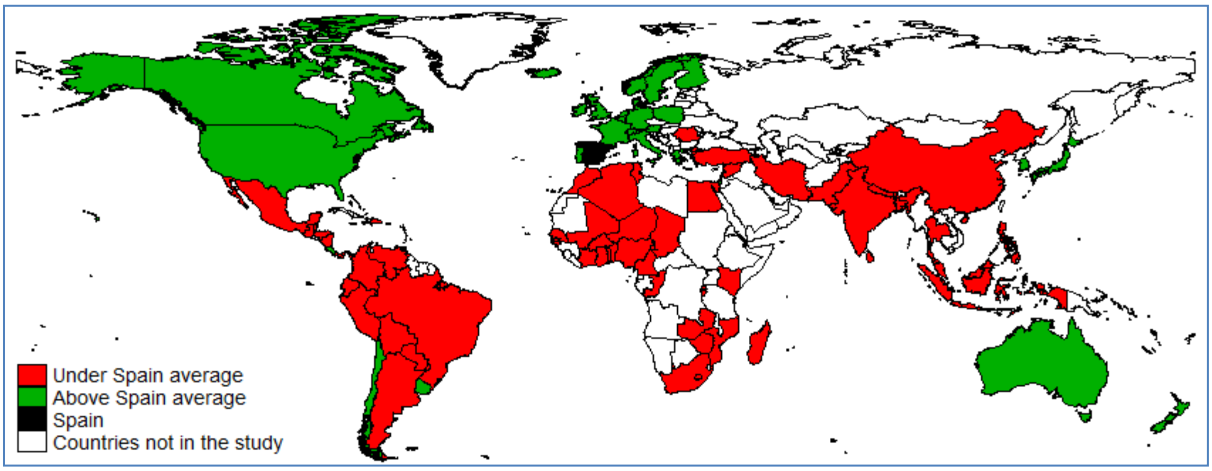


Figure 7 shows the neighboring countries with respect to the average weight of Spain. Countries shown in red are below the median and green ones are above it. The most influential institutional neighbors of Spain are the developed countries such as the USA, Canada, all of the European countries, Australia, Japan, South Korea and Chile. We also see that fewer countries are colored in green when comparing neighborhood with the average weight. Differences in the median and the mean are most probably due to an asymmetric distribution of the weights.

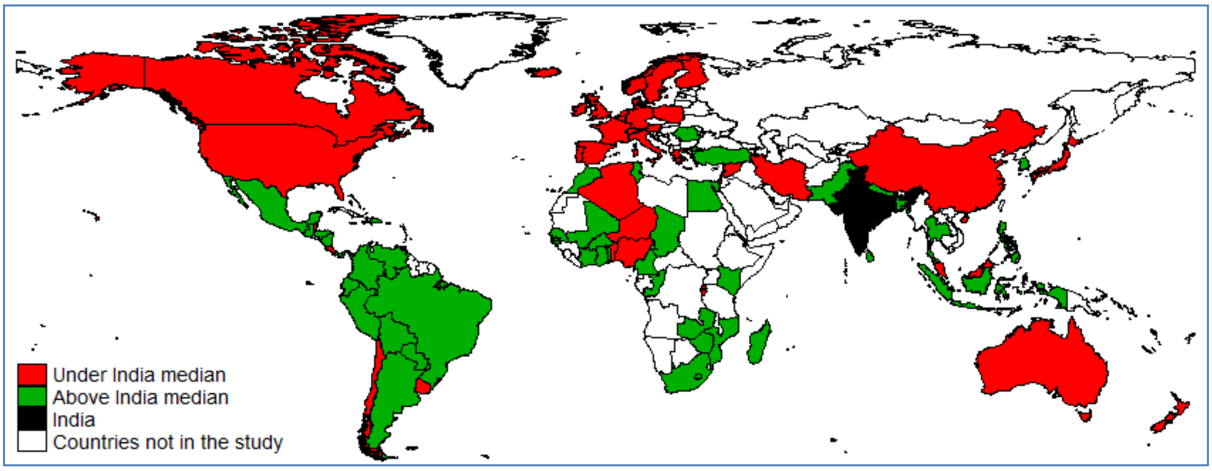
A second conclusion we can draw from this map is that countries that are above the median weight of Spain (i.e. the most influential neighbors) are all developed countries. We find the same group of institutional neighbors when performing the analysis for all the developed countries. This observation confirms the high institutional homogeneity of the developed countries that was noted following the Principal component analysis done previously.

Figure 7: Institutional proximities compared to the average weight of Spain.



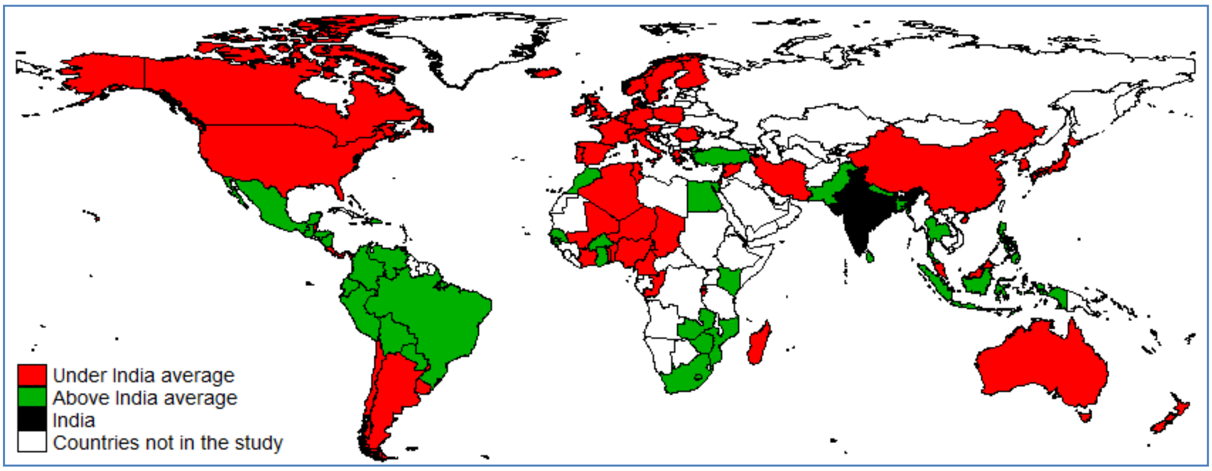
Looking at the weight distribution of India with respect to both the median weight (Fig 8) and the average weight (Fig 9), we obtain a cluster of countries that are totally different from the geographical space. The five nearest institutional neighbors of India are Bangladesh, Brazil, Nicaragua, Equator and Venezuela. India appears to have strong institutional similarities with countries from South America. Compared to the Indian weight average, the most influential group of countries is composed of Central and Southern American countries, as well as some African and Asian countries.

Figure 8: Institutional proximities compared to the median weight of India



This analysis indicates that there is a clear institutional group composed of developed countries. However, it does not mean that the opposite is true. By mapping the relationship for the developing countries, not a single cluster of developing countries appears. This also confirms the heterogeneity of institutional levels for the developing countries that was noted previously in this chapter in the Principal Component Analysis.

Figure 9: Institutional proximities compared to the average weight of India



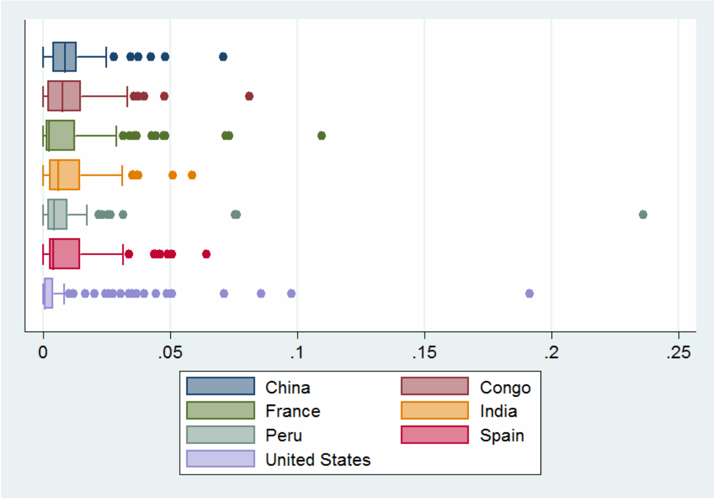
Replicating the same procedure for all the countries, institutional similarities always seem to follow the same pattern: fewer countries are above the average compared to those that are above the median. To understand this, we show the box plots of the weight distribution for several countries that are located in different continents in Figure 10 in order to see the shape of institutional proximity distribution.

In descriptive statistics, a boxplot or box plot (also known as a box-and-whisker diagram or plot) is a convenient way of graphically depicting groups of numerical data through their five-number summaries: i.e. the smallest observation, lower quartile, median, upper quartile, and largest observation. A box plot may also indicate which observations, if any, might be considered outliers. Box-and-whisker plots are uniform in their use of the box: the bottom and top of the box are always the 25th and 75th percentile (the lower and upper quartiles, respectively), and the band near the middle of the box is always the 50th percentile (the median). However, the ends of the whiskers can represent several possible alternative values. The chosen representation in this study is to draw the whiskers as the lowest datum still within 1.5 times the interquartile distance from the lower quartile, and the highest datum still within 1.5 times the interquartile distance from the upper quartile. Any data not included between the whiskers are plotted as an outlier with a dot.

We should keep in mind that the weights represent proximities and are row normalized. They are therefore always included in the range between 0 and 1. Any outliers located on the right-hand side of the boxplot are therefore 'abnormally' near the studied country while an outlier that is on the left-hand side of the boxplot is 'abnormally' far.

Figure 10 shows the boxplots for a set of countries located on different continents. All country boxplots of the institutional weights have a very asymmetric shape. In addition, they have outbox values. These values have a significant impact on the average and explain why the latter appears really high compared to the median. This figure also shows that a country has strong institutional relations with relatively few countries and is therefore influenced by a limited set of institutional neighbors.

<u>Figure 10</u>: Box plot – Institutional proximities



In order to better illustrate these differences in the weight distribution with respect to the institutional and geographical weights, the correlation between the average vectors has been computed for both types of distance. Taking the weight matrices in absolute value and making an average of weights for each line gives a vector with one average weight value for each country considered in the study.

For geographical proximities: $Avg_i^G = \frac{1}{N-1}\sum_{k=1}^{N} w_{ik}^G$

For institutional proximities: $Avg_i^I = \frac{1}{N-1}\sum_{k=1}^{N} w_{ik}^I$

Where w_{ik}^G represents the geographical weight between country $i$and country k and w_{ik}^I represents the institutional weight between country i and country $k, \forall\, i, k \in S$.

The correlation established between the two vectors is 0.267, which is a low positive relationship between the average institutional weight vector and the average geographical weight vector.

8.2. *Culture vs. Geography*

The comparison between the geographical and cultural dimensions is as challenging as the comparison conducted in the previous section with institutional weights. The tools used are therefore exactly the same. We first look at the cultural environment of the countries by continent and then compare the weight distribution in the matrices.

The tables presented in this section are similar to those made when comparing the institutional and geographical environments. Each table shows the five nearest cultural neighbors of countries that are located on the same continent. Colors have been attributed to the cultural neighbors regarding their geographical position: green if it is contiguous, orange if it is located on the same continent and red otherwise.

Table 13 shows the five nearest cultural neighbors for the European countries. As can be observed, the main cultural neighbor of 8 out of 20 European countries is geographically contiguous to them. Furthermore, 6 European countries have their main cultural neighbor in Europe. It seems that a geographical cluster of similar countries composed of the Scandinavian countries and the Netherlands appears in the same way as it appeared for the institutional weights.

Six of the European countries have their main cultural neighbor outside the continent and some of them are surprising, as for instance the proximity between Poland and Brazil, Romania and Thailand, or Greece and Mozambique. If we focus on the specific case of Brazil, it is not only the closest country to Poland, but it also appears among the five nearest countries of Luxembourg, Italy, Greece, Belgium and Austria. Looking at the four dimensions that comprise cultural proximity, these countries have a lot in common. First, apart from Greece, they share the same religious profile (Catholics). They also all share the same official language value which is set as ‘Other Language’, as well as the same legal origin which is French, except for Poland and Austria. Second, their Hofstede value indices are very similar. Poland, Belgium and Brazil have an above average value for each of the Hofstede indices and therefore the binary value attributed for each is one. The very close cultural relations between Poland and Brazil therefore come from similar ones in the binary vector for the values concerning Religion, Language and the four Hofstede dimensions. Similar relations can be shown for the other surprising cases.

Countries with a long colonial past also have some surprising results. The United Kingdom and Spain are mainly connected to their old colonies. France is mainly connected to non colonized French-speaking countries. On the other hand, Portugal does not show any neighborhood to its former colonized countries. This is probably due to the fact that the Portuguese language is considered as 'Other language' in the language dimension.

Table 13: The five nearest cultural neighbors of the European countries

Countries	First	Second	Third	Fourth	Fifth
Austria	Germany	Japan	Italy	Switzerland	Brazil
Belgium	France	Brazil	Luxembourg	Morocco	Colombia
Denmark	Finland	Iceland	Norway	Sweden	The Netherlands
Finland	Iceland	Norway	Denmark	Sweden	The Netherlands
France	Belgium	Burundi	Brazil	Luxembourg	Congo
Germany	Austria	Japan	Switzerland	Italy	Lesotho
Greece	Mozambique	Brazil	Thailand	Nepal	Sri Lanka
Iceland	Norway	Denmark	Finland	Sweden	The Netherlands
Ireland	Lesotho	India	New Zealand	South Africa	United Kingdom
Italy	Brazil	Luxembourg	Austria	Spain	Argentina
Luxembourg	Italy	Brazil	Belgium	Austria	Spain
The Netherlands	Italy	Spain	Portugal	Norway	Denmark
Norway	Denmark	Finland	Iceland	Sweden	The Netherlands
Poland	Brazil	Italy	Austria	Belgium	Luxembourg
Portugal	Italy	Honduras	Paraguay	Peru	Spain
Romania	Thailand	Greece	Mozambique	Korea, Rep.	Poland
Spain	Italy	Argentina	Honduras	Paraguay	Peru
Sweden	Denmark	Finland	Iceland	Norway	United Kingdom
Switzerland	Germany	Austria	Lesotho	Luxembourg	Canada
United Kingdom	New Zealand	South Africa	Australia	Jamaica	India

Table 14 shows the same table for the American countries (North, Central and South America together with the Caribbean). As we can see, there are very few red boxes. In fact, most American countries have their neighbors on the same continent. The Spanish-speaking countries appear to form a strong cultural cluster. The analysis of Hispanic countries made in point 7.3 shows that these countries have the same religion (Catholicism) as well as the same legal system origin (French). Furthermore they have a very similar Hofstede index profile.

The English-speaking countries are linked to other English-speaking countries which have the same legal system origin and the same profile on Hofstede's cultural dimensions. Finally, Brazil is connected to the set of European countries that have the same Religion, the same Language (set as 'Other') and the same Hofstede dimension profile.

<u>Table 14:</u> The five nearest cultural neighbors of the American continent countries

Countries	First	Second	Third	Fourth	Fifth
Argentina	Colombia	Ecuador	Italy	Mexico	Venezuela
Barbados	Ghana	Zambia	Zimbabwe	Thailand	Kenya
Belize	Bolivia	Dominican Rep.	Guatemala	Nicaragua	Panama
Bolivia	Dominican Rep.	Guatemala	Nicaragua	Panama	Colombia
Brazil	Italy	Belgium	Luxembourg	Poland	Colombia
Canada	Lesotho	United States	Jamaica	Australia	Ireland
Chile	Costa Rica	Dominican Rep.	Guatemala	Nicaragua	Panama
Colombia	Ecuador	Mexico	Venezuela	Dominican Rep.	Guatemala
Costa Rica	Chile	Dominican Rep.	Guatemala	Nicaragua	Panama
Dominican Rep.	Guatemala	Nicaragua	Panama	Bolivia	Honduras
Ecuador	Mexico	Venezuela	Colombia	Guatemala	Nicaragua
Guatemala	Nicaragua	Panama	Bolivia	Dominican Rep.	Honduras
Honduras	Paraguay	Peru	Nicaragua	Panama	Bolivia
Jamaica	Australia	New Zealand	South Africa	United Kingdom	United States
Mexico	Venezuela	Colombia	Ecuador	Nicaragua	Panama
Panama	Bolivia	Dominican Rep.	Guatemala	Nicaragua	Paraguay
Paraguay	Peru	Honduras	Bolivia	Dominican Rep.	Guatemala
Peru	Honduras	Paraguay	Bolivia	Dominican Rep.	Guatemala
United States	Australia	Jamaica	New Zealand	South Africa	Lesotho
Uruguay	Chile	Costa Rica	Bolivia	Dominican Rep.	Guatemala
Venezuela	Colombia	Ecuador	Mexico	Bolivia	Dominican Rep.

The same analysis can be done for the African countries (Table 15). A few red boxes appear, but many countries have cultural connections within the same continent. A cluster of Muslim countries clearly emerges with Algeria, Tunisia, Morocco, Turkey, Syria and Egypt (although Turkey and Syria are considered as Asian countries).

The other African countries are usually close to other countries on the African continent with the same religion and the same language. The fine tuning of similarities is made through Hofstede's cultural dimensions profile.

However, African countries do not seem to have specific links with their colonizers. France is in the cultural neighborhood of Congo and Burundi, which are former Belgian colonies. The United Kingdom only appears in the neighborhood of Lesotho. The fact is that even if the former colonizers and the former colonies usually have the same language and the same legal system origin, their religious profile and Hosfstede's cultural dimension systematically differ.

A last point to highlight is the cultural neighborhood of South Africa which is mainly composed of countries outside the African continent. Looking closer, South Africa appears to have the United Kingdom and its old colonies as cultural neighbors. This is due to the fact that South Africa is mainly Protestant, its legal system is of British origin and English is one of the country's many official languages.

<u>Table 15</u>: The five nearest cultural neighbors of the African countries

Countries	First	Second	Third	Fourth	Fifth
Algeria	Egypt	Syria	Tunisia	Morocco	Turkey
Benin	Togo	Burkina Faso	Cote d'Ivoire	Mauritius	Burundi
Burkina Faso	Cote d'Ivoire	Togo	Mali	Niger	Senegal
Burundi	Congo	France	Rwanda	Togo	Mali
Cameroon	Mali	Niger	Senegal	Congo	Cote d'Ivoire
Chad	Comoros	Mali	Niger	Senegal	Cote d'Ivoire
Comoros	Chad	Mali	Niger	Senegal	Cote d'Ivoire
Congo	Burundi	Cameroon	France	Rwanda	Mali
Cote d'Ivoire	Burkina Faso	Mali	Niger	Senegal	Togo
Egypt	Syria	Tunisia	Algeria	Morocco	Turkey
Gambia	Nigeria	Bangladesh	Ghana	Zambia	Zimbabwe
Ghana	Zambia	Zimbabwe	Barbados	Nigeria	Kenya
Guinea-Bissau	Indonesia	Mozambique	Burkina Faso	Cote d'Ivoire	Turkey
Kenya	Nepal	Sri Lanka	Thailand	Zambia	Zimbabwe
Lesotho	Ireland	New Zealand	South Africa	United Kingdom	Canada
Madagascar	Mauritius	Rwanda	Cameroon	New Zealand	South Africa
Mali	Niger	Senegal	Burkina Faso	Cote d'Ivoire	Chad
Mauritius	Rwanda	Madagascar	Togo	Benin	Mozambique
Morocco	Syria	Tunisia	Algeria	Egypt	Belgium
Mozambique	Guinea-Bissau	Indonesia	Greece	Mauritius	Togo
Niger	Senegal	Mali	Burkina Faso	Cote d'Ivoire	Chad
Nigeria	Gambia	Zambia	Zimbabwe	Ghana	Cameroon
Rwanda	Mauritius	Burundi	Philippines	Congo	Honduras
Senegal	Mali	Niger	Burkina Faso	Cote d'Ivoire	Chad
South Africa	United Kingdom	New Zealand	Australia	Jamaica	India
Togo	Benin	Burkina Faso	Cote d'Ivoire	Mauritius	Mozambique
Tunisia	Algeria	Egypt	Syria	Morocco	Turkey
Zambia	Zimbabwe	Ghana	Barbados	Kenya	Nigeria
Zimbabwe	Ghana	Zambia	Barbados	Kenya	Nigeria

Finally, Table 16 shows the cultural neighbors of the Asia-Oceanic countries. The overall neighborhood pattern shows more red than any other continent, indicating that the Asian and Oceanic countries have more cultural neighbors outside their own continent.

The neighborhood of Australia, New Zealand and India is with the United Kingdom and its former colonies. Syria, Iran and Turkey have their neighborhood in Muslim North African countries.

A cluster of Asian countries clearly appears to include Nepal, Sri Lanka, Malaysia, Bangladesh and Thailand.

Finally, there are some surprising results like the Philippines which is connected to South American countries, or Indonesia that is connected to African countries. The cultural similarities mainly come from the Hofstede's cultural dimension profile, but also from the religion (i.e. Catholic for the Philippines and Muslim for Indonesia).

Table 16: The five nearest cultural neighbors of the Asian and Oceanic countries

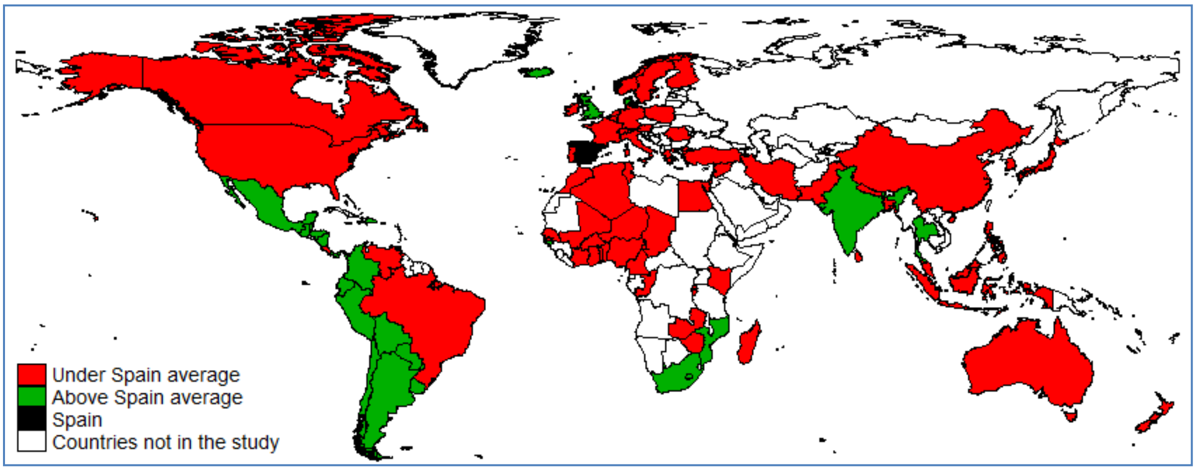
Countries	First	Second	Third	Fourth	Fifth
Australia	Jamaica	New Zealand	South Africa	United Kingdom	United States
Bangladesh	Malaysia	Nepal	Sri Lanka	Pakistan	Gambia
China	Hong Kong	Romania	Nepal	Sri Lanka	Greece
Hong Kong	Nepal	Sri Lanka	China	Malaysia	India
India	New Zealand	South Africa	United Kingdom	Nepal	Sri Lanka
Indonesia	Guinea-Bissau	Mozambique	Burkina Faso	Cote d'Ivoire	Malaysia
Iran	Syria	Tunisia	Algeria	Egypt	Chad
Israel	Thailand	Japan	India	New Zealand	South Africa
Japan	Germany	Austria	Korea, Rep.	Israel	Greece
Korea, Rep.	Japan	Thailand	Romania	Israel	Greece
Malaysia	Nepal	Sri Lanka	Bangladesh	India	Guinea-Bissau
Nepal	Sri Lanka	Malaysia	India	Thailand	Kenya
New Zealand	South Africa	United Kingdom	Australia	Jamaica	Lesotho
Pakistan	Bangladesh	Ireland	Malaysia	Lesotho	South Africa
Philippines	Honduras	Paraguay	Venezuela	Colombia	Ecuador
Sri Lanka	Nepal	Malaysia	India	Thailand	Kenya
Syria	Tunisia	Algeria	Egypt	Morocco	Turkey
Thailand	Nepal	Sri Lanka	Romania	Kenya	Greece
Turkey	Algeria	Egypt	Syria	Brazil	Tunisia

To conclude, the cultural weighting does not systematically lead to neighbors that are different from physical ones. Nonetheless, connections between countries seem natural and are justified with regard to the four dimensions used to build the cultural matrix. Furthermore, even if the countries usually have their main cultural interaction within the same geographical region, it is not always the contiguous countries that take the main neighboring places. The redistribution of neighborhoods in Africa for instance could make sense with regard to official language and religion. Therefore, former French and British colonies are better connected when we consider cultural proximities rather than geographical ones.

The next question is therefore: Does the cultural weight distribution have the same properties as the institutional weight distribution? Figure 11 shows cultural proximities compared to average weight. In point of fact, the median map is quite similar to the average map. Only Canada, the United States, Australia and Indonesia are green when compared with the median.

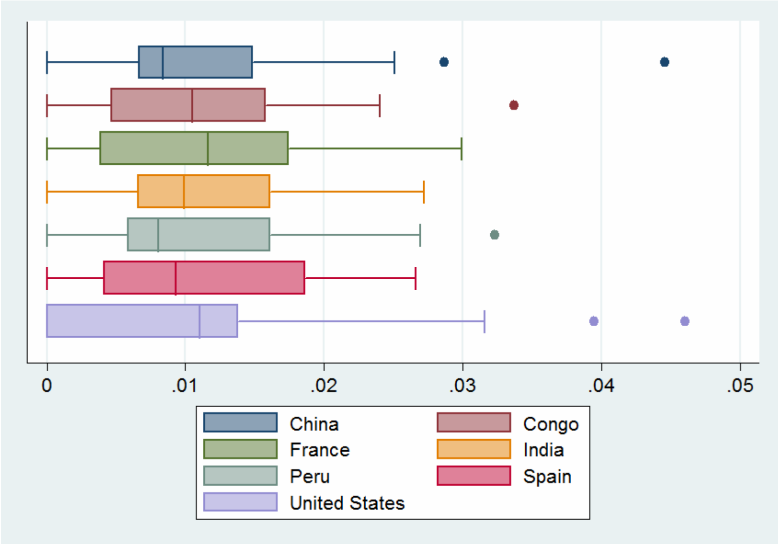
These observations can mean two things: first, the connections are above average for half of the countries considered in the study, and secondly, they do not have a really strong connection with any of the countries in particular.

Figure 11: Cultural proximities compared to the average weight of Spain



Looking at the boxplots (Fig. 12) for the same set of countries used for the institutional weights, it appears that the distribution shape is completely different. The shape of the boxplot looks much more balanced and symmetrical. Furthermore, there are fewer outliers, and they are not as outlying as they were compared to those obtained with the institutional weights. This means that cultural neighborhood is shared by many more countries than institutional neighborhood.

Figure 12: Box plots – Cultural proximities



All the maps considered previously show rather different connections compared to the geographical maps. These weights indeed connect countries that are not geographical neighbors. Furthermore, institutional and cultural weights do not exclude connections with nearby countries but do not systematically connect countries that are in the same region. Finally, to ensure that the three matrices are really different from one another, the following average values need to be considered:

$$Average_i^{G,I\ or\ C} = \frac{1}{N-1}\sum_{k=1}^{N} w_{ik}^{G,I\ or\ C} \qquad \forall i \in S$$

Table 1 gives the correlation matrix between the three average vectors. The correlation between the vectors is really low. Even if these correlations are constructed using average country values for each type of proximity, it is still possible to conclude that the different types of weights do not have a similar variation in their value. This means that when a country has many connections in one aspect, it could have a very low level of connections in another aspect, indicating even more strongly that cultural and institutional neighborhoods are different from the geographical type of neighborhood.

8.3. *Institution vs. Culture*

In the following section, we consider the differences between institutional and cultural distances. It was quite easy to compare geographical space in the previous sections (i.e. the map of the world) with the cultural or institutional space (i.e. the colors on the map). Showing both culture and institution on the same map would not be as easy to understand. The first way to compare them is to point to the differences between them with respect to geography. If these two matrices are very different from one another, they should diverge from geographical space in different ways.

For instance, institutional weights show a cluster of developed countries and several clusters of developing countries. Looking at the cultural neighbors of developed countries, it appears that they do have a close neighborhood with the developing countries. Spain’s ten nearest cultural neighbors are located in Latin America. France has its best proximity with Belgium, Luxemburg ranks fourth and Australia ranks sixth, but the other countries in the top ten nearest cultural neighbors are African countries such as Burkina Faso, Burundi, Benin, Ivory Coast or Congo, and Latin American countries such as Guatemala and Panama. The cultural relationship between developed and developing countries appears to be much more frequent than the institutional relationship between these two groups.

A second way to compare the cultural and institutional spaces is to compare the weight distribution of the two matrices. Figures 10 and 12 show the boxplots for a sub-set of countries regarding institutional and cultural proximities. The comparison of these two distribution shapes is quite obvious: while institutional weights are distributed asymmetrically with few influential outliers, the cultural weights show relatively symmetric distribution with fewer outliers. This difference in the distribution shape shows that institutional weights create stronger relations between close countries than cultural weights.

Table 17: Correlation between average weight vectors

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

A last way of comparing cultural and institutional weights is to compute the correlations between both vectors of average weights. Table 1 shows a slightly negative correlation of -0,223. This correlation indicates that the institutional and cultural weight distributions diverge significantly.

9. Conclusions

Countries are not isolated from one another. The most natural way of looking at a country's connections is through its geographical situation. The economic literature agrees that growth spillovers are due to the fact that borders are not impervious to growth and this enables us to take the physical proximity between entities into account.

This study explores whether other types of connection exist between countries, taking into account both cultural and institutional similarities. This type of proximity could also play an important role in growth or productivity propagation. Indeed, two countries with similar institutions or cultural behavior can reduce trade barriers and costs, FDI and economic collaboration. Therefore, non physical proximity has a role to play in economic spillover.

This paper describes a methodology to build institutional and cultural proximities. The weight matrices obtained are very different from one another, mainly in terms of geographical links. However, the most interesting findings concern how these matrices link countries together, giving rise to new clusters of countries due to their common institutions, language or religion.

First, a first cluster of countries arises from institutional proximities: i.e. the developed countries comprising all the European countries, North America, Japan, South Korea, Australia, New Zealand and Chile. Second, there is not one clear cluster of developing countries: there are several institutional levels within this cluster that lead to different institutional links. These findings are confirmed by the principal component analysis made on the 6 governance indices used to compute the proximities. Good economies tend to have good indices and are naturally close to one another in terms of institutional efficiency. On the other hand, developing countries can score well on one or two governance indices and poorly on others. Proximities between developing countries are therefore not straightforward and the 6 dimensions are needed to link all of the countries in the study.

For cultural proximities, many clusters tend to appear. Countries with the same language and religion are essentially quite close. Furthermore, the historical links based on colonial relations can be partially explained from the results: France is linked to a large number of French-speaking African countries and Spain is linked to a large chunk of South America.

All in all, the outcomes from both institutional and cultural proximities are generally coherent. Nevertheless, several surprising results have been detected that merit further analysis. The data unexpectedly links some countries such as Barbados with France via the institutional matrix or Poland with Brazil for cultural proximities. This occurs when two countries have similar scores in the six governance indices in the institutional weights or if similarities such as ‘Other religion’ or ‘Other language’ appear in the cultural weight. Our exploratory study helps to detect such cases. There are not that many, but they give insight as to why these countries can be considered as neighbors. However, the difficulties involved in taking such qualitative concepts into account to compute a distance are also a significant factor.

Finally, there are no doubt other ways of modeling institutional or cultural factors. Firstly, other variables could be used as there are no really clear definitions of culture or institutions. Secondly, whether we use other variables or not, we can also change the methodology used to compute proximities. However, the most important contribution of this chapter is to show a way of dealing with non physical proximities to build weight matrices. The links obtained between the countries are sensitive enough to offer a more extensive economic analysis.

The following chapters will therefore focus on growth and productivity models using spatial econometrics methods with these new matrices. This can help us to answer several critical questions such as: How do culture and institution affect economic spillovers? Are these types of proximities more or less important than physical links? Are rich and poor countries affected in the same way by the different types of neighborhood?

CHAPTER 2

DO CULTURAL AND INSTITUTIONAL NEIGHBORHOODS MATTER FOR GROWTH SPILLOVERS ?

Abstract:

Over the last few years, growth and productivity have often been studied through the lens of spatial models, and nowadays the idea of growth and productivity spillover is generally accepted in the literature. In most cases, the notion of neighborhood has been defined by certain physical proximities. In the first chapter, we described a methodology for building qualitative relations such as institutional or cultural weight matrices, indicating that these types of distance differ significantly. Our thesis sets out the reasons for dealing with spillover issues in growth and productivity models using such connection matrices. This allows us to develop an externality model that takes into account many kinds of proximity between countries. Our explorative study based on productivity and growth data leads us to conclude that there is a spatial autocorrelation presence with regards to the three types of proximity. The resulting estimations have a significant impact on growth in terms of the latter arising from geographical and institutional neighbors. Furthermore, it appears that the speed of convergence is greater when institutional weights are included in the model. The use of the externality model generally confirms the impact of the various neighborhoods. In addition, it indicates precisely which variables channel the spillover from one country to another.

1. Introduction

Empirical studies on growth and convergence processes have been undertaken by many authors. Barro and Sala-i-Martin (1992), Mankiw, Romer and Weil (MRW, 1992) and Nazrul (1995), among others, have made some of the most significant contributions to this literature. All of these studies have identified differences in production and growth values among countries. According to their models, two factors are at the source of these differences: physical and human capital. However, variations in the growth model residuals may suggest that some variables or factors are omitted in the model specification. Indeed, the estimates made in the previously mentioned studies were based on the hypothesis that country observations are independent from one another. However, in practice interactions may exist between observations made in different places. In other words, national borders are not impervious to economic performance. The treatment of spillover remains an unresolved issue in growth econometrics, with cross-section correlations an important factor in determining the estimates precisely.

Since the studies by MRW and Nazrul, spatial econometrics methods have been widely used in economic studies. The idea that growth observations in different localizations are mutually dependent has also been taken into account in such estimation methods. Ertur and Thiaw (2000) showed that the cross-sectional data used by MRW introduced a bias due to a problem of spatial autocorrelation. Other studies on growth and productivity have used spatial econometrics methods (Baumont, Ertur and Le Gallo (2000), Beck, Gleditsch and Beardsley (2006), Arbia, de Dominicis and Piras (2005)). All of them have defined spatial dependence with respect to geographic distances or contiguity. However, while the authors agree that spatial spillover exists, no consensus has emerged so far as to whether geographic proximities constitute the optimal way to weight observations. Durlauf, Johnson and Temple (2005) argue that one can imagine many reasons for the presence of spatial correlation in error terms. Akerlof (1997) states that countries are perhaps best thought of as occupying some general socio-economic-political space defined by a range of factors, while Durlauf et al. (2005) point out that nothing in the empirical growth literature suggests that the issue of long-term development can be dissociated from historical and cultural factors. Moreover, so far there are no testing methods available to select the optimal spatial weight method. A valid generalization of spillover treatment has yet to be developed.

Some empirical studies have attempted to determine the impact of cultural behavior on a country's economic performance. Duane Swank's point of departure (1996) was that communitarian policy countries should have better economic growth than non communitarian policy countries. Their statistical analysis suggested that human capital investment and communitarian policies are, from empirical evidence, more powerful than the contrary. Marcus Noland (2003) later studied the relationship between culture, religion and economic performance, identifying correlations between religious affiliations, the intensity of religious beliefs and cultural tendencies. He concluded that there were no correlations between cultural measures and economic performance whereas religion was always correlated with economic performance based on panel and cross-sectional data estimates. Easterly and Levine (1997), Alesina *et alii* (2003) and Masters and McMillan (2001) showed that ethno-linguistic fractionalization has a negative impact on economic growth, while Barro and McCleary (2004) noted a strong relationship between economic growth and religiosity. They found that religious beliefs tend to stimulate growth but that church attendance appears to reduce it. Their interpretation was that religious belief may help to see behind aspects of individual behavior. The theoretical literature agrees with the hypothesis of cultural behaviors influencing a country's economic growth.

Acemoglu, Johnson and Robinson (2004) and Hall and Jones (1999) suggested that differences in findings from cross-country data can be explained by the presence of different institutional systems. They argued that the way the government affects physical and human capital accumulation by means of taxes and rules has an indirect impact on economic productivity per capita. According to them, the redistribution system also affects economic performance. Another way for the State to ensure the productivity of individuals and firms is through the general security inside the country as the level of criminality can affect human and physical capital accumulation. Another stylized fact about institutions is that democracy is a precondition for prosperity. Indeed, all developed countries run a democratic system while, at the same time, some poor countries like India have had a democratic system for many years. All the emerging countries such as Chili, South Africa and South Korea have chosen a democratic system. In fact, living in autocracy means that individuals and firms cannot acquire private property and it thus forms a capital accumulation-proof fence. The findings by Acemoglu, Johnson and Robinson (2004) suggest that countries with a low growth rate also have poor institutions. They considered institutions as endogenous, pointing out that East and West Germany, North and South Korea, China, Taiwan and Hong Kong, all started at the same wealth level and evolved differently according to their chosen institutions. This remains an open question. Our thesis considers institutions as a pre-determined factor that can help to explain error term variability in growth estimation methods.

However, to date, the literature on the relationship between culture, institutions and growth has been investigated as an effect within a country. Our study, on the other hand, focuses on the institutional or cultural interactions between countries that could enhance growth propagation. The direct effects of a country's institutions and culture on the latter's development gives insights into how it can impact on the interactions between nations, as two countries that share the same beliefs or the same rules are more likely to exchange through trade and foreign direct investment (FDI). These features can be seen as 'deep factors' in capital accumulation. Trade effects on levels of growth have been noted by several authors such as Dollar and Kraay (2002), who use cross-country data to show that trade levels have a significant impact on growth. Romer and Frankel (1999) noted large and robust but less significant effects of trade on growth. Various studies by authors such as Bergstrand (1985) have used gravity models, arguing that the closer the countries are, the more likely they are to trade or FDI together.

Nevertheless, other type of proximities such as cultural or institutional links may also foster trade and FDI between countries. Quiso et al. (2009) show the impact of trust on economic exchange. They argued that lower trust leads to fewer trade and investment flows. Authors such as Beugelsdijk, de Groot, Linders and Slangen (2007) and Linders, Burger and Van Oort (2008) also identified the importance of institutional and cultural distance in trade using gravity models. Social infrastructure distances are considered as a cost for trade and investment. Culture may have a beneficial impact on trade and FDI as it remains at a low level of difference. However, it increases the cost of trade and FDI up to a certain point by complicating interactions, make them more prone to failure and hindering the development of trust. At the same time, they suggest that the cost of managing employees increases due to interactions between local stakeholders such as employees, unions, suppliers and governmental agencies. Thus, the legal, political and administrative system institutions determine the international attractiveness of a location.

Trade and FDI affect capital accumulation, which in turn impacts on growth. Indeed, growth theories state that capital accumulation is essential for growth, whether it is physical capital, human capital or technology accumulation. Lucas (1988) drew up a human capital accumulation model which assumes that the greater the knowledge, the stronger productivity will be, all other things being equal. Romer (1990) developed a technological capital accumulation model where technology was considered as a non-rival good shared by all the individuals. Research and development in any one company therefore has an external impact on the entire set of companies inside the country and the level of technology is thus enhanced for the country. However, these theoretical models do not take into consideration potential interactions between countries.

Indeed, externalities due to these accumulations of capital can spread to other countries through trade and FDI. It is generally acknowledged that two countries that are geographically, institutionally or culturally close are more likely to trade or to increase their investment flows. Therefore, an accumulation of capital in one country, whether it is human or physical capital, not only leads to externalities within the country but also extends knowledge to their neighbors. Let's assume, for simplicity's sake, a world composed of two countries. They are neighbors, whether the neighborhood is considered as geographical, institutional or cultural. Let's imagine that one of them has an advantage in human capital accumulation. It thus increases the productivity of the agent inside the country. The investments of the latter in its neighboring economy also mean that part of this productivity gain is transferred to the individuals in the neighboring country. The same dissemination process through trade and FDI can be applied to physical capital accumulation or to any technological improvement.

The aim of this chapter is therefore to include the matrices built into the first chapter in an economic analysis of growth, and to develop a model that takes into account the externalities of physical and human capital accumulation on neighboring economies.

The chapter is structured as follows. Section 2 shows the spatial econometric methods used for estimation. Section 3 details the theoretical growth externality model developed in order to justify the inclusion of institutional and cultural proximities in growth estimation. Finally, section 4 presents firstly the explorative results on both productivity and growth data and secondly the spatial growth estimates.

2. Spatial Econometrics

Observations on economic growth have often been considered as independent from one another. Inversely, these observations have actual 'spillover' problems as a country's positive economic results can have an impact on its neighborhood. This spillover is the result of a spatial autocorrelation between data collected in different places. In order to resolve these issues, we apply a statistical technique called spatial econometrics. The aim of this method is to weight observations using a proximity function so as to take into account such spillover effects. The objective of this study is to test several ways of weighting observations in order to identify the channels of propagation for economic performance. In this section, I first present the two common models used in spatial econometrics and then show how we can interpret them. The construction of the weight matrices is also presented. The models are taken from Anselin (2003) and from Ertur and Thiaw (2005).

2.1. *Spatial error model*

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

$$Y = X\beta + \varepsilon$$

$$\text{with: } \varepsilon = \lambda W \varepsilon + \mu$$

Where Y is the dependent variable vector $(N \times 1)$ and X the set of explanatory variables for the N countries of the study. β is the vector of estimates associated with each explanatory variable. W is the weight matrix that puts each pair of countries into relation. λ is the autoregressive coefficient of the error term ε and μ is the iid error term with an expectation equal to zero and a variance equal to $\sigma^2 I_N$, where I_N is the identity of size $(N \times N)$. By reducing this specification, we obtain:

$$Y = X\beta + (I_N - \lambda W)^{-1}\mu$$

The presence of the term $(I_N - \lambda W)^{-1}$ is only related to the error term. In other words, only an exogenous shock in a spatial unit of the model can have an impact on Y in all spatial units.

These impacts are more dramatic when spatial units are closer to each other, and more limited otherwise.

2.2. *Spatial lag model*

The principle of the spatial lag model is to introduce a spatial lag into the dependent variable:

$$Y = \rho WY + X\beta + \epsilon$$

Where W is an $N \times N$ matrix which represents a spatial link between each entity, with the diagonal elements equal to zero and each line normalized to 1. The term ϵ is the iid error term that has an expectation equal to zero and a variance equal to σ^2. By reduction we obtain:

$$Y = (I - \rho W)^{-1} X\beta + (I - \rho W)^{-1} \epsilon$$

The presence of $(I - \rho W)^{-1}$ with $X\beta$ and the error term in the equation generates two spatial effects. First, there is a spatial multiplier effect which means that Y depends on the explanatory variables from its own locality for each localization, as well as on observations in other localities. On the other hand, there is a spatial diffusion effect which means that every exogenous shock from a location affects its own dependent variable observation $(i.e.\ y_i)$ as well as all the dependent variable observations in the other locations.

2.3. *Weight matrices*

As explained in Chapter 1, the definition of W is the starting point for any spatial analysis. The matrix W sets up the relation between any pair of countries i and $(i, j\ \in \{1,2, \ldots, N\})$. The general properties of a connection matrix W are the following:

- The weights must follow a decreasing distance function that can foster a stronger relationship to the entities that are close to one another;
- The elements on the matrix diagonal must equal 0. The distance between a country and itself is null;
- W must be singular;
- Each line is normalized to 1.

In this chapter, three types of weight matrices will be used in the spatial models: geographic, institutional and cultural. The geographical weight will be defined using the inverse of the geographical distance separating two countries. These distances have been computed with the great circle area formula[9] which considers the latitudes and longitudes of the most important cities or agglomerations in the studied entities.

The geographical proximities are compared to the cultural and institutional proximities that were built in Chapter 1. The institutional matrix has been built on the basis of the six governance indicators of Kaufmann et al. (2008).[10] The Kogut and Singh formula has been applied in order to compute distances between each pair of entities.

The cultural matrix has been computed by taking language, religion, origin of legal system and Hofstede's cultural indicators into consideration.[11] After being transformed via binary information, the Jaccard formulation of proximity between objects has been used to calculate the proximities between any pair of countries.[12]

Spatial results using cultural or institutional links can lead to problems of endogeneity. In fact, the spatial structure used in spatial econometrics methods needs to be constant with respect to the time period. The volatility of institutional or cultural data is, without any doubt, higher than for geographic data. In this paper, it will be assumed that, for the set of countries used, the volatility of institutional and cultural data is null. Endogeneity problems arising from the use of such qualitative connection matrices are a major issue in spatial econometrics and should be the subject of a specific study, which is not the aim of this paper.

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

[10] 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

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

[12] All the estimations methods applied stem from the cultural weights obtained by Mahalanobis distances but did not give any different results.

3. The economic model

In this section, a growth model is developed that includes spatial externalities. Spatial externalities imply international technological interdependence. Our model is based on previous models developed by Ertur and Koch (2005, 2007) and Lopez-Bazo, Vaya and Artis (2004).

The main hypothesis of this theoretical framework is that the externalities within the technological constraint are influenced by the neighborhood of the countries, regardless of the neighborhood taken into consideration. This means that the definition of neighborhood does not necessarily have to comply with the geographical dimension usually used in spatial estimation. The institutional and cultural weights that were built in the previous chapter can also be used in the definition of neighborhood to fit in with this theoretical model.

Another interesting input to this kind of development is that it allows us to separate the effects of human and physical capital accumulation at technological level. In fact, spillover between countries tends to be higher for countries that are closer to one another, whatever the definition of neighborhood. This assumption is due to the fact that physically closer countries tend to trade or invest more than more distant countries. Trade and FDI between countries contributes to the dissemination of knowledge via the training of workers in new technological processes, demands in imported or exported product standards or simply through 'learning by doing' in the economic activities arising from the exchange.

Let us consider the following Cobb-Douglas production function with human and physical capital:

$$Y_{i,t} = A_{i,t} K_{i,t}^{\alpha} H_{i,t}^{\beta} L_{i,t}^{1-\alpha-\beta} \tag{1}$$

Where $Y_{i,t}$ is the output of country $i \in \{1,2,\dots,N\}$ for $t \in T$, the time span, $K_{i,t}$ and $H_{i,t}$ are respectively the level of physical and human capital for country i at time t, $A_{i,t}$ is the level of technology for country i at time t and where α and β are the output elasticity. Output per worker can therefore be defined by the following expression:

$$y_{i,t} = A_{i,t} k_{i,t}^{\alpha} h_{i,t}^{\beta} \tag{2}$$

Where $k_{i,t} = K_{i,t}/L_{i,t}$ and $h_{i,t} = H_{i,t}/L_{i,t}$, $L_{i,t}$ is the number of active individuals in country i at time t.

Let us suppose that the level of technology depends on human and physical capital accumulation externalities as well as on the technological level of the neighbors. Ertur and Koch (2005, 2007) developed a similar technological function, although they did not allow physical and human capital accumulation to have different externalities at technological level:

$$A_{i,t} = \Omega_t k_{i,t}^{\phi_1} h_{i,t}^{\phi_2} \prod_{i\neq j}^{N} A_j^{\gamma w_{ij}} \tag{3}$$

Where Ω_t is exogenous and identical in all the countries defined by the relation $\Omega_t = \Omega_0 e^{\mu t}$, and where μ is a constant growth rate.

We assume that the level of technology increases with the level of physical and human capital per worker. The parameters $\phi_1$and ϕ_2 are respectively the externalities of the physical and human capital, $0 \leq \phi_1 \leq 1$ and $0 \leq \phi_2 \leq 1$.

We assume that the level of technology of country i depends on the level of technology of its neighbors (countries j, $i \neq j$), with γ representing the degree of technological interdependence, influenced by the connection between country i and countries j , defined by the weight w_{ij}. Where $0 \leq w_{ij} \leq 1$, $w_{ij} = 0$ if $i = j$ and $\sum_{j\neq i}^{N} w_{ij} = 1 \quad \forall i \neq j \in \{1,2,\ldots,N\}$.

Taking the logs and rewriting equation (3) in a matrix form:[13]

$$A = \Omega + \phi_1 k + \phi_2 h + \gamma W A \tag{4}$$

If $\gamma \neq 0$ and if $1/\gamma$ is not an eigenvalue:

$$A = (I - \gamma W)^{-1}\Omega + \phi_1 (I - \gamma W)^{-1} k + \phi_2 (I - \gamma W)^{-1} h \tag{5}$$

[13] Be careful of the notation. k without any indices means that the physical capital accumulation is considered as a vector of the logarithms. $k_{i,t}$ corresponds to the value of physical capital accumulation for country *i* at time *t*, not taken in logarithm..

Developing the inversion of $(I - \gamma W)^{-1}$ present in (5) thanks to the Neuman development for matrix inversion[14] results in the following for country I:[15]

$$A_{i,t} = \Omega_{\mathrm{t}}^{\frac{1}{1-\gamma}} k_{i,t}^{\phi_1} h_{i,t}^{\phi_2} \prod_{i \neq j}^{N} k_{j,t}^{\phi_1 \sum_{r=1}^{\infty} \gamma^r w_{ij}^{(r)}} h_{j,t}^{\phi_2 \sum_{r=1}^{\infty} \gamma^r w_{ij}^{(r)}} \tag{6}$$

Replacing (6) in (1), we obtain:

$$y_{i,t} = \left(\Omega_{\mathrm{t}}^{\frac{1}{1-\gamma}} k_{i,t}^{\phi_1} h_{i,t}^{\phi_2} \prod_{i \neq j}^{N} k_{j,t}^{\phi_1 \sum_{r=1}^{\infty} \gamma^r w_{ij}^{(r)}} h_{j,t}^{\phi_2 \sum_{r=1}^{\infty} \gamma^r w_{ij}^{(r)}} \right) k_{i,t}^{\alpha} h_{i,t}^{\beta} \tag{7}$$

Let us assume that:

$$\begin{cases} u_{ii} = \alpha + \phi_1 \left(1 + \sum_{r=1}^{\infty} \gamma^r w_{ij}^{(r)} \right) \\ v_{ii} = \beta + \phi_2 \left(1 + \sum_{r=1}^{\infty} \gamma^r w_{ij}^{(r)} \right) \end{cases} \qquad \forall i \in \{1,2, \dots, N\}$$

and:

$$\begin{cases} u_{ij} = \phi_1 \left(1 + \sum_{r=1}^{\infty} \gamma^r w_{ij}^{(r)} \right) \\ v_{ij} = \phi_2 \left(1 + \sum_{r=1}^{\infty} \gamma^r w_{ij}^{(r)} \right) \end{cases} \qquad \forall i \neq j \in \{1,2, \dots, N\}$$

Hence, equation (7) can be rewritten as follows:

$$y_{i,t} = \Omega_{\mathrm{t}}^{\frac{1}{1-\gamma}} k_{i,t}^{u_{ii}} h_{i,t}^{v_{ii}} \prod_{i \neq j}^{N} k_{j,t}^{u_{ij}} h_{j,t}^{v_{ij}} \tag{8}$$

The steady state derived from the fundamental equation of the Solow model:

$$\begin{cases} \dot{k}_{i,t} = s_{k,i} y_{i,t} - (n_i + g + \delta) k_{i,t} \\ \dot{h}_{i,t} = s_{h,i} y_{i,t} - (n_i + g + \delta) h_{i,t} \end{cases} \tag{9}$$

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[14] My thanks to Christopher Bruffaerts who helped me to complete this difficult step. The details are shown in Annex 10 of the thesis.

[15] Equation obtained with the help of the Neumann development for matrix inversion: $B^{-1} = \sum_{i=0}^{\infty} (I - B)^i$. In our case : $(I - \gamma W)^{-1} = \sum_{i=0}^{\infty} \big(I - (I - \gamma W)\big)^i = \sum_{i=0}^{\infty} (\gamma W)^i = (\gamma W)^0 + \sum_{i=1}^{\infty} (\gamma W)^i = 1 + \sum_{i=1}^{\infty} (\gamma W)^i$

with s_k and s_h defined respectively as the part of output dedicated to physical or human capital. The steady state for output per worker is given by:

$$y_i^* = \Omega_{\mathrm{t}}^{\frac{1}{1-\gamma}} k_{i,t}^{*\,u_{ii}} h_{i,t}^{*\,v_{ii}} \prod_{i\neq j}^{N} k_{j,t}^{*\,u_{ij}} h_{j,t}^{*\,v_{ij}} \tag{10}$$

with $k_i^* = \frac{s_{k,i} y_{i,t}^*}{n_i+g+\delta}$ and $h_i^* = \frac{h y_{i,t}^*}{n_i+g+\delta}$.

Replacing y_i^* in k_i^* and h_i^*, we obtain the steady levels of physical and human capital:

$$\begin{cases} k_i^* = \left(\dfrac{s_{k,i}^{(1-v_{ii})} \Omega_{\mathrm{t}}^{\frac{1}{1-\gamma}} s_{h,i}^{u_{ii}} \prod_{i\neq j}^{N} k_{j,t}^{*\,u_{ij}} h_{j,t}^{*\,v_{ij}}}{n_i + g + \delta} \right)^{\frac{1}{1-v_{ii}-u_{ii}}} \\ h_i^* = \left(\dfrac{s_{h,i}^{(1-u_{ii})} \Omega_{\mathrm{t}}^{\frac{1}{1-\gamma}} s_{k,i}^{v_{ii}} \prod_{i\neq j}^{N} k_{j,t}^{*\,u_{ij}} h_{j,t}^{*\,v_{ij}}}{n_i + g + \delta} \right)^{\frac{1}{1-v_{ii}-u_{ii}}} \end{cases} \tag{11}$$

Both equations show how the physical and human capital per worker depends on the usual Solow model variables, but also on the physical and human capital of the neighbors.

To determine the steady state equation of output per worker for country i, we come back to the matrix form of the Cobb-Douglas production function where the variables are expressed as logarithms:

$$y = A + \alpha k + \beta h \tag{12}$$

Substituting A by its expression in (4) and pre-multiplying by $(I - \gamma W)$, we obtain:

$$(I - \gamma W) y = \Omega + \phi_1 k + \phi_2 h + (I - \gamma W) \alpha k + (I - \gamma W) \beta h \tag{13}$$

Hence,

$$y = \Omega + (\alpha + \phi_1) k + (\beta + \phi_2) h - \alpha \gamma W k - \beta \gamma W h + \gamma W y \tag{14}$$

Rewriting this equation for country i, we obtain:

$$\begin{aligned}\ln y_i^* = \ln \Omega_t + (\alpha + \phi_1)\ln k_i^* + (\beta + \phi_2)\ln h_i^* - \alpha\gamma \sum_{j\neq i}^{N} w_{ij} \ln k_j^* \\ - \beta\gamma \sum_{j\neq i}^{N} w_{ij} \ln h_j^* + \gamma \sum_{j\neq i}^{N} w_{ij} \ln y_j^*\end{aligned} \tag{15}$$

With:

$$\begin{cases}\ln k_i^* = \ln s_{ki} - \ln(n_i + g + \delta) + \ln y_i^* \\ \ln h_i^* = \ln s_{hi} - \ln(n_i + g + \delta) + \ln y_i^*\end{cases}$$

We finally obtain:

$$\begin{aligned}\ln y_i^* = \frac{1}{1-\alpha-\beta-\phi_1-\phi_2}\Bigg[\ln \Omega_t + (\alpha + \phi_1)\ln s_{ki} + (\beta + \phi_2)\ln s_{hi} \\ - (\alpha + \beta + \phi_1 + \phi_2)\ln(n_i + g + \delta) - \alpha\gamma \sum_{j\neq i}^{N} w_{ij} \ln s_{kj} \\ - \beta\gamma \sum_{j\neq i}^{N} w_{ij} \ln s_{hj} + (\alpha+\beta)\gamma \sum_{j\neq i}^{N} w_{ij} \ln(n_i + g + \delta) \\ + \gamma(1-\alpha-\beta) \sum_{j\neq i}^{N} w_{ij} \ln y_j^*\Bigg]\end{aligned} \tag{16}$$

The spatially augmented Solow model shows that the log of the output per worker of country i depends on:

- the physical capital, the human capital, and the population growth rate of country i;
- the physical capital, the human capital, and the population growth rate of the neighborhood. Each neighbor j has an influence on the output per worker of country i through their weighted variables with w_{ij} , which is the weight that represents the proximity between countries i and j ($\forall j \neq i$);
- the output of the neighborhood where each neighbor influences i proportionally to its weight w_{ij}.

The transitional dynamics are obtained by using a log linearization of k* and h*:

$$\begin{cases} \dfrac{d \ln k_{i,t}}{dt} = (n_i + g + \delta)\left[\left(\ln y_{i,t} - \ln y_i^*\right) - \left(\ln k_{i,t} - \ln k_i^*\right)\right] \\ \dfrac{d \ln h_{i,t}}{dt} = (n_i + g + \delta)\left[\left(\ln y_{i,t} - \ln y_i^*\right) - \left(\ln h_{i,t} - \ln h_i^*\right)\right] \end{cases} \quad (17)$$

Replacing these expressions in the production function with variables expressed in logarithms yields the following equation:

$$\frac{d \ln y_{i,t}}{dt} = \frac{\mu}{1-\gamma} + \sum_{j=1}^{N} u_{ij} \frac{d \ln k_{i,t}}{dt} + \sum_{j=1}^{N} v_{ij} \frac{d \ln h_{i,t}}{dt} = \frac{\mu}{1-\gamma} + \lambda_i \ln\left(y_{i,t} - \ln y_i^*\right) \quad (18)$$

where λ_i is the speed of convergence.

Finally, the solution of the equation for $\ln y_{i,t}$ is obtained by subtracting $\ln y_{i,0}$ on both sides:

$$\ln y_{i,t} - \ln y_{i,0} = \left(1 - e^{-\lambda_i t}\right) \frac{\mu}{1-\gamma} \frac{1}{\lambda_i} - \left(1 - e^{-\lambda_i t}\right) \ln y_{i,0} + \left(1 - e^{-\lambda_i t}\right) \ln y_i^* \quad (19)$$

which, in matrix form, gives:

$$G = DC - Dy(0) + Dy^* \quad (20)$$

where:

- G is the growth vector of the growth rate of the N countries of size $n \times 1$
- $y(0)$ is the vector of the initial level of output per capita of size $n \times 1$
- y^* is the vector of output per capita of size $n \times 1$
- D is a diagonal matrix of size $n \times n$ with $\left(1 - e^{-\lambda_i t}\right)$ on its diagonal
- C is a constant vector of size $n \times 1$

Reintroducing $\ln y_i^*$ in (20), we obtain the following growth model specification:

$$\begin{aligned} G = DC - Dy(0) &+ \frac{(\alpha+\phi_1)}{1-\alpha-\beta-\phi_1-\phi_2} DS_k + \frac{(\beta+\phi_2)}{1-\alpha-\beta-\phi_1-\phi_2} DS_h \\ &- \frac{\alpha+\beta+\phi_1+\phi_2}{1-\alpha-\beta-\phi_1-\phi_2} DN - \frac{\alpha\gamma}{1-\alpha-\beta-\phi_1-\phi_2} DWS_k \\ &- \frac{\beta\gamma}{1-\alpha-\beta-\phi_1-\phi_2} DWS_h + \frac{(\alpha+\beta)\gamma}{1-\alpha-\beta-\phi_1-\phi_2} DWN \\ &+ \frac{\gamma(1-\alpha-\beta)}{1-\alpha-\beta-\phi_1-\phi_2} DWD^{-1}G + \frac{1-\alpha-\beta}{1-\alpha-\beta-\phi_1-\phi_2} DWy(0) \end{aligned} \tag{21}$$

The externality model presented in this study makes growth dependent on the classical variable of the Mankiw Romer and Weil (1992) specification. The physical and human capitals, population growth rate and initial output level of the countries indeed impact on their growth performance.

Moreover, the externality model takes the neighboring values of physical and human capitals, population growth rate and initial output level into account as an explanatory variable. This means that countries are not only impacted by their own observation but also by the weighted observation of the explanatory variables of the neighbors.

Finally, the externality model shows a spatially lagged country growth rate. The model for estimation can therefore be rewritten as follows:

$$\begin{aligned} G = \beta_0 + \beta_1 \ln(y_0) &+ \beta_2 \ln(I/Y) + \beta_3 \ln(School) \\ &+ \beta_4 \ln(n+g+\delta) + \beta_5 W \ln(I/Y) + \beta_6 W \ln(School) \\ &+ \beta_7 W \ln(n+g+\delta) + \beta_8 W \ln(y_0) + \lambda WG \end{aligned} \tag{22}$$

where I/Y is the investment share of the countries and $School$ is the human capital investment variable for the countries. In fact, this specification corresponds to the Durbin spatial specification of a model where both dependent and explanatory variables are spatially lagged. This specification can be generalized as follows:

$$G = \lambda WG + X\beta + WX\theta + \varepsilon \tag{23}$$

Growth therefore depends on three kinds of variables:

- Its own explanatory variables that are the logarithms of the share of investment, the population growth rate, the rate of education and the initial level of income;

- The spatial growth lag, which represents the direct spillover of growth between countries;
- The spatially lagged explanatory variables. This last category includes the human and physical capital accumulation of the neighbors that disseminate the technology of country j into country i through trade and FDI. It also includes the growth rate of the neighboring population, which impacts on country growth rates through the effects of migration. Finally, it includes the neighbors' initial wealth level.

This model therefore allows us to view the different effects of neighborhood on one country's growth, whatever the kind of neighborhood taken into consideration. It has the advantage of identifying from which of the neighbors' variables the spillovers are channeled from one country to another. These channels may differ depending on the type of space (i.e. geography, institution or culture) used to weight the variables.

4. Empirical study

The previous chapter undertook a comprehensive exploratory study of geographical, institutional and cultural spatial weights. In this chapter, we focus on a global spatial autocorrelation study in order to inform the use of spatial estimates in the study of growth. This section introduces an exploratory study on both productivity and growth in order to check the presence of spatial autocorrelation when using both measures. Finally, we present the estimates from the growth model, computed with the aid of methods borrowed from the spatial econometric literature. The data used in this analysis are presented in the annexes (Annex 1).

4.1. *Explorative results*

In order to test if there is a global spatial autocorrelation for the data concerning productivity, we ran two tests: Moran's I test of global autocorrelation and Geary's C global autocorrelation test. Both procedures test the null hypothesis of no global autocorrelation of a variable against the hypothesis of global autocorrelation.

Moran’s I test specification is:

$$I = \frac{N}{S_0} \frac{\sum_{i=1}^{N} \sum_{j=1}^{N} w_{ij} \, (x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^{N} (x_i - \bar{x})^2}$$

With $i \neq j$ and where $S_0 = \sum_{i=1}^{N} \sum_{j=1}^{N} w_{ij}$, Moran’s I value is compared to its expected value $E(I) = -1/(N-1)$. Beyond this value, X has a positive autocorrelation with respect to the spatial weights, which means that the neighbors of one entity i have similar values of X. On the other hand, if Moran’s I has a value below its expectation, it means that X has a negative global autocorrelation and that neighboring countries have opposite values. Moran's I statistic follows a normal distribution such as $I \sim N(E(I), Var(I))$ under the null. Centered and reduced, it follows an $N(0,1)$ and it is therefore possible to compare I to its expected value. If it is significant, it means that the null hypothesis of no global autocorrelation is rejected.

Table 18 shows the result of Moran's global autocorrelation test using the geographic, institutional and cultural weight matrices.

Table 18: Moran's I global autocorrelation tests for production per capita (GDP per capita in 2000)

	Geography	Institution	Culture
Moran's I	0,289	0,551	0,177
$\boldsymbol{E(I)}$	-0,011	-0,011	-0,011
p-value	0,000	0,000	0,000

The data concerning productivity indicates a global spatial autocorrelation regarding the three types of distances: geographic, institutional and cultural. Geary's C test was then applied to check the results.

Geary's C is also a global autocorrelation test on x which is defined as follows:

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

Where the definition of the elements are the same as the Moran's I expression. Geary's C is compared with its expected value $E(C) = 1$. A significant test of Geary's C value implies a positive global autocorrelation if $C < 1$ and a negative global autocorrelation if $C > 1$. Table 19 shows the results for Geary's C global autocorrelation test using the geographical, institutional and cultural weights.

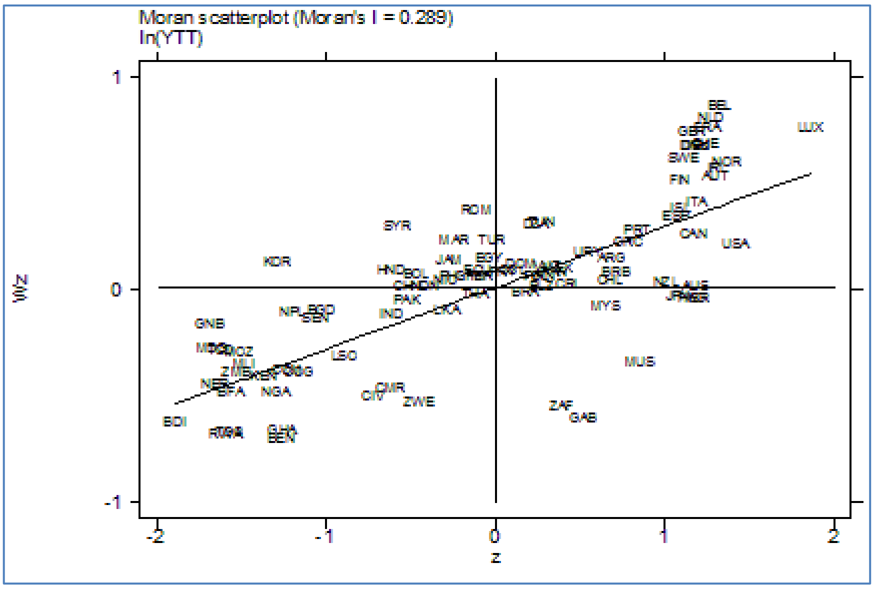
Table 19: Geary's CI global autocorrelation tests for productivity (GDP per capita in 2000)

	Geography	Institution	Culture
Geary's C	0,739	0,453	0,796
$\boldsymbol{E(C)}$	1	1	1
p-value	0,000	0,000	0,000

Geary's C confirms the result obtained with the Moran's I test. The productivity observations for the 90 countries in the dataset show spatial autocorrelation with respect to the three weight matrices. The largest autocorrelation effects on the production data are observed when using the institutional weights. The use of the cultural and geographical weight matrices appear to lead to a lesser autocorrelation effect but remain highly significant. A positive autocorrelation on production is observed regarding all three types of weight matrices. In other words, the closer one country is to another, the greater the spillover effects between them.

In order to visualize the spatial dependence between countries with regard to geographical, institutional and cultural proximities, we plot the centered productivity observation (z) with respect to the spatially weighted and centered productivity observation (Wz). This yields the so-called Moran's scatterplot that shows the relation between a country's productivity and the productivity of its neighboring countries.

<u>Figure 13</u>: Moran's scatterplot of geographical weights on productivity (GDP per capita in 2000)



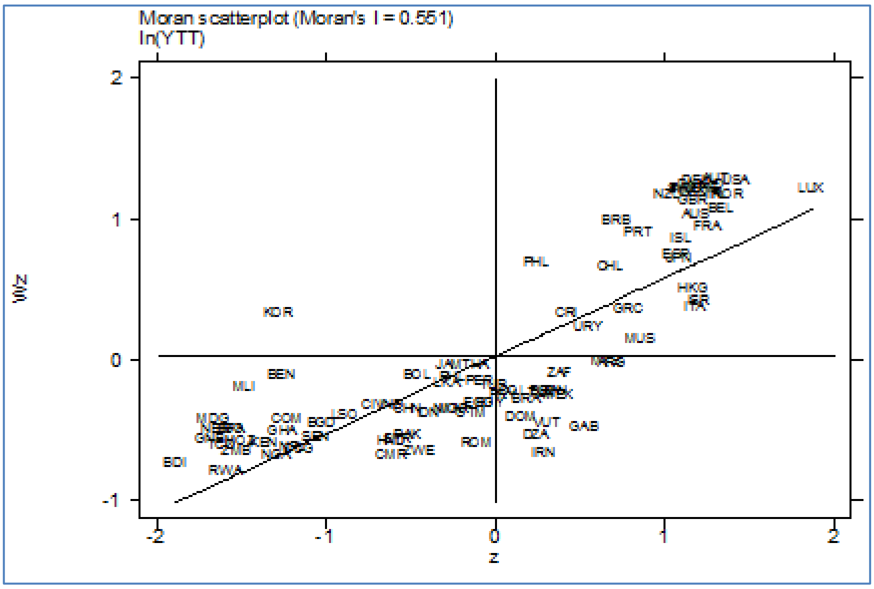
As the two axis of Moran's scatterplot are centered variables, it is therefore divided into four quadrants which each entity can be placed in. If a country i ($i \in \{1, \dots, N\}$) is located in the upper right quadrant (called HH), this country i is highly productive and its neighborhood is also composed of highly productive countries. The opposite quadrant (LL), the bottom-left hand one, represents the set of countries with low production that are surrounded by countries with below average production as well. The last two upper-left (HL) and bottom-right (LH) quadrants represent respectively low productive entities surrounded by highly productive countries and highly productive countries with a low productive neighborhood. From the slope of the scatterplots' linear regression, we recover the value of Moran's I statistic.

Figure 13 shows the scatterplot incorporating the geographical weights. There appears to be an obvious relationship between a country's production and the production of its geographical neighborhood. In fact most countries are located in the HH and LL quadrants. Moreover, the slope of the regression is positive and fits into the scatterplot relatively well. However, we see three countries that are significantly located in the lower right-hand side of the plot. These three countries are South Africa, Mauritius and Gabon, which are African countries that perform better than average in terms of productivity, but are surrounded by countries with low output. Three other countries show the opposite pattern: i.e. countries with lower than average productivity that are located in a favorable neighborhood: Korea, Syria and Romania.

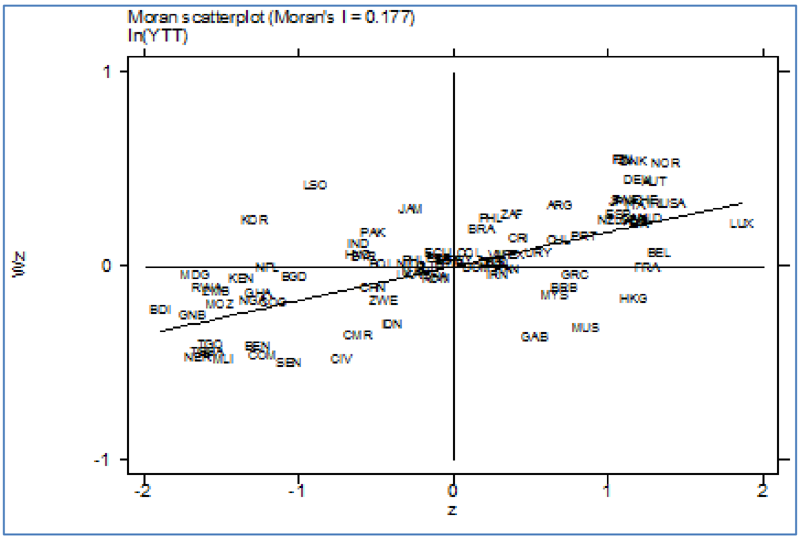
Figure 14 shows Moran's scatterplot made with the institutional weights. The observations from this plot lead to the same conclusion as for the geographical weights. It shows that some countries are not surrounded by countries with a similar profile: on the lower right-hand quadrant of the plot, we find Gabon, Iran, Venezuela and Dominica, which are countries that have better than average productivity, but their institutional neighbors have lower than average output. On the other hand, the Republic of South Korea is a low performer in terms of output but it has institutional neighbors that perform above the average. These results are not surprising given the institutional proximities set out in Chapter 1. Indeed, the five nearest institutional neighbors given in Annex 3 confirms what we observe on the Moran scatterplot.

Figure 15 shows Moran's scatterplot made with cultural weights. While many countries are located in the HH and LL quadrants, the slope of the regression differs from the previous one. Numerous countries are located near the origin. Furthermore, the regression slope seems very low compared to the geographical and institutional plots. Moreover, some countries appear in both the HL and the LH quadrants. Gabon, Mauritius and Hong Kong have an above average production level, while their cultural environment is composed of low production countries. On the other hand, Lesotho and the Korean Republic have lower than average output but are culturally surrounded by more productive countries. Here again, the results are confirmed by the exploratory study led in Chapter 1.

<u>Figure 14</u>: Moran's scatterplot of institutional weights on productivity (GDP per capita in 2000)



<u>Figure 15</u>: Moran's scatterplot of cultural weights on productivity (GDP per capita in 2000)



The second goal of the exploratory study was to determine whether spillover impacts on growth. The same two tests were therefore applied in order to detect global autocorrelation in growth data: Moran's I test and Geary's C test. We should remember that both test for the null hypothesis of no global autocorrelation for a variable against the alternative of global autocorrelation.

Table 20 gives the results obtained with the different weight matrices.

Table 20: Moran's I global autocorrelation tests on growth (1980-2000 period)

	Geography	**Institution**	**Culture**
Moran's I	0,154	0,107	0,070
$\boldsymbol{E(I)}$	-0,011	-0,011	-0,011
p-value	0,000	0,000	0,000

The null hypothesis of no global autocorrelation is rejected for the three matrices at a highly significant level. Table 21 gives the results of the tests performed on growth data regarding geographical, institutional and cultural weight matrices.

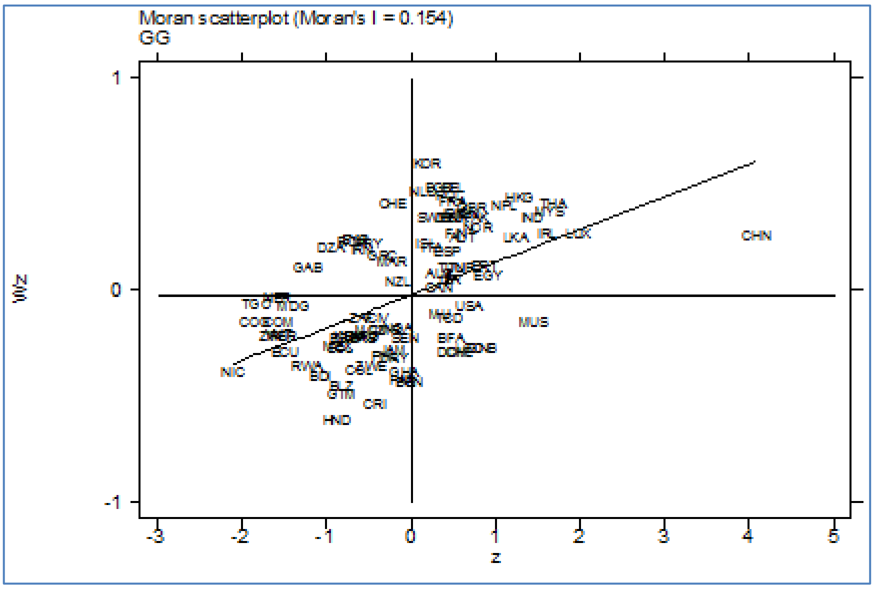
Table 21: Geary's C global autocorrelation tests on growth (1980-2000 period)

	Geography	**Institution**	**Culture**
Geary's C	0,818	0,841	0,898
$E(C)$	1	1	1
p-value	0,000	0,000	0,000

Geary's C tests confirms the results of Moran's I global autocorrelation tests. All three tests reject the null hypothesis of no global autocorrelation with highly significant values. The value of Geary's C with respect to the geographical weights keeps the larger deviation from the expected value of 1 ahead of the value obtained with the institutional weights, while that derived from the cultural weight matrix shows a slight deviation.

In order to visualize what happens at local level, Figures 16, 17 and 18 depict Moran's scatterplot for the geographical, institutional and cultural weights respectively. While some countries are situated in the HL and LH quadrants, a many countries are located in the HH and LL quadrants for all three types of distance. Furthermore, the regression slope is positive and reflects the Moran's I value.

<u>Figure 16</u>: Moran's scatterplot of growth (1980-2000 period) with respect to geographical weights

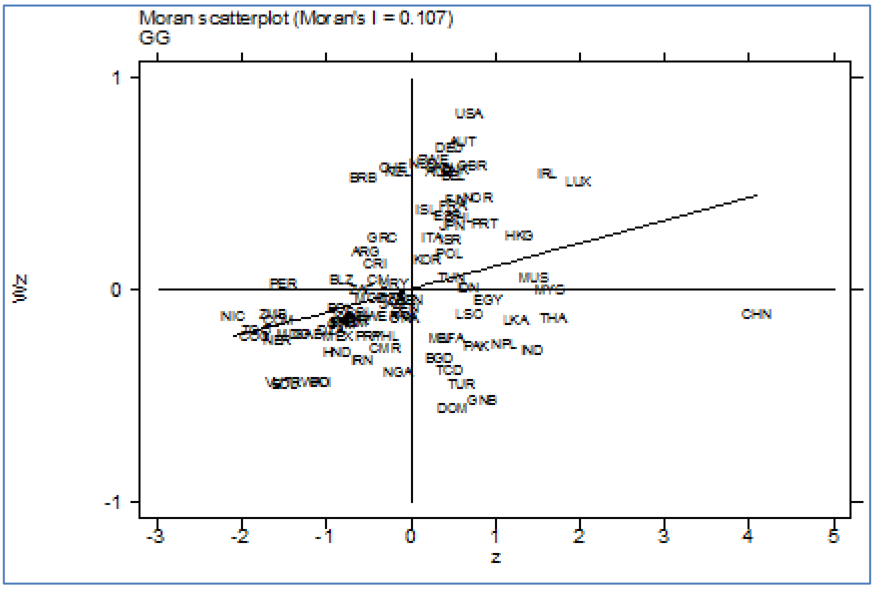


This implies that the neighborhood of countries with high (low) growth is composed of countries with high (low) growth whatever the weights used. From the regression slopes, we can observe a slight impact of the growth of the cultural neighbors on countries' growth. These observations confirm the results obtained from the global autocorrelation tests.

Going further in the analysis of the plots, Figure 16 appears to indicate that some countries are located in the HL quadrant. India, Turkey, Nepal, Dominica, Guinea-Bissau, Sri Lanka, Thailand, Pakistan and Bangladesh represent a cluster of countries with an above average growth rate but with an institutional neighborhood that reports below average growth. These results correspond perfectly with the analysis of institutional distances led in Chapter 1.

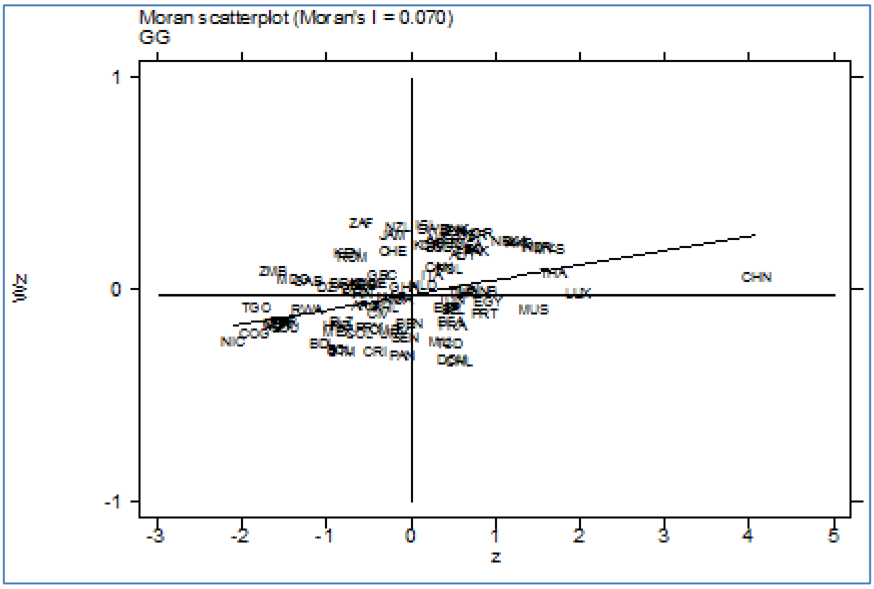
Moreover, all the Moran scatterplots for growth show the same outliers, regardless of the type of distance considered. In fact, China has a high growth rate for the years 1980 to 2000 and is therefore located in the extreme right-hand side of the plot. Its value may act as outlier data on the explorative result for growth.

<u>Figure 17</u>: Moran's scatterplot of growth (1980-2000 period) with respect to institutional weights



Moran's I and Geary's C show different values when recomputed without China. Both tests remain highly significant regarding the three types of distance. Nevertheless, Moran's I increases dramatically after the suppression of China from the dataset, while Geary's C remains relatively stable. The Moran's I scatterplots remain unchanged, apart from the fact that China has disappeared from the picture and the slope of the regression line has been adapted in consequence.

<u>Figure 18</u>: Moran's scatterplot of growth (1980-2000 period) with respect to cultural weights



The exploratory results show that both growth and productivity data suffer from a spatial autocorrelation problem with respect to the three types of proximities. We therefore need to get the spatial estimates of the growth model in order to determine which spatially weighted growth vectors impact on the growth level of our country set.

4.2. *Regression results*

All the results were computed with STATA spatial econometrics toolboxes.

We started from the hypothesis that a spatial methodology can be applied to the classical Mankiw, Romer and Weil (1992) specification. The results obtained may therefore be compared to those arising from the externality model developed earlier in the chapter. The idea is to discover the contribution of the theoretical externality model compared to the simple implementation of spatial econometrics on the growth model. The results from the standard MRW growth model are always shown in the first column of the following tables. These results are compared to the spatial error model estimates and the spatial autoregressive model estimates. All three tests presented in the table test the null hypothesis of 'no global autocorrelation' against the alternative of global autocorrelation. A significant test means that there is a significant impact of the weights on the estimates with the spatial error model. The Lagrange test gives a robust result and enables us to choose between the spatial error model and the spatial lag model.

Table 22 shows replicated estimates from the MRW model in the first column using ordinary least square estimates. The results obtained are similar to the ones from the MRW analysis and show that the constant term and many other variables are significant. Moreover, the model's global quality is comparable to that obtained by MRW given the high value of the R^2 (i.e. 0,31).

The spatial error model estimates for growth indicate insignificant spillover effects when using cultural or geographical weights. This result is confirmed by the three tests that do not reject the null hypothesis of no global autocorrelation in the model. However, even if the use of institutional weights leads to a significant spatial spillover, not all the tests are significant. It may be that the spatial error model is not the best model for this specification.

<u>Table 22</u>: Growth model (1980-2000 period) - Spatial error estimates

	OLS	Spatial error estimates		
	MRW replication	Geography	Institutions	Culture
Constant	0,614 *	0,560 *	1,109 ***	0,577 *
ln $(n+g+\delta)$	-0,107 **	-0,086	-0,056	-0,105 **
ln (I/Y)	0,338 ***	0,303 ***	0,331 ***	0,332 ***
ln $(School)$	0,086	0,079	0,056	0,079
ln (Y_0)	-0,176 ***	-0,158 ***	-0,216 ***	-0,167 ***
λ -Spatial effect	-	0,457	0,725 ***	0,329
R^2	0,31	0,26	0,28	0,33
Wald test	-	1,351	12,302 ***	0,406
Likelihood test	-	1,005	3,527 *	0,338
Lagrange test	-	0,637	1,093	0,283
N	90	90	90	90

(***) significant at 1%, (**) significant at 5% and (*) significant at 10%

Investment share and initial level of income appear as the explanatory variables of the model with a significant impact on growth, whether estimated with the classical OLS or with the spatial error model regarding the three types of proximities. Investment share indicates that the accumulation of physical capital is an important growth factor. The estimate of the log of initial income per capita gives the speed of convergence for the set of countries in the study. The idea of convergence is that poorer economies will experience a faster growth rate than richer economies. This allows poorer countries to catch up with the richer ones until all economies should finally converge in terms of per capita income.

Both ordinary least square and spatial methods yield significant and negative coefficients for the initial level of production per capita. This result means that the set of countries has a tendency towards convergence. Nevertheless, the speed of convergence seems greater when controlling with institutional space. Unfortunately, the difference in estimates is not large enough to be significant. Indeed, the confidence intervals of the estimates overlap with one another.

Given the results of the tests of no global autocorrelation in the model, it would appear that spatial error estimates are not the best way of considering spillover effects. The spatial lag results are shown in Table 23.

Table 23: Growth model (1980-2000 period) - Spatial lag estimates

	OLS	Spatial error estimates		
	MRW replication	Geography	Institutions	Culture
Constant	0,614 *	0,511 *	0,760 **	0,541 *
ln $(n + g + \delta)$	-0,107 **	-0,077 *	-0,076	-0,098 **
ln (I/Y)	0,338 ***	0,296 ***	0,341 ***	0,326 ***
ln $(School)$	0,086	0,068	0,074	0,070
ln (Y_0)	-0,176 ***	-0,158 ***	-0,199 ***	-0,167 ***
λ -Spatial effect	-	0,630 ***	0,549 **	0,462
R^2	0,31	0,36	0,36	0,35
Wald test	-	7,288 ***	5,087 ***	1,634
Likelihood test	-	5,439 **	3,893 **	1,346
Lagrange test	-	7,394 ***	3,826 **	1,712
N	90	90	90	90

(***) significant at 1%, (**) significant at 5% and (*) significant at 10%

Looking at the spatial lag model, it appears that the growth spillover with respect to cultural weights is still insignificant. However, the estimations of the spatial lag with respect to geographical weights appear to have an impact.

Both institutional and geographical spatial growth lags have a positive spatial estimate in the spatial lag model. This implies that a country's growth depends on its own explanatory variables as well as on the explanatory variables of its neighboring geographical or institutional countries. Furthermore, the Lagrange test is significant in both types of distances, which means that the spatial lag model is the best fit for this dataset. Finally, in both regressions we observe an increase in the R^2 from 0.31 in the MRW replication to 0.36 in the spatial lag models. Growth spillover within the geographical and institutional spaces thus explains part of the growth variation and helps to reduce the importance of the residuals in the study of growth.

Once again, our selected set of countries shows a tendency towards convergence with respect to the ordinary least square method as well as to the three spatial estimates. Moreover, the tendency towards a greater speed of convergence when taking the institutional weights into account is confirmed. However, we cannot come to clear conclusions on this matter as the confidence intervals again overlap for the various estimates of the initial level of income per capita.

All in all, the classical spatial study gives interesting insights into how the consideration of different dimensions influences growth. The exploratory study indicated that spatial autocorrelation does exist with regard to the geographical, institutional or cultural dimensions.

However, the spatial growth lag regarding the cultural dimension is not significant in the spatial models. Moreover, it appears that the spatial lag model is the best spatial specification when using geographical and institutional weight matrices. This means that spillovers are channeled through the neighbors' explanatory variables.

An interesting contribution to this chapter is therefore the development of the externality growth model which includes neighborhood effects when taking the international interdependency of the level of technology into consideration. The final specification of this model corresponds to the spatial Durbin model which includes a spatial lag for growth and for the explanatory variables as well. As a consequence, it allows us to define the explanatory variables of the neighbors that impact on a country's growth rate. The estimation is done via the spatial lag model techniques and by including the spatially lagged X as an explanatory variable in the model. The spatially lagged growth rate is therefore included in the estimation through the spatial method and the estimation is done using maximum likelihood techniques. The results are presented in Table 24.

Table 24: Growth externality model (1980-2000 period)

Spatial lag	Geography	Institutions	Culture
Constant	2,221	-0,464	2,174
ln $(n + g + \delta)$	-0,039	-0,021	-0,070
ln (I/Y)	0,292 ***	0,174 *	0,357 ***
ln $(School)$	0,024	0,133	0,045
ln (Y_{1980})	-0,169 **	-0,254 ***	-0,138 *
W ln $(n + g + \delta)$	-0,406 *	0,165	0,285
W ln (I/Y)	1,405 *	-1,753 **	3,295 **
W ln $(School)$	0,038	1,579 ***	-0,381
W ln (Y_{1980})	-0,533 *	0,055	-0,976 **
λ -Spatial effect	-0,615	0,058	-0,545
R^2	0,47	0,49	0,41
Wald test	1,021	0,026	0,340
Likelihood test	-	-	-
Lagrange test	0,817	0,016	0,218
N	90	90	90

While the effect of the spatial growth lag in the previous specification is significant for the institutional and the geographical neighborhood, this effect disappears in the externality model specification. In return, the 'neighbor variables' manifest the spatial effects. The geographical neighbors impact on a country's growth rate through their population growth rate, their physical capital accumulation and their initial output level, while the institutional neighbors influence a country's growth rate thanks to their physical and human capital accumulation. The cultural neighborhood, which did not present significant spatial effects in the classical spatial specification, this time shows the strong impact of the physical capital and the initial output level of the cultural neighbors.

Let us analyze how each neighborhood variable impacts on a country's growth rate, taking each type of neighborhood separately. The population growth rate of the geographical neighborhood has a negative impact on a country's growth rate. This result is not surprising since the physical proximities of the geographical neighbors allow individuals to migrate from one country to another. The negative impact of a country's population growth rate on the country's economic growth may therefore have an influence outside its borders. The investment rate of the geographical neighbors, i.e. the accumulation of the neighbors' physical capital, has a positive and significant impact on a country's growth rate. It would seem normal that an investment in physical capital implies some positive spillovers for the geographical neighbors. Moreover, the theoretical externality model developed in section 3 states that if a geographical neighbor accumulates physical capital, it impacts on its level of technology. The level of technology then increases the productivity of the agents in the country and finally this gain in productivity is transmitted to the individuals in the geographical neighbor through trade and FDI. On the other hand, the estimate of the impact of the geographical neighbors' investment in human capital has no significant effect on a country's growth rate. Similar to the investment in physical capital, the theoretical framework assumes that an increase in the accumulation of human capital impacts on a country's level of technology. This accumulation therefore increases productivity inside the country. The results tell us that this increase in productivity does not involve a significant dissemination of knowledge through the bordering countries. Finally, it is natural to find a negative impact of the neighbors' initial outcome level as wealthier countries have less growth and therefore fewer spillover effects on the growth of the neighbors.

With regard to the institutional neighborhood, the estimate of the neighbors' population growth rate has no impact on the growth rate. This outcome means that the migration effect between countries is not significant for countries that are institutionally close; the proximity has to be physical. It would also appear that the investment in physical capital is negative regarding the countries' growth (while positive for the geographical neighbors). This result suggests that an investment has to be physically close if it is to spill positively onto a country's growth. However, surprisingly, an accumulation of physical capital in one country can affect another country's growth rate negatively. This may represent an investment that is not captured by the neighbors and will thus be something that the second country needs to catch up with. This result needs further investigation to understand the mechanisms behind such an outcome. On the other hand, the investment in human capital by the institutional neighbors positively influences a country's growth rate. Once again, this result fits in relatively well with the theoretical framework of section 3. Indeed, the model indicates that the level of technology in a country is impacted by the accumulation of capitals, whether it is human or physical, and by the levels of technology in the neighboring countries. This indicates that if a country's neighborhood accumulates human capital, it increases their level of technology, which in turn impacts on the level of technology in the country.

The cultural neighborhood, which has no effect on the spatially lagged growth in the classical spatial study, shows interesting estimates when considering the cultural neighbors' variables. The impact of the investment in physical capital on the cultural environment appears to be positively significant while the initial wealth of the cultural neighbors is negative and significant.

By comparing the estimation outcomes when different notions of neighborhood are under consideration, several interesting points appear. First, the differences in sensibilities regarding the neighbors' accumulation of physical capital present opposing values when compared to the institutional and geographical dimensions. While the channels of interdependence with regard to physical capital between countries in the geographical dimension appear to be easily explained by trade and FDI, it is difficult to explain why the accumulation of physical capital in the institutional neighborhood negatively influences a country's growth rate. One can easily imagine that physical proximity facilitates the spillover of a physical investment in a country but the way a physical investment impacts negatively on a country's growth rate is not altogether clear. Second, the fact that estimates of the neighbors' human capital accumulation differ according to the dimension taken into consideration indicates that countries are sensitive in different ways to their geographical and institutional neighborhood. The results suggest that institutional proximities facilitate the dissemination of knowledge compared to the geographical dimension. These outcomes may indicate that countries tend to exchange more human-capital intensive goods when they are institutionally similar. This kind of proximity may also facilitate exchanges between the countries' intellectual elite thanks to their institutions that are keen to work together[16].

The speed of convergence also tends to be higher when the institutional space is taken into consideration. This result confirms the outcomes of the classical spatial study. The results obtained on the speed of convergence of the countries are more robust than the results from the classical spatial model; institutional clusters converge faster than either geographical or cultural ones. However, this represents an interesting insight for studies of convergence club, which is not the aim in this paper.

Finally, the variance explained by the model increases dramatically in the externality model. The use of the externality model allows us to identify which explanatory variables regarding the neighbors influence a country's growth rate. It increases the fit of the regressions to 47%, 49% and 41% for the geographical, institutional and cultural neighborhood respectively.

As shown in the exploratory section, China is a clear outlier in the growth observation. We therefore made the estimations without taking China into account. The estimates do not appear to really change in general except for the initial income level. Indeed the estimation of the speed of convergence is lower with regard to each type of distance and each method applied to the dataset.

[16] The general quality of the institution may interfere with these results about the distance between institutions. It could be necessary to go further by controlling for the general level of the institutions. These question request the development of a model that takes into account the level of the institutions and the growth spillovers with respect to the institutional dimension together. This is not include in the framework of this thesis but should be investigated in the future works on this topic.

5. Conclusion

The starting point for this analysis was the construction of non-physical proximity matrices as shown in Chapter 1. In fact, institutional and cultural types of weight are very different from geographical ones. The geographical neighborhood of a country is therefore not composed of the same set of countries as the institutional or cultural type of neighborhood. This observation enables us to perform further economic studies on growth and productivity. Spatial econometrics has already explored these fields of research in order to take the physical proximity dependence of observations into account. This analysis provides a similar approach in order to check whether the observations on growth or productivity show a non-physical proximity dependence.

The first part of the analysis tends to demonstrate that global spatial autocorrelation regarding the three types of distances does exist. Actually, both productivity and growth, suffer from spatial autocorrelation with respect to geographical, institutional and cultural proximities. Nevertheless, the explorative studies indicate that geographical and institutional neighborhoods tend to have a larger impact on growth and productivity. The cultural matrix also shows a slight but significant impact.

Regarding these exploratory results, it is quite natural to consider the hypothesis of spatial autocorrelation while estimating the growth specification. We therefore apply the classical spatial regressions to the MRW specification for growth. The estimates demonstrate that the error model does not fit into the dataset well. Looking at the results of the lag models, it appears that the spatial lags with respect to both institutional and geographical weights have a significant impact. Furthermore, both types of distance imply a significant Lagrange test. Similarities in institutions are therefore a channel of spillovers which come through the explanatory variables of the institutional neighborhood of a country. Nevertheless, a physical proximity between countries leads to the same conclusions. The classical spatial regression results suggest that countries are dependent from the explanatory variables of the neighbors but do not throw light on the way these variables interact with the neighborhood.

The externality model developed in the chapter allows us to separate the effects of each of the neighbor's explanatory variables. Furthermore, the theoretical model allows the countries' levels of technology to depend on both human and physical capital accumulation separately. Therefore, the spillover from the human and physical capital accumulation may differ depending on the spatial dimension taken into consideration. At first sight, the estimates appear to show that the spatial growth lag becomes totally insignificant in favor of the neighbors' variables.

Second, the most interesting result is that the neighbors' explanatory variables do not interact in the same way depending on the spatial dimension under consideration. On the one hand, the spatial lag of investment in physical capital with respect to the geographical weights impacts positively on a country's growth rate, while the use of institutional weights gives a significant and negative estimate for this variable. On the other hand, the spatial lag of the human capital accumulation variable appears to have no significant effect on the geographical dimension, while it is significantly positive when using institutional weights. These differences between the results obtained regarding physical proximity versus institutional proximities points to the nature of the interactions with respect to the two concepts. The physical proximity between two countries implies that they are interdependent regarding the physical changes to their economies. The estimate of the spatial lag of the population growth rate with geographical weights confirms this conclusion. On the other hand, the institutional proximities reveal that investments in physical capital by the neighbors lead to a lack of income for a country, while investments in human capital of the institutional neighbors have a positive impact on a country's growth rate. This indicates that two countries with similar institutions tend to exchange their knowledge more easily.

The externality model also allows us to explain the variations in countries' growth rates more easily. In fact, the replication of the MRW specification gives an R^2 value of 0,31. Estimating the MRW model by including physical and human capital accumulation with the spatial methods increases the R^2 to a value of 0,36. The externality model specification, which identifies the neighborhood effect through each of the explaining variables, allows the variability explanation to increase dramatically to a value of 0,47 for the geographical weights and to 0.49 for the institutional weights.

Speed of convergence was the last issue on which we focused. It appears that all the estimates of the initial level of income data are significant and negative. Looking at the OLS or the spatial estimates suggests that there is a tendency towards convergence. Nevertheless, the spatial lag and the spatial error models give a higher speed of convergence when using the institutional weights compared to the estimates obtained when using the geographical or the cultural weights, or by replicating results with the classical OLS. The estimates made from the externality model confirm this tendency towards a higher convergence when considering the institutional space. The replication of the results without China, which is a clear outlier in terms of growth, decreases the speed of convergence in all the models but retains this difference in favor of the institutional dimension.

Unfortunately, the confidence intervals overlap with one another and it is therefore impossible to make a clear cut decision on the issue of which neighboring clusters converge faster. However it gives researchers another avenue to investigate in the future. Our results indeed suggest that similarities in institutions can promote convergence and thus the convergence club can be studied with respect to institutional clusters.

CHAPTER 3

DO POOR AND RICH COUNTRIES BENEFIT EQUALLY FROM NEIGHBORHOOD SPILLOVERS?

Abstract:

The chapter focuses on the role of three significant factors, namely geography, institutions and religion, to explain the spillovers between nations. Combining proximity measures and quintile regression, the analysis led to the following results. First, controlling for the effects of geography and institutions, religion appears to be more or less irrelevant in explaining income spillovers between nations. Second, geographic and institutional neighborhoods are significant explanatory variables of such spillovers. Finally, the chapter concludes that international assistance should target policies that help poor countries to overcome the consequences of their adverse geographical environment and that these policies should go hand in hand with, or be conditional on, an improvement in the quality of institutions in order to overcome inequalities between nations and help them to manage their environment.

1. **Introduction**

An increasing amount of evidence points to the importance of growth spillover between countries i.e. growth in one country tends to have a positive impact on the growth of neighboring countries (Barro and Sala-i-Martin (1995); Easterly and Levine (1997); Moreno and Trehan (1997, and Roberts and Deichmannused (2009)). All of these studies consider the notion of neighborhood as a geographical type of proximity. The economic mechanisms by which such spillover occurs are identified with trade and Foreign Direct Investment (FDI). Distance determines access to foreign markets as well as access to the domestic market by foreigners. There is a large body of empirical evidence showing that the trade flows and foreign direct investment (FDI) between countries depend on the distance that separates them. This is a traditional feature of the "gravity equation" that attempts to explain bilateral trade (Bergstrand, 1985), but it is also increasingly recognized as an important feature of FDI flows (Eaton and Tamura, 1994) as trade and FDI are important channels through which growth can spread across countries (e.g. Grossman and Helpman, 1991 and Frankel and Romer, 1999).

The last chapter in this thesis examined the role of the different notions of neighborhood, such as cultural or institutional neighborhood, in growth spillover. The theoretical framework supporting spillover is of course linked to the FDI and trade literature. To the best of our knowledge, this issue has been scarcely studied to date. One exception is Rodrik et al. (2004), who sought to disentangle the relative importance of geography and institutions as determinants of growth. However, their approach encountered the reservations discussed below. In this chapter, we will also consider the various dimensions of neighborhood. Indeed, our specific question throughout the thesis is whether economic observations in nearby countries tend to have an impact on country-specific observations. Of course, geography, as an important feature of proximity, continues to be examined. In chapter 2, institutional neighborhood was identified as an important factor in growth spillover. However, we decided to restrict the cultural notion of neighborhood to the religious dimension alone for two reasons. First, the results of chapter 2 led to the conclusion that the cultural dimension is not an important channel of growth or productivity spillover. Second, the role of religion in economic performance is an important issue, widely discussed in the literature (see Barro and McCleary (2003), Grier (1997) and Noland (2005)).

Nevertheless, the main contribution of this chapter is to examine whether this spillover differs according to between-nation income distribution. Indeed, recent studies suggest that growth spillover might not be the same between rich countries and poor ones. One reason may be that the above-mentioned spillover vehicles (Trade and FDI) are weaker for poor countries. Recent confirmation of this hypothesis is provided by Roberts and Deichmannused (2009) who found that growth spillover is strong among the OECD countries and essentially absent in Sub-Saharan Africa. It follows that a proper assessment of regional spillover and the extent to which one can count it as a regional or neighborhood boost should help to distinguish between rich and poor countries. Most such studies add geographic, institutional or religious indicators to the basic growth regression. For instance, to test for geography, economists usually use indicators such as the growth rate of neighboring countries, land-locked dummies or distance from the Equator. Barro and Sala-i-Martin (1995) showed that the initial income level of neighboring countries is marginally significant in explaining growth rates. Easterly and Levine (1997) use a border dummy variable to analyze the growth experience of Africa. They concluded that spillover has a large impact on a country's growth. Ades and Chua (1997) showed that political instability in adjacent countries has a negative impact on a country's growth rate, while Rodrik et al.'s (2004) measurements used the distance separating a country from the equator.

However, the use of border indicators or neighbor's growth implicitly assumes that only direct neighbors have an impact on the economy under consideration. For instance, Germany can have an influence on France but not on any other country in the data set, such as Portugal or Spain. This implies an arbitrary cutoff of influence. A similar reasoning holds for religion and institutions: do countries grow in the same way only if they are wholly similar from a religious point of view?

To address this issue, we use a distance approach which takes into account different types of proximity between the countries in the sample. This means that a country can be influenced by non-neighboring countries, with a potential decrease in such influence as the distance between them widens. In order to build an indicator for all pairs of countries i and j $(i, j \in D)$ where $D = \{1,2,\ldots,N\}$ is the set of countries, we need to build a square matrix W composed of weights: w_{ij}. This matrix represents proximities between different entities and means that the higher the weight w_{ij}, the closer the countries i and j.

Regarding geography, the metric distance per se (simple distance between two cities) is used in many economic studies, especially those dealing with trade. The distance approach used here is less common. We are aware of only a few studies that have adopted a similar strategy (Moreno and Trehan, 1997 and Rupasingha and Goetz, 2007), although such studies only focus on geographic distance. In this paper, we will construct a weight matrix for each of the channels of economic growth spillover, namely geography, religion and institutions. The objective is to tease out the relative importance of each of these channels of spillover. We would like to stress that we are not seeking to examine the mechanisms by which such spillovers takes place.

As mentioned above, the empirical literature on growth spillover presents another drawback. Estimation methods generally assume that the type of relation between countries has the same impact over the whole of the growth distribution. However, such relations may differ depending on the distribution segment being examined. Given the focus of this paper, we consider the possibility that the impact may differ across the distribution i.e. the role of geography or religion might not be the same in poor countries as in rich ones. Hence, we use the quintile regression method instead of the classical linear regression to allow for differences that could exist between different groups of countries. While the traditional regression method estimates the impact of the mean of the dependent variable on changes in a given set of explanatory variables, the quintile regression allows us to estimate the impact of a given quintile. Quintile regression is increasingly used by economists studying union wage effects, returns to education, labor market discrimination and earnings inequality (see Koenker and Hallock, 2001, for further discussion).

The rest of the paper is organized as follows. Section 2 presents the specifications to investigate the impact of neighboring wealth on a given country’s wealth and the empirical econometric approach for the quintile regressions. Section 3 discusses the empirical results on two main questions: Do geographic, religious or institutional types of neighborhood channel GDP per capita across nations differently according to their wealth level? Which type of neighborhood, if any, is the most significant in terms of income spillover? Section 4 concludes.

2. **Methodology**

This section first presents the method used to take dependence across residuals into account or, alternatively, to measure the proximity of countries in terms of their geography, religion and institutions. Second, it explains the quintile regression methodology that combines the proximity measures in order to examine the impact of these factors on inequality across nations. The second subsection also presents an empirical generalization of the instrumental variables technique for the quintile regression.

2.1.Measuring inter country proximity

This section illustrates how to build any type of distance matrix for any set of *n* countries. The general idea is to build a square matrix W $(N \times N)$ that captures the proximity measures w_{ij} between the different countries under study. The closer two countries i and j are in terms of proximity, the higher the coefficient w_{ij} will be. We construct three matrices, each pertaining to one of the significant growth determinants under consideration: geography, institution and religion. All three matrices are different, given that geographical, institutional and religious distances are not the same.

We make use of the three widely used and accepted indicators for geography (distances are computed following the great circle formula[17]), institutions (see Kaufmann et al., 2002) and religion (the percentage of Catholics, Muslims, Protestants and Other religions).

As far as ***geography*** is considered, we define the proximity between two countries i and j $(i, j \in D)$ using the metric distance between their geographical centers. Denoting d_{ij} as the distance between country i and country j, we can build the geographical weight w_{ij}^{Geo} as follows:

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

$$w_{ij}^{Geo.} = \frac{\frac{1}{d_{ij}}}{\sum_{j=1}^{N}\left(\frac{1}{d_{ij}}\right)} \qquad \forall i, j \in D \qquad (1)$$

with $w_{ii}^{Geo.} = 0, \forall i \in D$.

These distances are computed according to the great circle formula which uses latitude and longitude measurements of the most important cities or agglomerations in terms of population. This yields a classical geographical weight matrix that is used in many spatial studies on growth or productivity analyses.

Dividing the inverse of the distance by the sum of the matrix line associated with each w_{ij} guarantees that each row of the spatial matrix is normalized. This means that each weight is given as a percentage of the total weights. In view of the way this matrix is defined, each row and each column of the matrix represents a geographical entity; one row gives all the relative links a country has with respect to the other countries of the dataset.

With regard to ***institutional*** weights, we use the measures of institutional quality given in Kaufmann and al. (2002). Worldwide governance indicators are provided as a World Bank database for the years 1996-2007. The present study uses the observations from the year 1996. Kaufmann et al. identified six dimensions of governance and defined them as: voice and accountability, political stability and the absence of violence, government effectiveness, regulatory quality, rule of law and control of corruption (See Appendix A). These indicators based on factor analyses adequately represent all the institution-related issues. In this paper, our aim is to build a similar kind of institutional measure in order to obtain a new weight matrix. First, we need to define an institutional type of distance for each pair of countries *i* and j ,$\forall i, j \in D$. The Kogut and Singh (1988) index is a first attempt to measure distances between the two vectors of indexes:

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

where I_{ki} is the k^{th} institutional index for country i and V_k is the variance of the k^{th} institutional index.

In order to measure the proximity between two entities *i* and *j*, we first need to invert the index defined here above and then normalize each row of the computed matrix. This can be written as follows:

$$w_{ij}^{Inst.} = \frac{1/ID_{ij}}{\sum_{j=1}^{N}\left(1/ID_{ij}\right)} \tag{3}$$

$\forall i, j \in D.$

Finally, ***religiou***s proximities are built in a similar way to institutional proximities. The religious type of distance is defined using four different indexes and computed with the Kogut and Singh formula. The proximity measure can then be obtained by taking the inverse of the distance. Finally, the matrix obtained is row-normalized as with the other types of proximities. The four indexes we use to define the religious type of distance are the percentage of Catholics, Muslims, Protestants and of the remaining Other religions. Using these indexes in the Kogut and Singh formula yields the following index:

$$RD_{ij} = \frac{1}{4}\left[\sum_{k=1}^{4}\frac{\left(I_{ki} - I_{kj}\right)^2}{V_k}\right] \tag{4}$$

$$\forall i, j \in D$$

where I_{ki} is the k^{th} religious index for country i and V_k is the variance of the k^{th} religious index. Each distance RD_{ij} has to be inverted in order to obtain the proximity between country *i* and country j. Finally, the matrix $W^{Relig.}$ has to be row normalized in order to recover the relative weights in each of its lines.

$$w_{ij}^{Relig.} = \frac{1/RD_{ij}}{\sum_{j=1}^{N}\left(1/RD_{ij}\right)} \tag{5}$$

$\forall i, j \in D.$

2.2. Estimating income spillovers between nations

The idea of this section is to check whether the proximity of countries in terms of geography, religion or institution is somehow related to the level of their GDP per capita. The section presents the model and methodology used to make the estimations.

The aim is check more precisely whether a country's income level depends on the wealth of its neighbors, wealth being measured as the per capita income of the countries. The explanatory variables are the incomes of the neighboring countries which can be represented as a spatial lag of income:

$$Y = \lambda WY + \varepsilon \tag{6}$$

where Y (Nx1) represents the vector of GDP per capita for all countries. W (NxN) is a spatial matrix representing geographical, institutional or religious neighborhood and can be computed using the tools presented earlier. λ is a scalar which estimates the impact of the spatial lag of Y. The vector λWY (Nx1) represents the general neighborhood income. ε (Nx1) is the error term.

The above equation is estimated separately for each of the three types of neighborhood discussed previously. However, we are also interested in the relative importance of each of the three types of neighborhood on a given country's income. We therefore estimate a more general equation that incorporates the three types of neighborhood simultaneously.

$$Y = \lambda_{Geo.}W^{Geo.}Y + \lambda_{Inst.}W^{Inst.}Y + \lambda_{Rel.}W^{Rel.}Y + \varepsilon \tag{7}$$

where $W^{Geo.}$, $W^{Inst.}$ and $W^{Rel.}$ respectively represent the proximity matrix for geography, institutions and religions.

Equation (7) can be estimated using standard econometric techniques. The resulting estimates will give us the impact of the spatial lag of Y regarding the three types of neighborhood on average country income. To this end, we need to assume that the impact the neighbors can have on a given country is the same for both poor and rich countries. It is possible however that such an impact will differ, and this could explain certain inequalities across groups of countries. To take these differences into account, we use the quintile regression method to estimate the differences that could exist between different clusters of countries.

The classical linear regression methods which are based on minimizing the sum of squared residuals enable us to estimate models for the conditional mean function. Let us assume:

$$Y = X'\beta + \eta \tag{8}$$

The estimated parameters $\hat{\beta}$ are those which minimize the sum of the squared residuals. This can be written as follows:

$$\hat{\eta} = Y - X'\beta \tag{9}$$

Similarly, the quintile regression method from Koenker and Bassett's seminal contribution (1978) assumes that for a given quintile τ, with $\tau \in (0,1)$:

$$Y = X'\beta_\tau + \eta_\tau \tag{10}$$

The estimated parameters $\hat{\beta}_\tau$ are those that minimize the following function of the residuals:

$$\hat{\beta}_\tau = argmin\ \Big((1/N)\big\{\tau \textstyle\sum_{\hat{n}_i \geq 0} |\hat{n}_i| + (1-\tau) \sum_{\widehat{n_i} < 0} |\hat{n}_i|\big\}\Big) \tag{11}$$

Equation (11) can be solved using linear programming techniques. By making τ range between 0 and 1, one can see how the impact of the explanatory variables changes X across the distribution of Y.

Both ordinary least square and quintile regression techniques lead to non convergent estimates while using a spatial lag of the dependent variable. Indeed, the spatial lag of Y is correlated with the error term. The exogeneity property of the explanatory variables is therefore not fulfilled.

The traditional resolution of this issue in spatial regressions is to use maximum likelihood techniques. However, in this paper our focus is on quintile regression estimates, which does not allow us to use the maximum likelihood techniques. Another solution, involving the use of instrumental variables, was proposed by Aselin (1988), Kelejian and Robinson (1993) and Kelejian and Prucha (1998). Practically, the traditional explanatory variables of Y, the X's, are independent from the error term. It is therefore possible to use the spatial lag of these explanatory variables as an instrument for the spatial lag of the dependent variable.

In this case, the model specification requires the introduction of explanatory variables:

$$Y = \lambda WY + X\beta + \varepsilon \tag{12}$$

where WY is correlated with ε while the X is not. The use of instrumental data gives the following estimates:

$$\widehat{\beta_{IV}} = \left[\breve{X}'Z(Z'Z)^{-1}Z'\breve{X}\right]^{-1}\breve{X}'Z(Z'Z)^{-1}Z'Y \tag{13}$$

with $\breve{X} = [WY \;\; X]$ and $Z = WX$.

Unfortunately, this generalization of the instrumental variable is only available when the focus is on the conditional mean function. In other words, the estimate of β cannot be obtained in this way when using the quintile regression. However, it is empirically possible to extend this instrumentation to the quintile regression as well.

Let us estimate the spatial lag with the instruments:

$$WY = Z\theta + \epsilon \tag{14}$$

It is thus possible to obtain the vector of predicted values for the spatial lag of Y:

$$\widehat{WY} = Z\theta \tag{15}$$

The predicted values of WY are then introduced into the original specification as explanatory variables:

$$Y = \lambda\widehat{WY} + X\beta + \varepsilon \tag{12}$$

This specification can therefore be used either with ordinary least square or quintile regression techniques.

3. **Empirical analysis**

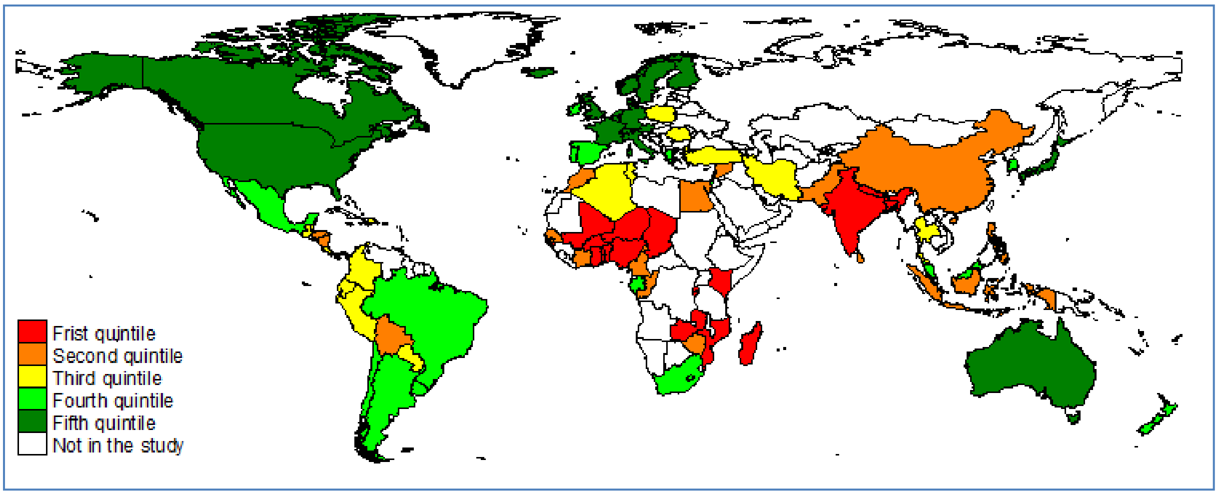
In addition to the indicators concerning geographical, institutional and religious neighborhood, we also need to include the variables relating to real GDP per capita, investment share, population growth rate and proportion of population with school degree. Our data come from the World Bank's World Development Indicators (WDI) database and take into account 90 developed and developing countries over the period 1985-2005. The income variable is taken as an average over sub-periods of five years, which yields a vector of pooled incomes with 4 observations for each country. To answer the questions raised earlier, we proceed in two steps. First, we test whether the different types of neighborhood matter. In the second step, we assess how important they are in understanding a country's economic growth.

3.1. Does neighborhood matter?

As a first illustration of the inequality across nations and the fact that countries tend to be grouped in separate clusters, Figure 19 maps the different income quintiles for the set of countries used in this paper.

<u>Figure 19</u>: The quintile distribution of GDP per capita

(average for the period 1985-2005)



It is no surprise to see that most African countries belong to the two first quintiles i.e. the lowest GDP per capita. Only a few countries such as Tunisia and Algeria belong to the third quintile. Gabon and South Africa are in the fourth. In Asia, Bangladesh, India and Nepal belong to the first quintile of lowest income per capita. Other countries such as China, Pakistan, Indonesia, the Philippines and Sri Lanka are in the second quintile. In Latin America, almost all the countries are in the third and fourth quintiles. Bolivia, Honduras and Nicaragua belong to the two first quintiles. Finally, North America, Australia, and Europe have the highest levels of income per capita. Table 25 shows the first and fifth quintiles of GDP per capita. We can note that both tables have been matched with the 18 poorest and richest countries respectively.

Table 25: Highest and lowest GDP per capita (first and fifth quintile)

Countries with the lowest GDP per capita *(First quintile)*	**Countries with the highest GDP per capita** *(Fifth quintile)*
Bangladesh	United States
Benin	United Kingdom
Burkina Faso	Switzerland
Burundi	Sweden
Chad	Norway
Ghana	Netherlands
Guinea-Bissau	Luxembourg
India	Japan
Kenya	Italy
Madagascar	Iceland
Mali	Germany
Mozambique	France
Nepal	Finland
Niger	Denmark
Nigeria	Canada
Rwanda	Belgium
Togo	Austria
Zambia	Australia

Broadly speaking, Table 25 suggests that the poorest countries are clustered in Africa and Asia, the richest are in Europe, North America and Australia, while Latin America is in the middle. However, one cannot conclude that inequalities between nations are driven by geography alone. On the one hand, for many countries, location overlaps with other factors such as religion, i.e. Latin America is mainly Catholic while a large part of Africa and Asia is Muslim. On the other hand, the analysis we described above needs to be supported by more robust investigation. The only conclusion one can draw at this stage is that a study of the impact of neighboring countries' income on GDP per capita using appropriate and advanced methods is extremely useful to understand inequality among nations. We start by testing whether the different types of neighborhood have an impact on the GDP per capita.

The Moran's I statistic allows us to test the null hypothesis of no spatial dependence (Moran, 1950) against the hypothesis of spatial dependence. For a given variable x, the statistic is given by:

$$I = \frac{N}{S_0} \frac{\sum_{i,j}^{N} w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\sum_{i,j}^{N}(x_i - \bar{x})^2} \tag{12}$$

where $S_0 = \sum_{i=1}^{N} \sum_{j=1}^{N} w_{ij}$

Under the null hypothesis, Moran's I statistic follows asymptotically a standardized normal distribution *N(0,1)* and has to be compared with its expected value *E(I)=-1/(N-1)*. Significant values above *E(I)* mean that there is a positive global autocorrelation, e.g. a positive spillover for countries that are close to each other. On the other hand, significant values of *I* lower than *E(I)* mean that there is a negative global spatial autocorrelation and therefore a negative spillover for nearby countries. Table 26 indeed confirms that the income observations suffer from spatial autocorrelation regarding the three types of proximities. For all three factors considered, the null hypothesis of no spatial dependence is always rejected.

Table 26: Moran's I test for global spatial autocorrelation of GDP per capita

	Geography	**Institution**	**Religion**
Moran's I	0.287	0.650	0.222
E(I)	-0.011	-0.011	-0.011
p-value	0.000	0.000	0.000

In order to visualize the spatial dependence with respect to geography, institution and religion, we can use the Moran's scatter plot. For a given country *i*, this plot consists of the country's centered income per capita *Z* and its centered weighted income per capita *WZ*. This gives the relation between a country's income and the income of neighboring countries.

Each country will be situated in one of the four quadrants of the Moran's scatterplot. If a country is situated in the upper right quadrant (called HH), this means that the country has a high income per capita and a neighborhood with high income per capita. The opposite bottom-left quadrant (LL) represents the low-income countries which are surrounded by low-income countries. The last two quadrants, the upper-left (HL) and the bottom-right (LH) respectively represent the low GDP per capita entities which are surrounded by highly productive countries, and the high GDP per capita countries where the neighboring countries have a low income. Finally, the scatter's linear regression slope yields the Moran's I statistic.

Figure 20: Moran's scatterplot of GDP per capita using geographical, institutional and religious weights

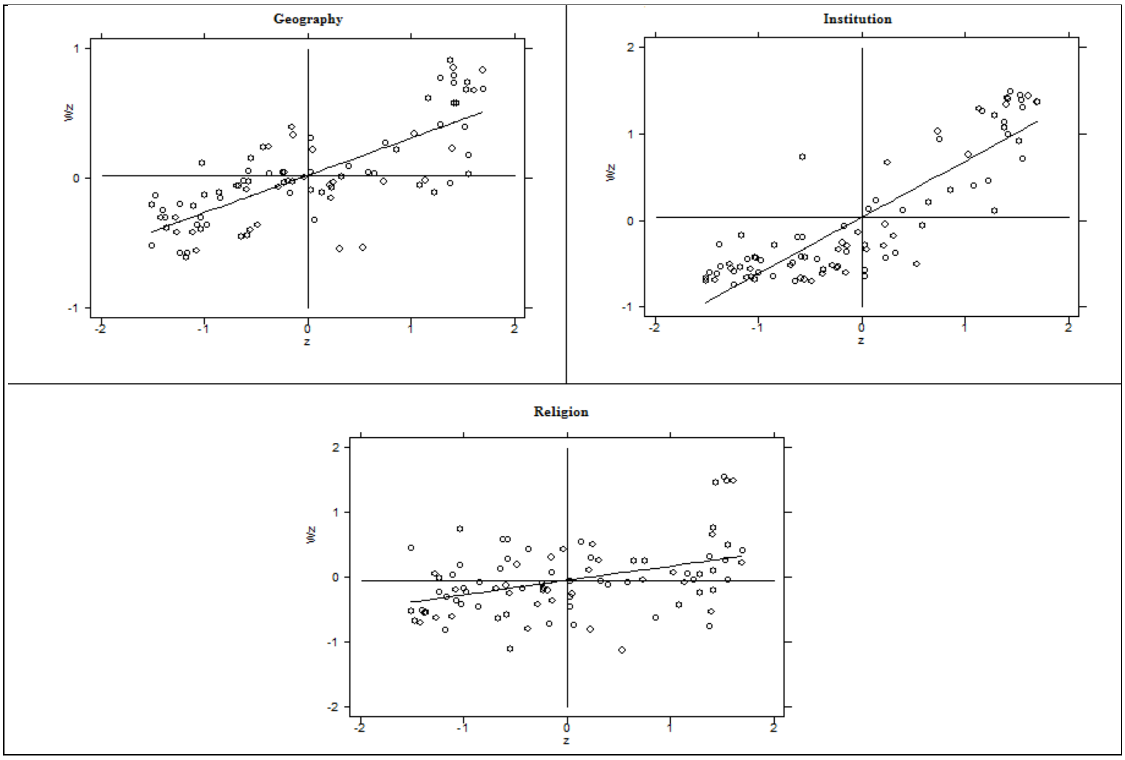


Figure 20 depicts Moran's scatter plots with respect to the different types of weighting matrix: geography, institution and religion. The plots corresponding to geographical and institutional proximities show a somewhat linear scatter with few points in the upper-left and bottom-right quadrants. Moran's I statistic has a positive significant value when computed with both geographical and institutional weight matrices. Moreover, this positive spatial autocorrelation concerns the majority of the countries i.e. only a few observations are in the upper-left (HL) and bottom-right (LH) quadrants. Geographical and institutional dependences of income are not only 'globally' verified but are also checked for almost every individual country.

The same conclusion cannot be made concerning the religious type of proximity. Although the Moran's I statistic has a positive significant value when using the religious weight matrix, many countries are nonetheless located in the HL and LH quadrants of the scatter plot. The spatial autocorrelation is 'globally' positive but numerous countries seem to experience a negative relation between their GDP per capita and the GDP per capita of their neighboring countries.

In conclusion, all three types of neighborhood weights seem to be important for the countries' income spillover. The next step is therefore to investigate whether a certain type of neighborhood is more important with respect to the others and to see the ways in which the impact is significant from an economic point of view.

3.2. Which and how much neighborhood matters?

In the introduction to this thesis, we raised the possibility that institutions, religion and geography can be correlated. A given factor might have a direct impact on the inequality between nations or an indirect impact through its relationship with one of the other factors. Introducing each factor separately into the regression might not capture the direct effect but rather the indirect effect. By adding them together in the regression, direct effects are also considered because each factor captures its own direct effect. In this section, we examine the existence of both direct and indirect effects.

Direct effects

In order to benchmark this new approach with other studies that only consider one of the key factors, Table 27 presents the results of the quintile regression for each of the neighborhood matrices separately (geographical, institutional and religious). The table also presents the OLS results of the regressions where the weighting matrices were used for comparative purposes. Looking first at the OLS results, it appears that neighboring wealth weighted with the three types of neighborhood explain the level of GDP per capita. The strongest explanatory factor (highest R^2) is for the institutional type of neighborhood.

Table 27: Quintile regression of GDP per capita with respect to different types of neighborhood's GDP

	OLS		$\tau = 0.20$		$\tau = 0.40$		$\tau = 0.60$		$\tau = 0.80$	
	β	p-value	β	p-value	β	p-value	β	p-value	β	p-value
Constant	-5.413	0.001	-0.806	0.000	-0.234	0.000	0.304	0.000	0.812	0.000
Geographic neighbors	2.107	0.000	2.639	0.000	2.625	0.000	2.451	0.000	2.416	0.000
R^2	0.414		0.355		0.392		0.407		0.350	
Constant	-0.552	0.408	-0.758	0.000	-0.350	0.000	0.191	0.000	0.592	0.000
Institutional neighbors	1.066	0.000	1.316	0.000	1.219	0.000	1.060	0.000	1.015	0.000
R^2	0.632		0.514		0.533		0.557		0.551	
Constant	3.607	0.014	-1.285	0.000	-0.395	0.001	0.320	0.008	1.670	0.000
Religious neighbors	0.531	0.006	0.899	0.000	1.107	0.000	0.874	0.000	0.504	0.001
R^2	0.071		0.093		0.107		0.114		0.086	
N	90		90		90		90		90	

The results of the quintile regression show that the geographically weighted spatial lag of income matters regardless of the quintile considered for the income variable. The explanatory power is fair, i.e. the R^2 is always above 30%. The coefficients are all significantly positive with comparable levels. This means that countries located near one another see their income per capita increasing in a similar way. The results are qualitatively similar to those of Redding and Venables (2004) and Moreno and Trehan (1997). However, we find that our coefficient levels are unexpectedly high and do not really make sense. A significant coefficient of around 2 would imply that a country's income grows/declines by twice the growth rate of the countries located in the neighborhood, which would make the situation either explosive or collapsing. Although this could fit in with Pritchett's (1997) findings that growth rates of less developed countries exhibit either explosive growth or implosive decline, we do not take this for granted. Closer to our framework, Moreno and Trehan (1997) also find significantly positive coefficients, but which this time are closer to 1. When they introduce other explanatory variables into the model, the coefficients remain significantly positive but their levels decrease. In the following, we will examine whether this is also the case in our framework.

The spillovers due to institutional neighborhood by quintile regression are broadly similar to those due to geographical type of neighborhood. However, the quality of fit is much better than for geography (i.e. the R^2 is always above 50%). The coefficients are all significantly positive with comparable levels across quintiles. Countries that have similar institutions see their income per capita evolve in a similar way. This is in accordance with the rich literature showing the significant impact of the quality of institutions on growth. The additional information our results provide is that this significance holds over the whole distribution of per capita income; the effect persists regardless of the quintile considered. Rich, poor and medium-income countries are all affected by the quality of their institutions.

Although quintile estimates for the religious type of neighborhood are qualitatively similar to the ones for geography and institutions, quantitatively there are major differences and the explanatory power is much lower than for geography and institutions (i.e. the R^2 is always below 12%). The levels of the coefficients are also lower than for the other types of neighborhood. They are, nevertheless, all significantly positive. We consider this result as weakly supporting the argument that religion drives income growth. This result mirrors the lack of consensus in the literature in this respect (Grier, 1997; Barro and McCleary, 2003 and Noland, 2005).

Another important outcome of the quintile regression is that the estimates decrease regarding the order of the quintile when using geographical and institutional weights, in other words, the greater the interest of the quintile, the lower the estimate of the geographical and institutional neighborhood's income. This observation allows us to conclude that the conditional distribution of income per capita narrows when the wealth of the neighbors is higher. This will be the subject of further comments in the robustness checks below.

The above results suggest that all three types of neighborhood are sources of spillover. Although this finding may be considered useful as, using more robust econometric techniques, it confirms previous ones, disentangling whether the institutional, cultural or geographical factor is more important than the others is of far more use. To this end, we repeated the same analysis by including all three factors at the same time (Equation 7). The results are presented in Table 28 and give the relative effects of neighborhood with respect to institution, geography and religion. As in Table 27, we also report the OLS results.

Starting with the OLS results, the explanatory power is higher than when geographic or religious neighborhood are introduced separately, but it is similar to the one with institutional neighborhood introduced separately. This suggests that geographically and institutionally weighted income per capita does not affect the average of income per capita very much once the institution is controlled for. The estimated coefficients of the two factors support this conclusion (no significant estimates at a nominal level of 10% for religion and significant at a nominal level of 5% for geography only). This observation also supports the finding by Rodrik et al. (2004) of "the supremacy of institutions over geography."

Table 28: Quintile regression of GDP per capita with respect to all the types of neighborhood GDP

	OLS		$\tau = 0.20$		$\tau = 0.40$		$\tau = 0.60$		$\tau = 0.80$	
	β	p-value	β	p-value	β	p-value	β	p-value	β	p-value
Constant	-1.127	0.432	-0.616	0.000	-0.263	0.000	0.105	0.074	0.538	0.000
Geographic neighbors	0.942	0.046	0.969	0.000	0.935	0.000	0.883	0.000	0.260	0.257
Institutional neighbors	1.010	0.000	0.934	0.000	0.885	0.000	0.835	0.000	0.935	0.000
Religious neighbors	-0.274	0.110	-0.016	0.779	-0.040	0.306	-0.077	0.221	-0.044	0.638
R^2	0.648		0.559		0.587		0.587		0.554	
N	90		90		90		90		90	

Using quintile regressions, three significant observations emerge from Table 28. First, the explanatory power which is measured by the R^2 is high although it is not much higher than in the regression that only includes the institutional type of neighborhood. This is true regardless of the quintile considered (see Table 27). This suggests that the inclusion of geographic and religious neighborhood indicators does little to help explain spillovers between nations. Second, in contrast to Table 27 where the coefficient of the religious neighborhood was significant for all quintiles, the corresponding coefficient in Table 28 is no longer significant for all of the quintiles. Controlling for the effects of other important growth factors reveals the irrelevance of religion as a determinant of spillover between nations. Third, the coefficients for geographic neighborhood are significantly positive for the first three quintiles and non-significant for the fourth. This implies that while the evolution of low to medium income countries in the conditional distribution might be negatively affected by an adverse geographical environment, the evolution of the richer countries for the income conditional distribution is not. For a same level of neighboring wealth, richer countries seem better able to overcome unfavorable geographical positioning while poorer ones have more difficulty overcoming it. In contrast to the suggested interpretation based on the explanatory power (i.e. low explanatory value), the estimated coefficients for geography imply another interpretation which is discussed below. We should also note that in Table 28, the coefficient for the spatial lag using geographical weights is closer to 1 and significant in contrast to Table 27. In this former table**,** we found that the level of coefficients is above 2, which is obviously too high and does not really make sense. We assumed that after introducing other explanatory variables, the level of these coefficients would decrease, which turned out to be the case. Finally, introducing the other indicators has almost no effect on the institutional neighborhood income coefficients. Although the coefficient is slightly lower than in Table 27, it is significantly positive and close to 1 regardless of the quintile. Because it is generally acknowledged that rich countries have good institutions while poor countries have dissatisfactory ones, the latter result suggests that institutional neighborhood is an important factor in explaining inequality between nations.

Since adverse geographical environment negatively affects the income of the lower to medium income countries in the conditional distribution but not that of the richer countries, geography appears to be a major source of spillover in inequality between nations, especially since geographical conditions can hardly be changed. However, this does not necessarily mean that countries facing adverse geographical environment are condemned to remain in the same situation. Targeted policies (especially through international assistance) can help these countries to overcome the consequences of such an environment, to grow further and, subsequently, to be able to deal with the adverse geographic environment by themselves.

In contrast to the geographical indicator, coefficients pertaining to institutional neighbors' income are significant, positive and close to 1 regardless of the quintile. This means that the institutional environment has an impact on all income classes and may not be able to explain the inequality of spillovers between nations. This is not necessarily the case for two reasons. First, rich countries in general have good institutions while poor countries have less efficient ones, and the literature shows that improving the quality of institutions is pro-growth. However, 'low quality' countries have far more potential for institutional improvement compared to 'high quality' countries where institutions are already at a relatively high level. Assuming that the impact of a given degree of improvement to institutions is the same in 'high quality' and 'low quality' countries, there is room for more growth from improved institutions in the latter than in the former. This suggests that institutional neighborhood is an important factor in explaining the spillover between nations. Second, one can expect the impact of a similar degree of improvement in the quality of institutions to be higher in a ‘low quality’ country (e.g. Democratic Republic of Congo) than in a ‘high quality’ country (e.g. Sweden). In this case, improving the quality of institutions by the same degree could have a much higher impact on the income of poor countries than on that of rich countries, thereby reducing the gap between poor and rich nations. Here again, institutions appear to be an important driver of inequality between nations.

Robustness checks

However, our results suffer from various bias issues. For instance, the explosive relation of spatial lags with the dependent variable is a consequence of an omitted variable bias. Effectively, if the estimation of the gross impact of neighbor’s income gives an idea of the relationship between a country and its neighborhood, some explanatory variables are *de facto* excluded in the explanation of level of income per capita. A simultaneity bias is also introduced through the structure of the specification itself. The spatial lag must be estimated by maximum likelihood methods in order to avoid the simultaneity between the dependent variable and its lag. There is indeed a correlation between the spatial lag of the dependent variable and the error term. Another way of avoiding this bias is to instrumentalize the WY vector in a two-step OLS approach (2SLS). The choice of instrumental variables is made according to the economic relations between output per capita (Y) and the explanatory variables of the classical MRW model: i.e. the investment share logarithm, the population growth rate logarithm and the investment in human capital represented by the logarithm of the proportion of individuals with a college degree (X_1, X_2 and X_3). This set of vectors (X_1, X_2 and X_3) used as explanatory variables has indeed a theoretical relationship with output per worker and naturally represents the most appropriate tool to build instrumental variables for the spatially lagged vector of output per worker. Vector Y is indeed related to X_1, X_2 and X_3 and it is obvious that WY is related to WX_1, WX_2 and WX_3. These vectors can therefore be used as instruments of WY in the estimation process.

Table 29: Gross effects of neighbors' wealth regarding the three types of neighborhood – Introduction of other explanatory variables – no instrumentation

	OLS		$\tau = 0.20$		$\tau = 0.40$		$\tau = 0.60$		$\tau = 0.80$	
	β	p-value	β	p-value	β	p-value	β	p-value	β	p-value
Constant	-0.475	0.830	-3.462	0.107	-1.784	0.518	2.045	0.436	3.746	0.217
Geographic neighbors	0.653	0.014	1.036	0.000	0.793	0.031	0.329	0.315	0.138	0.713
$\ln School$	0.826	0.000	0.570	0.072	0.522	0.069	0.848	0.000	0.907	0.000
$\ln(n + g + \delta)$	-0.088	0.468	-0.230	0.263	-0.130	0.348	-0.092	0.377	-0.073	0.447
$\ln I/Y$	0.222	0.316	0.221	0.414	0.629	0.054	0.475	0.168	0.486	0.124
R²	0.75		0.57		0.58		0.59		0.54	
Constant	-0.361	0.615	-7.937	0.015	-0.180	0.696	0.244	0.796	1.320	0.270
Institutional neighbors	0.683	0.000	0.791	0.000	0.611	0.000	0.560	0.000	0.451	0.001
$\ln School$	0.717	0.000	0.694	0.000	0.658	0.000	0.838	0.000	0.826	0.000
$\ln(n + g + \delta)$	0.070	0.393	0.006	0.941	0.059	0.333	0.189	0.063	0.144	0.256
$\ln I/Y$	0.205	0.323	0.309	0.082	0.454	0.127	0.299	0.154	0.360	0.037
R²	0.80		0.63		0.62		0.64		0.60	
Constant	5.343	0.000	5.142	0.076	5.662	0.002	4.848	0.000	5.464	0.000
Religious neighbors	-0.044	0.711	-0.029	0.904	-0.050	0.705	-0.033	0.702	-0.044	0.675
$\ln School$	0.956	0.000	0.950	0.000	0.792	0.002	0.907	0.000	0.830	0.000
$\ln(n + g + \delta)$	-2.235	0.070	-0.525	0.092	-0.347	0.007	-0.111	0.225	-0.129	0.086
$\ln I/Y$	0.344	0.112	0.261	0.217	0.493	0.019	0.641	0.000	0.619	0.010
R²	0.73		0.50		0.55		0.58		0.54	
N	90		90		90		90		90	

As explained previously, Moreno and Trehan (1997) also identified an explosive relationship between income and neighbors' income when estimating the gross effect of the spatial lag. They managed to solve this issue by introducing more explanatory variables into the model. This bias should therefore disappear when adding the classical explanatory variables of an MRW specification for outcome per capita. Tables 29 and 30 show the results obtained by using the spatial lags for the three types of distances first separately and then simultaneously with the MRW explanatory variables. In order to isolate the effect of the omitted variable bias, the estimations were also made without any instrumentation of the spatial lag.

The introduction of omitted variables indeed stabilizes the relationship between the spatial lags and the dependent variable. The explosive nature of the estimates disappears completely in both the separate effects of the lags of income per capita regarding the three types of neighborhood and their relative impacts. Furthermore, the economic interpretation of the results remains the same. The weighted income per capita vectors regarding geographical and institutional neighborhoods impact the average level of output in the same way. Moreover, the geographic neighborhood effect is insignificant for the top quintiles (i.e. the richer countries in the conditional distribution) and significant for the low quintiles (i.e. the poorer countries in the distribution). The income lag with respect to institutional neighborhood impacts in the same way on all levels of the conditional income distributions. These comments hold when looking at the relative impacts of both spatial lags regarding geographical and institutional types of neighborhood. The weighted income vector is not significant with the religious type of neighborhood when looking at it separately or relative to the other kinds of proximities.

Table 30: Impacts of neighbors' wealth regarding the three types of neighborhood simultaneously – Introduction of other explanatory variables – no instrumentation

	OLS		$\tau = 0.20$		$\tau = 0.40$		$\tau = 0.60$		$\tau = 0.80$	
	β	p-value	β	p-value	β	p-value	β	p-value	β	p-value
Constant	-2.874	0.170	-4.694	0.056	-6.686	0.008	-1.014	0.608	0.391	0.880
Geographic neighbors	0.479	0.034	0.470	0.094	0.778	0.012	0.291	0.250	0.164	0.525
Institutional neighbors	0.639	0.000	0.795	0.000	0.670	0.000	0.463	0.000	0.516	0.000
Religious neighbors	-0.127	0.224	-0.097	0.238	-0.081	0.499	-0.038	0.772	-0.095	0.512
$\ln School$	0.643	0.000	0.490	0.008	0.537	0.002	0.726	0.000	0.787	0.000
$\ln(n+g+\delta)$	0.123	0.170	0.103	0.418	0.248	0.079	0.170	0.081	0.199	0.141
$\ln I/Y$	0.158	0.461	0.292	0.403	0.230	0.319	0.383	0.243	0.272	0.224
R²	0.81		0.66		0.64		0.64		0.61	
N	90		90		90		90		90	

The introduction of the classical MRW model explanatory variables treated the bias of omitted variables. Nevertheless, the spatial structure of the specification induces another bias, this time of endogeneity. The correlation between the spatial lag and the error term implies that the estimates are not convergent. The classical treatment of this bias is to estimate with the maximum likelihood techniques. However, this technique is not suitable with the quintile regression approach. In order to resolve this problem, we use the empirical strategy shown in point 2.2 which consists of replacing the spatial lag by its estimation made with the instruments. Table 31 yields the results when the spatial lags are instrumented and the explanatory variables introduced into the specification.

As the two-step OLS requires instruments, the quality of the instrumentation matters a great deal. Three tests are therefore presented for each of the 2SLS estimation applications. The Sargan-Hansen test (Hansen J test) is a test of overidentification of all the instruments. The joint null hypothesis is that the instruments are valid instruments (i.e., uncorrelated with the error term), and that the excluded instruments are correctly excluded from the estimated equation. Under the null hypothesis, the test statistic is distributed as chi-squared in the number of overidentifying restrictions. A rejection casts doubt on the validity of the instruments. The Anderson canonical correlations test is a likelihood-ratio test used to assess whether the equation is identified (i.e. if the equation is correlated with the endogenous regressors). The null hypothesis of the test is that the matrix of reduced form coefficients has a rank of $K-1$, where K is the number of regressors (i.e., that the equation is underidentified). Under the null hypothesis, the statistic is distributed as chi-squared with degrees of freedom equal to $L-K+1$, where L is the number of instruments (included and excluded). A rejection of the null indicates that the model is identified. Nevertheless, a result of rejection of the null should be treated with caution because weak instrument problems may still be present. The test for weak identification is based on the Cragg-Donald F statistic. The latter has to be compared with the critical values of a Fisher distribution which depend on the number of degrees of freedom under consideration. The degree of freedom of the Cragg-Donald test depends on the number of instruments, the number of excluded and included instruments, and the number of valid instruments.

Table 31: Gross effects of neighbors' wealth regarding the three types of neighborhood (instrumented) with the introduction of other explanatory variables

	IVREG		$\tau = 0.20$		$\tau = 0.40$		$\tau = 0.60$		$\tau = 0.80$	
	β	p-value	β	p-value	β	p-value	β	p-value	β	p-value
Constant	-0.760	0,760	-5,442	0,089	-1,067	0,751	2,158	0,407	1,231	0,420
Geographic neighbors	0,689	0,019	1,277	0,000	0,682	0,086	0,329	0,284	0,454	0,260
ln $School$	0,819	0,000	0,461	0,006	0,574	0,018	0,863	0,000	0,951	0,003
ln$(n+g+\delta)$	-0,081	0,501	-0,198	0,336	-0,134	0,461	-0,077	0,580	0,013	0,477
ln I/Y	0,217	0,312	0,265	0,045	0,705	0,017	0,399	0,152	0,252	0,192
Hansen J test	1.043	0.594	-		-		-		-	
Anderson	165.812	0.000	-		-		-		-	
Cragg Donald	146.948		-		-		-		-	
R^2	0,75		0,57		0,57		0,59		0,55	
Constant	-1.621	0.455	-2.684	0.513	-2.389	0.429	1.181	0.594	3.098	0.347
Institutional neighbors	0.845	0.002	0.901	0.105	0.937	0.024	0.485	0.119	0.247	0.576
ln $School$	0.660	0.000	0.683	0.109	0.473	0.112	0.775	0.000	0.776	0.000
ln$(n+g+\delta)$	0.141	0.320	-0.049	0.889	0.084	0.656	0.018	0.866	-0.005	0.973
ln I/Y	0.174	0.405	0.198	0.455	0.408	0.183	0.326	0.162	0.529	0.087
Hansen J test	0.027	0.868	-		-		-		-	
Anderson	11.662	0.003	-		-		-		-	
Cragg Donald	5.811		-		-		-		-	
R^2	0.80		0.52		0.57		0.59		0.55	
Constant	4,970	0,001	4,845	0,008	5,866	0,001	4,423	0,008	5,259	0,001
Religious neighbors	-0,002	0,990	-0,015	0,902	-0,070	0,698	0,025	0,889	-0,021	0,895
ln $School$	0,954	0,000	0,963	0,000	0,794	0,000	0,973	0,000	0,827	0,000
ln$(n+g+\delta)$	-0,225	0,073	-0,497	0,020	-0,359	0,000	-0,104	0,219	-0,125	0,111
ln I/Y	0,335	0,106	0,300	0,192	0,485	0,033	0,499	0,034	0,617	0,040
Hansen J test	1.968	0.374	-		-		-		-	
Anderson	107.865	0.000	-		-		-		-	
Cragg Donald	64.052		-		-		-		-	
R^2	0,73		0,50		0,55		0,58		0,54	
N	90		90		90		90		90	

In fact, the explosive nature of the spatial lag estimates disappears entirely. The effect on the average of output per capita is highly significant for the weighted income vector with respect to the institutional and the geographical proximity matrices, while this is not the case for the religious proximity weights. However, the instrumentation tests appear to give good results for the three spatially lagged vectors. The effects on the quintiles are more ambiguous. Indeed, if the effects for geographical weights are the same as before (i.e. not significant for rich countries and significant for poor countries), the income of the institutional neighborhood appears to be insignificant in three of the four quintile regressions. Nevertheless, two of the insignificant quintiles are close to the nominal level of 10%. These results on the quintiles appear surprising compared to the effect on the average which is highly significant.

<u>Table 32:</u> Impacts on neighbors' wealth regarding the three types of neighborhood simultaneously – Introduction of other explanatory variables – with instrumentation

	IVREG		Quintile (0,20)		Quintile (0,40)		Quintile (0,60)		Quintile (0,80)	
	Beta	p-value	Beta	p-value	Beta	p-value	Beta	p-value	Beta	p-value
Constant	-2.971	0.203	-7.064	0.162	-5.599	0.206	1.703	0.666	0.354	0.929
Geographic neighbors	0.538	0.045	1.095	0.001	0.637	0.157	0.128	0.706	0.360	0.281
Institutional neighbors	0.515	0.006	0.256	0.621	0.544	0.205	0.387	0.116	0.352	0.342
Religious neighbors	-0.063	0.652	0.036	0.884	0.070	0.774	-0.099	0.591	-0.112	0.571
$\mathbf{ln}\, \boldsymbol{School}$	0.672	0.000	0.549	0.000	0.589	0.003	0.764	0.000	0.836	0.000
$\mathbf{ln}(\boldsymbol{n}+\boldsymbol{g}+\boldsymbol{\delta})$	0.096	0.308	-0.023	0.951	0.149	0.624	0.043	0.804	0.077	0.733
$\mathbf{ln}\, \boldsymbol{I/Y}$	0.158	0.441	0.329	0.090	0.295	0.319	0.397	0.183	0.200	0.324
Hansen J test	1.274	0.938	-		-		-		-	
Anderson	24.782	0.000	-		-		-		-	
Cragg Donald	3.091		-		-		-		-	
R²	0.81		0.57		0.58		0.60		0.56	
N	90		90		90		90		90	

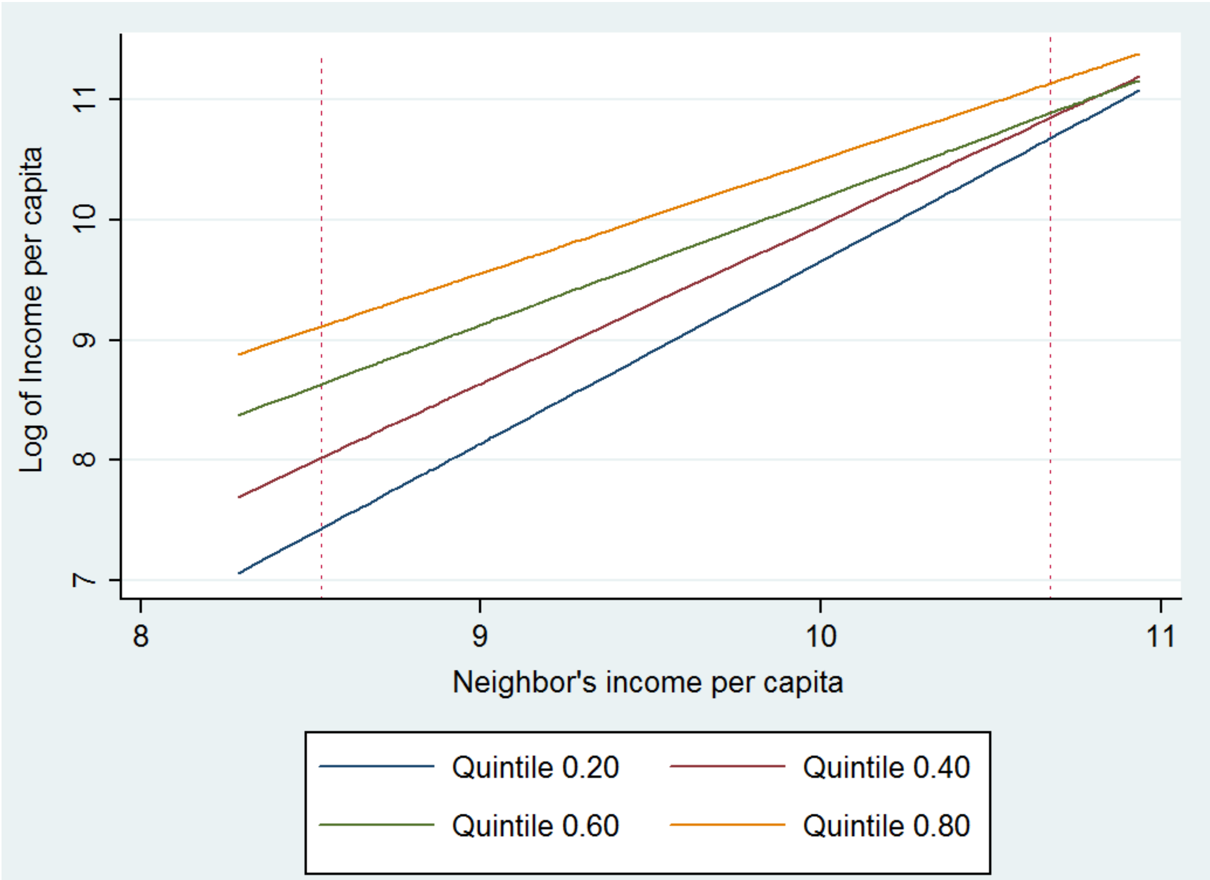
Table 32 presents the same kind of table when the three weight matrices are considered simultaneously. The estimates lead to the same type of conclusion made for Table 30. On the one hand, the effects on income distribution average are highly significant for both geographical and institutional neighborhood, while they are insignificant for religious neighborhood. On the other hand, the effects on the quintiles appear to be insignificant despite the comparable impacts regarding the average. These results confirm the impact of neighbors' income on a country's level of income, whether they are geographic or institutional neighbors. However, the significativity of the estimates needs to be interpreted with caution. Indeed, the introduction of an instrumented variable (i.e. the spatial lag) implies that the estimates are less efficient than they could be. It could therefore be that the significativity is under evaluated.

Finally, the evolution of the impact of the neighbors' income on the quintiles is an important issue as well. As stated earlier, it seems that the spatial lag estimates decrease with the rank of the quintile. This intuition is confirmed in all the estimates when the explanatory variables are included, and with the use of instruments for the spatial lag. Figure 21 shows how the conditional distribution of income differs regarding the geographical neighbors' income. This kind of figure is very similar whether using the institutional or the religious weight matrices to model the spatial lag. The four lines depict the impact of neighbors' income regarding the quintile under consideration. The red left-hand dash vertical line represents an arbitrary cut-off to assess the distribution of the countries' income when their neighborhood has a somewhat low level. The red right-hand dash vertical line looks at the distribution of countries' income when their neighborhood has a somewhat high income level. It appears that the dispersion of countries' income is higher when the neighborhood is poorer. On the other hand, the countries' distribution of income per capita is narrower when the neighborhood is richer.

The shape of these conditional distributions with respect to the wealth of the neighbors is confirmed by the exploratory analysis led in chapter one. Considering the geographical space, it is obvious that some geographical zones are composed of the most developed countries. Europe, North America and South East Asia are homogenous in terms of income per capita which is relatively high. On the contrary, the geographical zones where the income level is lower are less homogenous. South America for instance shows countries with very different levels of income such as Chile, Peru and Bolivia which pertain to different quintiles of income distribution.

The institutional environment shows a similar pattern. The analysis in chapter one showed that the developed countries comprise an institutionally homogenous group. These high income level countries constitute a group where disparities are low and where institutions are of good quality. On the other hand, countries with a poorer level of institutions generally belong to the group of lower income countries. Nevertheless, below a certain level of income, countries may have similar institutions whether they are in the lower or the middle range of income distribution.

<u>Figure 21</u>: Income conditional distribution regarding the geographical neighbors' income



The robustness analysis leads us to conclude that the former results are valid: institutional and geographical types of neighborhood are sources of spillover, while the religious type is not.

Indirect effects

Up to now, the results suggest that only the institutional and geographical dimensions channel spillover between nations. The religious environment does not seem to have a direct effect on spillover. It may however have an indirect effect due to a possible correlation with the other two factors. Since there is no sense in considering that religion might affect geography, we focus on the possible impact of religion on institutions. If such an impact exists, this means that religion also has an impact on inequality between nations, but indirectly through its effect on institutions. One justification for the possibility of such an indirect effect is that many countries in the world have a state religion, which grants a monopoly situation on a given religion *de facto* or by constitution. As Barro and McCleary (2005) argued, "the choice of a state religion is a political calculus that involves interactions between the government and the religion sector" (p. 1332). Such an interaction or agreement might have an impact on the type and quality of institutions in a given country. However, whether the impact tends more to the positive or the negative is unknown.

Since a low institutional level is associated with an inequality impact across nations, Table 33 shows the results of the regressions when considering the institutional neighbors' income. We follow the same methodology as before, i.e. distinguishing the effects for each quintile using the neighborhood weighting matrices. To enable us to compare the results, the impacts of both geographical and religious neighbor's income are considered and the OLS estimates are presented.

The OLS results show that both geographical and religious neighbor's income explain the institutional neighbor's income with a much higher explanatory power for geography. The quintile regression also exhibits a much higher explanatory power than for geography. Focusing on the third set of results (i.e. where both factors are included in the model), the geographical neighbors' income has significant and positive coefficients for all of the quintiles. Countries that are located nearby tend to have a similar quality of institution. This is in line with Hall and Jones (1999) who used the distance from the equator to measure institutions. However, beyond the issue of targeted policies discussed above, it is difficult to give an economic interpretation in terms of spillover between nations. On the one hand, the coefficients linked to geographically weighted spatial lag of income are similar across all quintiles. On the other hand, due to the exogenous nature of the geography factor used, this measure cannot be manipulated to improve the quality of institutions. Overall, these results show that some institutional clusters are also geographical clusters. Indeed, chapter one showed that some institutional neighbors are geographically linked. For instance, the Scandinavian countries all share a comparably high level of institutions. The African countries are shown to be quite homogenous with a low level of institutions. However, while some of these clusters overlap, it is important to stress that the geographical and institutional environments are not systematically the same (see Chapter 1).

The results concerning the income of the religious environment are far more interesting. The coefficients are significant for the first two quintiles and non-significant for the last two quintiles, meaning countries that have institutional neighbors with a low or medium income level (i.e. generally low quality of institutions) in the conditional distributions also have a similar religious profile. In addition, countries that have a higher income level within the neighborhood (i.e. higher quality of institutions) are independent of the neighborhood's religious profile. In other words, religion does not affect the quality of institutions when the quality is good, but it does when the quality is poor. As discussed previously, countries with low quality institutions are associated with low GDP per capita. Our results therefore suggest that religion plays a significant role in poor countries but not in rich ones. This might be coherent with the findings of Barro and McCleary (2005) on a sample (that are not on quintiles) of around 190 countries. After examining the determinants of the adoption of a state religion, the authors found no consistent effect of per capita GDP on the probability of adopting a state religion.

Our results on the different impacts of religious neighbors' income across quintiles leaves the question open as to whether religion improves or deteriorates the quality of institutions in poor countries and therefore on the spillover between nations. If it improves such quality, the indirect impact of religion on these spillovers is beneficial. If it deteriorates such quality, the indirect effect is detrimental. Addressing this question is beyond the scope of this paper and, in our opinion, beyond the scope of economics alone. First, one needs to distinguish between religion, as set out in 'holy books' or other relevant references, and religiosity, referring to how people practice the religion, which necessitates considerable theological and sociological knowledge. Second, the effect of all religions or religiosity on institutions is not necessarily the same and can even prove not to be unique to a given religion. For instance, Becker and Woessmann (2009) provided an alternative to Weber's argument that Protestantism affects economic growth. While Weber attributed the Protestants' higher prosperity to their work ethic, Becker and Woessmann (2009) argued that they prospered because instruction from reading the Bible generated human capital. In similar vein, Botticini and Eckstein (2007) explained how the enforcement of a religious norm requiring fathers to educate their sons in various Jewish communities around the world, explains the accumulation of human capital and prosperity of these communities. Hence, it is not religion per se but human capital (irrespective of how it is accumulated) that can improve the quality of institutions. Finally, in a large number of countries (113 out of 188 in the year 2000),[18] a majority of the population is from a given religion but adopt more or less strict separation between public and religious affairs. In this kind of so-called secular country, religion may still affect institutions, and this is why not only political but also socio-historical analysis needs to be undertaken.

Table 33: Quintile regression of institutional neighborhood's income with respect to other types of neighborhood income

	OLS		Quintile (0,20)		Quintile (0,40)		Quintile (0,60)		Quintile (0,80)	
	Beta	**p-alue**	**Beta**	**p-value**	**Beta**	**p-value**	**Beta**	**p-value**	**Beta**	**p-value**
Constant	-0.039	0.002	-0.121	0.000	-0.077	0.000	-0.026	0.130	0.073	0.036
Geo. neighbors	2.034	0.000	1.887	0.000	2.292	0.000	2.178	0.000	1.683	0.000
R^2	0.547		0.269		0.317		0.401		0.370	
Constant	0.008	0.568	-0.087	0.000	-0.043	0.014	0.012	0.446	0.124	0.000
Rel. neighbors	0.982	0.000	0.816	0.000	0.926	0.000	1.112	0.000	1.181	0.001
R^2	0.267		0.091		0.140		0.226		0.179	
Constant	-0.041	0.001	-0.112	0.000	-0.085	0.000	-0.043	0.061	0.048	0.077
Geo. neighbors	1.746	0.000	1.810	0.000	1.838	0.000	1.947	0.000	1.684	0.000
Rel. neighbors	0.518	0.000	0.588	0.000	0.554	0.000	0.324	0.084	0.368	0.188
R^2	0.610		0.379		0.413		0.429		0.395	

[18] Barro and McCleary (2005): 77 out of a total of 188 in 1900 and 116 out of 189 in 1970.

4. **Conclusion**

The focus of this paper is on the role of three important factors, namely, geography, institutions and religion, in explaining the spillover between nations on different ranges of income distribution. The use of a quintile regression approach allows us to check whether nations are unequal with regard to the spillover they acquire from their neighbors. Indeed, inequality between nations is very important since it affects about two-thirds of global inequality (inequality between all citizens of the world) and appears to persist and make it difficult for poor countries to move towards the top.

Given that prior literature on the determinants of economic growth has failed to address the question adequately, we propose and apply a combination of two approaches: proximity measures and quintile regression. The proximity or distance measure takes into account all degrees of proximity between the countries in the sample and allows a country to be linked to non-immediate neighbors. The quintile regression allows the effects of the three factors to differ across groups of countries. We are therefore able to test whether countries with similar factors (at different degrees of proximity) grow in the same way, and whether this relation holds for both poor and rich countries. Moreover, including the three factors together in the same equation allows us to disentangle the relative importance of each of them.

The analysis led to four main results. First, controlling for the effects of geographical and institutional proximities, the coefficients of the income of religious neighbors appear non-significant for all the quintiles, indicating that religion is irrelevant as a determinant of spillover between nations. Second, the coefficients of the income of geographic neighborhood are significantly positive for the first three quintiles and non-significant for the fourth quintile. This implies that while the evolution of the lower to medium levels of the countries' income distribution might be negatively affected by adverse geographical environment, the income distribution of richer countries is not. Third, the income coefficients of the institutional neighbors are significantly positive regardless of the quintile considered; countries sharing similar institutions have similar per capita income. Fourth, estimates of the impact of neighbors' wealth on income decrease with the quintile leve, and the conditional income distribution regarding the wealth of the neighbors tends to narrow.

In terms of policy implications, these results lead to the following recommendations. First, international aid should aim for policies that help poor countries to overcome the consequences of the adverse geographical environment. Second, such policies should go hand in hand with, or be conditional on, an improvement in the quality of institutions. These implications are further discussed in what follows.

Since an adverse geographical environment negatively affects the income of low to medium income countries but not that of rich countries, geography appears to be a major source of inequality between nations through the spillover it causes, particularly as geographical conditions can hardly be changed. This implies that international aid targeted toward policies that help poor countries to overcome the consequences of an adverse geographical environment should be given priority, especially as rich countries appear to have considerable know-how in this respect. This could help to facilitate the growth of poor countries. They may subsequently be able to deal with an adverse geographic environment by themselves.

In contrast to geography, institutions appear to cause similar spillover on all income classes. However, this does not mean that institutions are irrelevant in explaining inequality between nations but only that countries with similar institutions have similar per capita income. Since rich countries in general have good institutions while poor countries have poor institutions, the link to inequality between nations holds. Moreover, the literature shows that improving the quality of institutions is pro-growth. It is clear that the extent of further improvement to institutions in 'high quality' countries (e.g. Sweden) is more limited than in 'low quality' countries (e.g. Democratic Republic of Congo). It follows that, even with a similar impact of a given improvement on 'high quality' and 'low quality' countries, growth could be higher in the latter than in the former due to improved institutions. One can also reasonably expect a decreasing return in the improvement to the quality of institutions: the impact of a similar magnitude improvement in 'low quality' and 'high quality' countries is likely to have a greater impact on growth in the former countries. Hence, improving the quality of institutions would be more beneficial to poor countries than rich ones, and could partially reduce inequalities between nations thanks to the good spillover it would induce.

Finally, the decreasing values of the quintile estimates of neighbors' wealth confirm that there are institutional and geographical homogenous clusters of richer countries. It is indeed obvious that the wealthier countries are not spread out and isolated when considered in terms of geographical space. The institutional space is far more difficult to interpret and its representation is rather complex. However, the explanatory study in chapter one confirms the existence of a homogenous institutional cluster in terms of income level. The richer countries indeed have strong similarities in their institutions that are of higher quality. On the other hand, there are no clear lower quality institutional clusters with regard to their income level. All in all, the fact that the richer the neighborhood, the lower the dispersion of income may reflect a kind of convergence with respect to space instead of time.

CHAPTER 4

DOES NEIGHBORHOOD MATTER IN TERMS OF THE POVERTY IN A COUNTRY ?

Abstract:

Poverty alleviation will be an important issue for developing countries in the coming years. Many authors have focused on the sources and causes of poverty in order to give such countries the most judicious recommendations for tackling poverty. This study investigates the impact of neighborhood wealth and relative poverty on the proportion of individuals living on less than one or two dollars a day. Several channels of poverty spillover are studied such as physical proximity (i.e. geography), and non-physical forms of proximity (i.e. institutional level and religious distribution). The main results demonstrate that the geographical and institutional environment has a definite impact on poverty spillover between countries and on the influence of neighboring wealth on levels of poverty within a country.

1. **Introduction**

Poverty remains a major issue in developing countries. In addition to having to catch up in terms of production level with other countries, developing countries also struggle to reduce inequality and poverty within their own population. According to World Bank indicators, the number of people living on less than one dollar a day has decreased significantly in the past few decades. However, it is still a serious problem in many countries. In sub-Saharan Africa, for instance, inequality between individuals remains one of the main brakes to economic development.

Many researchers have worked on measures to reduce poverty in developing countries. They usually start by defining poverty as they see it, and then analyze how we could reduce inequality and poverty. Various studies have defined poverty as closely related to the measurement of the concept itself. Ajakaiye and Adeyeye (2005) listed a number of different methods used to measure poverty. They first point to absolute poverty measures such as the *head count ratio* or the *poverty gap* which capture the level of income that is transferred to the poor. Secondly, they present composite indexes such as the *Sen index* which includes measures such as head count ratio, income gap and the Gini coefficient. Another index used to capture how well societies ensure 'achieved wellbeing' is the physical quality of life index (Doessel and Gounder, 1994). One well-known composite index is the *human development index* that was used by the United Nations Development Programme (UNDP, 1990) and which takes both income and non-income factors into account. Finally, a third type of index found in the literature is the relative measure of poverty, defined by the fraction of the population that is poor compared to the overall population. The percentage of the population that lives below a certain standard, such as the proportion of individuals who live on less than one dollar a day or the first quintile of income distribution, are among these relative indexes.

Agenor (2005) argues that a poor population does have enough assets to deal with both economic fluctuations and other crises. This observation explains why macroeconomists are interested in poverty-related issues. In order to tackle poverty, income needs first to be generated at national level and the country then has to be protected from economic hazards. However, Agenor also points to the need for microeconomic studies in poverty alleviation as well as a redistribution of the national income in favor of the poor.

A new literature on pro-poor growth has therefore emerged. The basic definition of pro-poor growth is growth that significantly reduces poverty. Agenor (2005) gives three definitions of pro-poor growth. The first states that growth is pro-poor if poor people all benefit equally from any income increase in the country. The second definition argues that there is pro-poor growth if the poorest class in the population benefit more than proportionally from a rise in income. A third definition is that pro-poor growth has to be labor intensive as labor is the main source of income for poorer people. Among authors who have built the most interesting concepts in this literature, Ravallion and Chen (2003) developed the so-called “growth incidence curve,” which gives the growth rates by quintiles of income distribution, offering a better measurement of pro-poor growth. Dollar and Kraay (2001) argued that when the national income increases in a country, the income of the poorest fifth of the population also rises automatically. Controlling for other determinants such as rule of law, openness to international trade or the quality of the financial markets, they found little impact on the share of income that accrues at the bottom quintile. However, Loayza and Raddatz (2010) went further by identifying the sectors in which pro-poor growth takes place. They demonstrate that growth in unskilled labor-intensive sectors such as manufacturing, construction and agriculture are of more benefit to the poorest class of the population. From this study, we can say that not only does growth matter but its composition does as well.

Piachaud (2002) studied the sources of growth in more depth, i.e. the different notions of capital that determine poverty and social exclusion. He distinguished five forms of capital: financial capital, physical capital, human capital, public infrastructure and social capital. The first three on the list have already been used in many economic growth models since the seminal paper by Mankiw, Romer and Weil (1992). The other two forms are new to the economic literature. Piachaud stressed the need to take broader categories of capital into account in order to better understand the poverty mechanism. Another aspect of his study concerns the range of the analysis. It is in fact possible to consider social exclusion at various levels: individual, community or national. Our focus is on whether the national level of relative poverty is impacted by determinants from abroad such as foreign wealth or foreign poverty. The aim is therefore to include neighborhood observations as explanatory variables of absolute poverty. Spatial econometrics is thus at the core of our methodology.

Very few economic studies on poverty to date have used spatial econometrics. Rupasingha and Goetz (2007) studied US poverty with spatial methods for states, and came to the conclusion that when poverty increased in a state’s neighbor, the poverty of the first state also increased. Of course, many studies on macroeconomic issues use spatial methods. This type of literature was reviewed in the previous chapters. The goal of this paper is to investigate whether inequality could be impacted by the regional environment. On the one hand, poverty is due to poor economic performance in the countries in question, or to macroeconomic shocks and failures. The main hypothesis in this chapter is that one determinant of a country's poverty could arise from its neighborhood. To this end, the study will use the wealth of the neighboring countries as an explanatory variable of poverty inside countries. However, labor market deficiencies, migration and unemployment are also sources of poverty, and thus poverty in the neighboring environment can also affect a country's poverty. In order to take poverty spillovers into account, we will consider relative neighborhood poverty levels as an explanatory variable to explain inequality within a country.

The notion of neighborhood needs to be reviewed as it can be defined in several ways. It is natural to assume that the physical environment can have an impact on poverty in countries. Our study will also test some non-physical environmental factors such as institutional neighborhood and religious neighborhood. This gives rise to two questions. First, is wealth transfer between countries pro-poor? The three first chapters of the thesis showed that there is indeed growth spillover between geographical and institutional neighbors. It is therefore relatively straightforward to check whether this propagation reduces the relative poverty of the countries in question. In other words, is wealth spillover pro-poor? Second, does poverty spillover exist? There are two reasons for poverty spillover: migration of the poorest individuals and the common shocks that countries can experience. However, our main focus is on whether these effects are driven by geographical, institutional or religious proximity.

The measures of inequality considered in this study are firstly the percentage of the population that lives on less than one dollar a day, and secondly the percentage of the population that lives on less than two dollars a day. The data left us with 52 developing countries. This is because the data on the percentage of the population with less than 1 dollar a day is not available for the developed countries.

Section 2 of the study reviews how proximity matrices were built for the 52 countries under consideration. Section 3 presents the statistical approach to compute the gross effects of neighboring wealth on poverty and poverty spillover. A descriptive study of the data is also presented. Section 4 presents the results for both points of interest and finally section 5 concludes.

2. **Building proximity connection matrices**

The aim of this study is to investigate the presence of spillover by using different notions of proximity on relative national poverty. Traditionally, neighborhood is defined with respect to the geographic position of the entities. It is clear that in any economic study, geography is an important factor in the channel of spillover. It would be over-restrictive however to define space and interaction between countries only in terms of geography. This study shows that a qualitative form of proximity such as institutional or religious proximity can also be a channel of spillover.

The following section explains how we built the proximity connection matrices for our set of 52 developing countries according to the type of proximity considered: geographical, institutional or religious.

2.1 ***Geographic proximities***

To build pairwise relationships between all the countries included in the dataset, we need to build a square matrix that is usually denoted W. This spatial matrix contains the proximity measures between all the different entities studied. The weights w_{ij} included in the matrix W can be interpreted as follows: the higher the weight w_{ij} between the countries i and j, the closer the countries will be to each other. There are many ways to build the geographical weights. The most common are to use either the metric distance between the centers of the entities or to assess whether two countries are contiguous or not. Modeling geography using the contiguity criteria (binary view of interdependence) appears somewhat restrictive given the worldwide aspect of this study.

Therefore, to define the interaction between two entities i and j, we use the real distances between their two respective centers. By defining d_{ij} as the distance between i and j, we build the geographical weight matrix W as follows:

$$w_{ij}^{Geo.} = \frac{1/d_{ij}}{\sum_{j=1}^{N}\left(1/d_{ij}\right)} \qquad \forall i,j \in D \; with \; D = \{1,2,\dots,N\}$$

with $w_{ii}^{Geo} = O, \forall i \in D.$

These distances are computed by using the great circle formula[19] which is based on latitudes and longitudes of the most important cities or agglomerations (in terms of population). The resulting W matrix is the classical geographical weight matrix used in many spatial studies on growth and productivity.

Dividing the proximities obtained by the sum of the corresponding row for each element gives a row-normalized spatial matrix. Each weight between a country i and a country j is then given as a percentage of the total of the weights of country i with respect to all the countries in the dataset. The rows of the matrix therefore represent the relative proximities of a country with respect to all the other countries in the dataset.

2.2 *Institutional proximities*

Institutional weights are built based on the observations made by Kaufmann et al. (2002) concerning governance indexes. The worldwide governance indicators are provided by a World Bank database for the period 1996-2007. In the present study, only the data for the year 1996 were used. Kaufmann et al. identified six dimensions of governance, namely:[20]

[19] 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.

[20] 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

- **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.
- **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.

In this paper, our interest is to build an institutional type of proximity in order to have a new weight matrix to use in the spatial analyses. We first need to compute an institutional type of distance for each pair of countries i and j. The Kogut and Singh index (1988) provides a tool to compute distances between the two vectors of indexes:

$$ID_{ij} = \frac{1}{6}\left[\sum_{k=1}^{6} \frac{\left(I_{ki} - I_{kj}\right)^2}{V_k}\right] \qquad \forall i, j \in D$$

where I_{ki} is the k^{th} institutional index for country i, and V_k is the variance of the k^{th} institutional index.

As this formula computes the distances between two countries i and j, we need to invert the result to obtain the proximity between the two countries. Finally each row of the matrix has to be normalized.

The institutional proximities can therefore be computed as follows:

$$w_{ij}^{Inst.} = \frac{1/ID_{ij}}{\sum_{j=1}^{N}\left(1/ID_{ij}\right)} \qquad \forall i,j \in D$$

2.3 ***Religious proximities***

Religious proximity is constructed in the same way as institutional proximities. The religious type of distance is defined by four indexes and computed with the Kogut and Singh formula. Proximity is once again obtained by taking the inverse of the distance. Finally, the obtained matrix is row-normalized.

The four indexes that define religious type of distance are:

- percentage of Catholics within the country.
- percentage of Muslims within the country.
- percentage of Protestants within the country.
- percentage of the population with beliefs other than Catholic, Muslim and Protestant within the country.

These indicators were used in the database of La Porta et al. (1999). The Kogut and Singh formula applied with these indexes yields the following religious distances (RD):

$$RD_{ij} = \frac{1}{4}\left[\sum_{k=1}^{4}\frac{\left(I_{ki} - I_{kj}\right)^2}{V_k}\right] \qquad \forall i,j \in D$$

where I_{ki} is the k^{th} religious index for country i and V_k is the variance of the k^{th} institutional index.

Each distance RD_{ij} has to be inverted in order to obtain the pairwise proximities between countries. Finally, the matrix $W^{Relig.}$ has to be row normalized in order to have the relative weights in each line.

$$w_{ij}^{Relig.} = \frac{1/_{RD_{ij}}}{\sum_{j=1}^{N}\left(1/_{RD_{ij}}\right)} \qquad \forall i, j \in D$$

3. Methodology and data

The main focus of this section is to study how the relative poverty that exists within a country evolves with respect to the neighborhood. Instead of checking whether rich and poor countries react differently to their respective environment, we examine the dependence of one country's proportion of poor individuals with respect to the richness or poorness of its neighborhood. The first part of this section introduces the equations, the variables and the estimation method. The second part presents descriptive and explorative results concerning the dataset.

3.1 *Equations of the models*

In fact, data regarding the income share of population quintiles are not available for many of the countries where we attempted to build proximities with respect to geography, institution or religion. Hence, the data on the proportion of the population living on less than 1 or 2 dollars a day are used to give an idea of the poverty level in the countries studied. These data come from the World Bank's World Development Indicators (WDI). As this proportion is close to zero for all the developed countries, the set of countries studied is limited to the developing countries for which we were able to build geographical, institutional and religious proximities.

The first equation of this section looks at the gross effect of neighborhood wealth on the percentage of people in the population living on less than 1 or 2 dollars a day. The dependent variable is denoted by Z:

$$Z = \rho WY + \varepsilon$$

where Y is the income per capita vector. Depending on the proximity matrix W used, the term ρWY therefore represents the neighborhood in terms of geographical, institutional or religious proximities.

However, these equations only take into account a gross effect of the different proximities on the proportion of people living on less than 1 or 2 dollars a day. In order to obtain the relative impact of the different types of neighborhood wealth or poverty, we used the following equation:

$$Z = \rho_1 W_1 Y + \rho_2 W_2 Y + \rho_3 W_3 Y + \varepsilon$$

The estimation method used throughout this section is the robust linear regression model: robust OLS.

The notion of dependence and inequality within certain countries with respect to their neighbors' wealth automatically raises another issue. Inequalities in this country could indeed be reduced by a neighbor's wealth, but could also be exacerbated by the inequalities in other countries in the same neighborhood. This phenomenon is called 'spillover effect' and is modeled via the following specification:

$$Z = \rho W Z + \varepsilon$$

where $\rho W Z$ represents the poverty of neighboring countries with respect to geographic, institutional or religious proximities.

With regard to wealth, it is interesting to determine which neighboring countries are the most relevant in the propagation of inequalities within a country. The specification can be written as follows:

$$Z = \rho_1 W_1 Z + \rho_2 W_2 Z + \rho_3 W_3 Z + \varepsilon$$

However, the spatial lag of the dependent variables as explanatory variables introduces an endogeneity bias. There is indeed a correlation between this spatial lag and the error term that leads to non convergent estimates. This issue can be resolved by using either the maximum likelihood techniques or the instrumental variables.

The fact that the specifications used in this chapter aim to determine the gross effect of the spatial lag of relative poverty, without including other explanatory variables, gives a complex derivation of the maximum likelihood function. On top of this, the estimation of the relative impacts of the different weights makes it even more difficult. The choice is therefore to use the instrumental variables techniques developed by Kelejian and Prucha (1998).

In practice, the use of instrumental variables means including explanatory variables in the model. In fact, the previous model on the impact on neighboring wealth gives us a straightforward set of explanatory variables:

$$Z = \rho W_p Z + \beta_1 W_1 Y + \beta_2 W_2 Y + \beta_3 W_3 Y + \varepsilon$$

The question is therefore to know which instrument to use for $W_p Z$ (where p indicates whether the proximity used is geography, institution or religion). The answer comes directly from the model that estimates inequalities within countries with respect to neighboring wealth. Z is indeed a variable that depends on $W_p Y$, which means that $W_p Z$ depends on $W_p W_p Y$. This method gives three instrumental variables for each spatial lag of the inequalities as Z is related to neighborhood income with respect to the three types of proximities. It is therefore possible to replace $W_p Z$ by its predicted values with respect to the explanatory variables $W_p W_p Y$ as follows:

$$\widehat{W_p Z} = \alpha_1 W_p W_1 Y + \alpha_2 W_p W_2 Y + \alpha_3 W_p W_3 Y$$

Finally, the following specification can be estimated with OLS as follows:

$$Z = \rho \widehat{W_p Z} + \beta_1 W_1 Y + \beta_2 W_2 Y + \beta_3 W_3 Y + \varepsilon$$

The same methodology is followed when estimating the relative impact of the spatial lags with respect to the three types of environment.

3.2 *Data description*

In this section we study the impact of the wealth or poverty of a country's neighbors on its own poverty level. The variables used to measure the poverty level are, first, the fraction of people living on less than a dollar a day within a country and, second, those living on less than two dollars a day. The wealth of a country is measured by its GDP per capita, taken in logarithm. The three variables come from the World Development Indicators (WDI) of the World Bank.

The three different types of proximity – geographical, institutional and religious – have been computed for the dataset composed of 90 countries. This dataset includes both developed and developing countries. In fact, the data concerning the percentage of individuals living on less than 1 or 2 dollars a day are close to zero for the developed countries. We therefore only work with the developing countries, which leaves us with a set of 52 countries.

3.3 *Explorative results*

Table 34 lists the ten countries considered as the richest and poorest from the sample for each variable considered in the model.

Table 34: The first ten and the last ten countries in terms of poverty level

People living on less than 1$/day (ascending order)	People living on less than 2$/day (ascending order)	GDP per capita (descending order)
Thailand	Mexico	Mexico
Mexico	Thailand	South Africa
Colombia	Colombia	Brazil
Jamaica	Panama	Panama
Panama	Jamaica	Turkey
Sri Lanka	Brazil	Iran
Brazil	Algeria	Belize
South Africa	Tunisia	Algeria
Tunisia	South Africa	Jamaica
Syria	Paraguay	Tunisia
Mozambique	Burkina Faso	Bangladesh
Zambia	Rwanda	Burkina Faso
Chad	Madagascar	Madagascar
Burkina Faso	Mozambique	Niger
Rwanda	Zambia	Mali
Nigeria	Nigeria	Chad
Guinea-Bissau	Guinea-Bissau	Mozambique
Burundi	Burundi	Guinea-Bissau
Mali	Mali	Burundi
Niger	Niger	Nepal

The top ten and bottom ten are quite similar regarding the percentage of individuals living on less than one or two dollars a day, whereas the top ten and bottom ten classifications differ slightly for the GDP per capita variable. Indeed, while some countries in the GDP per capita top and bottom ten can be found in the relative poverty variables classification, the ranking differs systematically. Furthermore, the GDP per capita top ten is composed of countries from different continents, whereas the bottom ten contains mainly African countries. We therefore expect a high geographical interdependence for poverty. This cluster of African countries shows that it is indeed worth looking at other types of proximities that can have an impact on the propagation of poverty.

In order to perform a complete analysis to interpret the results, we need to look at the description of the two dependent variables used in this study in more detail: i.e. the proportion of a population living on less than either 1 or 2 dollars a day.

To better visualize both variables, we split the poverty level distribution into different classes:

- between 0% and 10% of population living on less than 1 or 2 dollars;
- between 10% and 20%;
- between 20% and 30%;
- between 30% and 40%;
- between 40% and 50%;
- over 50%.

<u>Figure 22</u>: Map showing the distribution of people living on less than 1 dollar a day

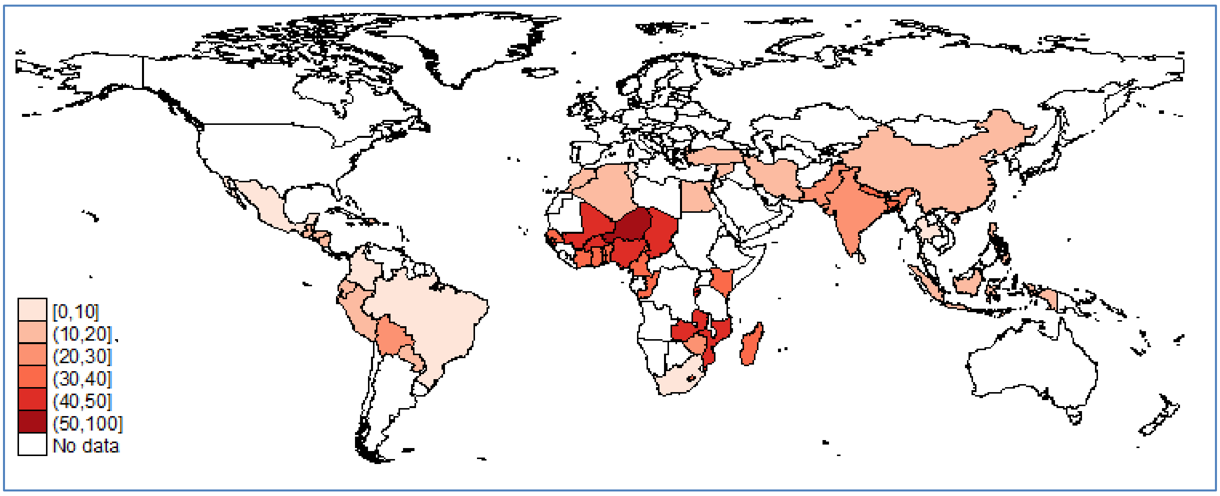
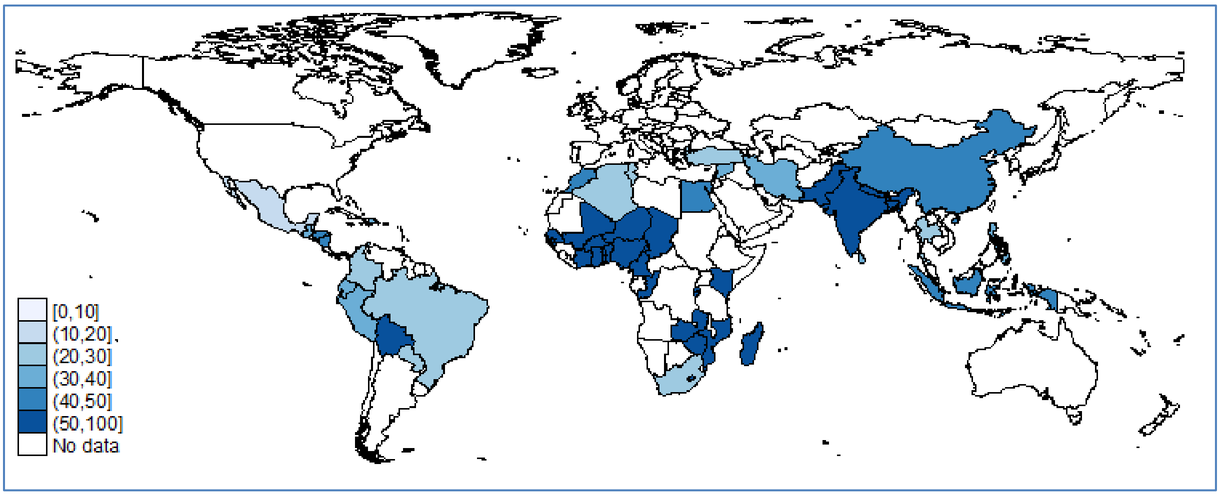


Figure 22 shows that the only country in the study which has more than half of its population living on less than 1 dollar a day is Niger. We observe that most countries with between 40% and 50% of their population below the 1 dollar a day threshold are African countries. Only two non African countries appear in the cluster (30%-40%), Bangladesh and Nepal. The countries with under 10% of their population living on less than 1 dollar a day are Mexico, Colombia, Brazil, Tunisia, South Africa, Thailand and Sri Lanka.

Figure 23 shows the same map but this time for the proportion of individuals living on less than 2 dollars a day. In fact, the whole sub-Saharan region, except for South Africa, has more than half of its population living below the 2-dollars-a-day threshold. Compared to the previous map, the difference is that the poorest cluster is not only composed of African countries. Indeed, in this case, Pakistan, India, Nepal and Bolivia join the group of African countries. On the other hand, no country in the sample has between 0% and 10% of its population living below the 2 dollar threshold.

Figure 23: Map showing the distribution people living on less than 2 dollars a day



Both maps show a geographical cluster of poverty in the African region and the Indian peninsula. Our interest is of course in geographical proximity to check for poverty spillover. However, geographical links may not be the only channel of spillover. Institutional or religious proximity could also have an impact on poverty propagation. In order to introduce the spatial study, we need to conduct an explorative spatial study on the dataset to justify the use of such types of proximity.

First, the spatial autocorrelation of the dependant variable has to be pointed out. The test of Moran tests the null hypothesis of no global spatial autocorrelation against the hypothesis of global autocorrelation with respect to the matrix used: geography, institution or religion. The results are shown in Table 35.

Table 35: Moran's I test for the fraction of people living on less than 1 dollar a day

	Geography	Institution	Religion
Moran's I	0.304	0.128	0.268
E(I)	-0.020	-0.020	-0.020
p-value	0.000	0.000	0.001

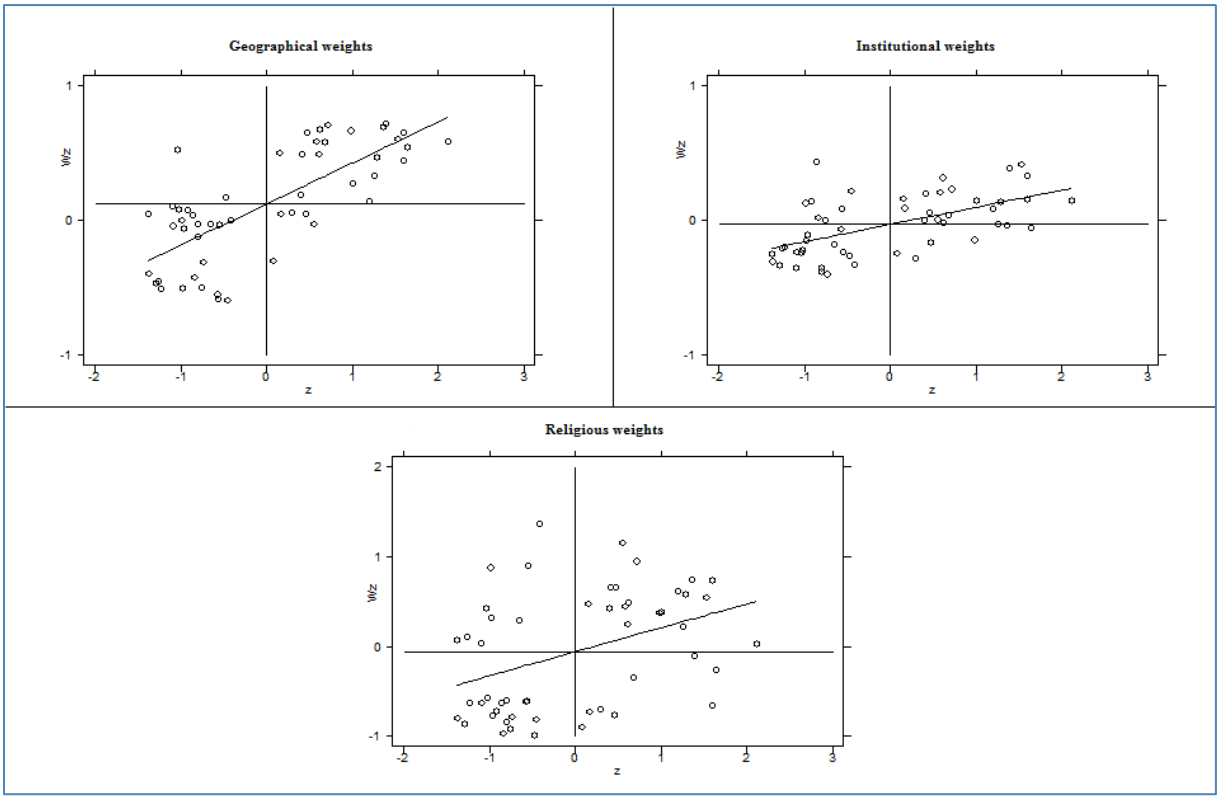
Moran's I test shows that the three types of distance are a channel of spatial autocorrelation. The values of Moran's I test are all positive and suggest that poverty spillover in a given country evolve in the same way as its neighbors. Conclusions are similar when looking at the second dependant variable which is the fraction of people living on less than 2 dollars a day (see Table 36).

Table 36: Moran's I test for the fraction of people living on less than 2 dollar a day

	Geography	Institution	Religion
Moran's I	0.289	0.123	0.298
E(I)	-0.020	-0.020	-0.020
p-value	0.000	0.000	0.002

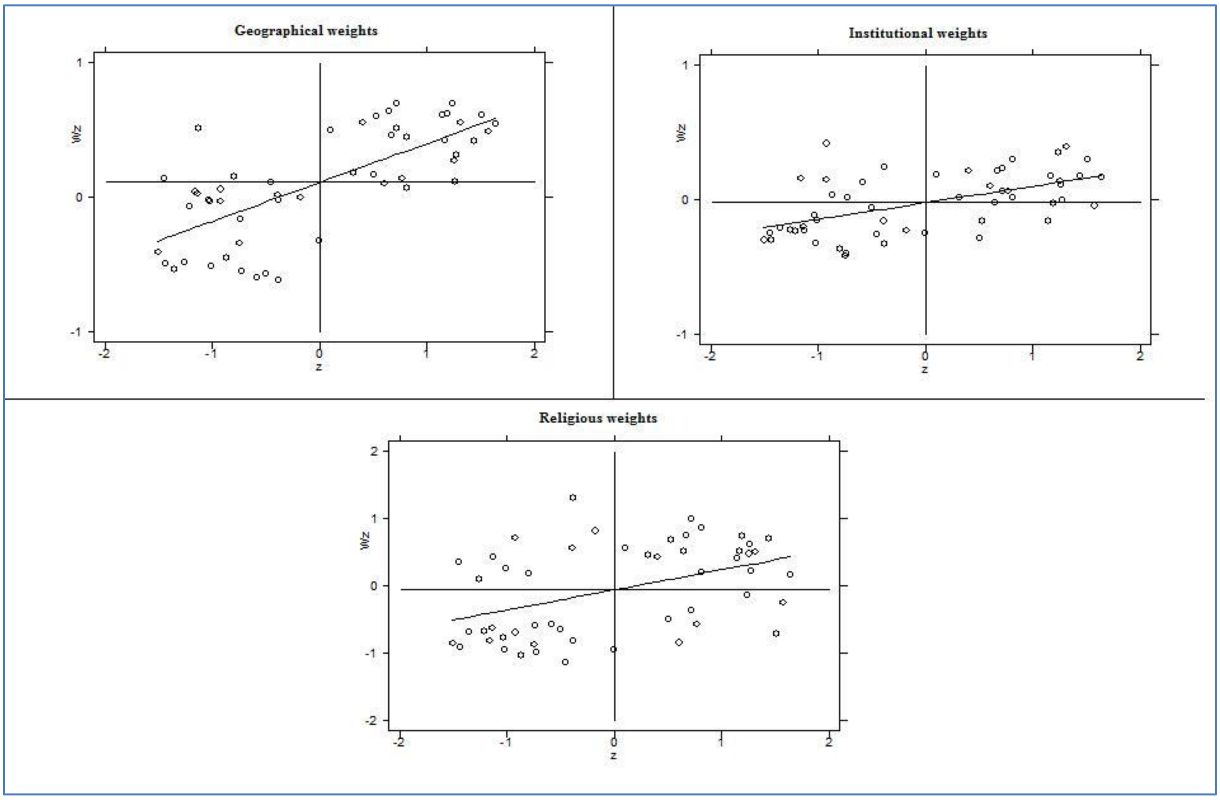
The final step in the spatial explorative study is to analyze the Moran's scatterplot in order to check the local autocorrelation. Moran's I test checks the presence of global spatial autocorrelation but does not consider the local effect for all the countries in the study. Figure 24 and 25 respectively show Moran's scatterplot for the fraction of people living on less than 1 dollar a day and the fraction of people living below the threshold of 2 dollars a day.

Figure 24: Moran's scatterplot for the fraction of people living on less than 1 dollar a day



Moran's scatterplot shows four distinct quadrants in which a country could find itself. If a country is situated in the upper right quadrant (called HH), it means that this country has a high income per capita level and has a neighborhood with the same level of GPD per capita. The opposite quadrant (LL), the bottom left-hand one, represents the low income countries that are surrounded by other low income countries. The last two quadrants, the upper-left (HL) and the bottom-right (LH) one, represent respectively a low GDP per capita country that is surrounded by highly productive countries and a high GDP per capita entity with a low income neighborhood. Finally, the slope of the scatter's regression yields Moran's I statistic.

Figure 25: Moran's scatterplot for population share living on less than 2 dollar a day



The dispersion of the cloud of points (i.e. the countries) differs according to the type of distance used (geographical, institutional or religious weights) in Figures 24 and 25. While geography and institution show a scatter that is quite close to the regression, religion does not perform so well. Even if the general autocorrelation regarding religion is significantly positive, many countries are situated in the LH and HL quadrants, indicating that the spatial autocorrelation is locally negative for them. Furthermore, these countries are quite far from the regression line and have a significant position on the scatterplot. The general spatial autocorrelation with respect to the religious weights shows more local positive spillovers than negative ones. Nevertheless, while both geographical and institutional scatterplots indicate some positive spillover between the countries, the slope of the regression is obviously flatter for the institutional weights. We can thus assume that neither religious nor institutional weights will yield results as good as for the geographical type of proximity.

4. Regression results

This section presents the results obtained by analyzing the two dependent variables: the proportion of people living on less than one dollar a day and the fraction of the population that lives on less than two dollars a day. The first part of the section shows the results when the wealth of the neighborhood is taken into account, while the second part shows the impact of neighboring inequalities on a country's inequalities.

4.1 *Relative poverty and neighbors' income*

Table 37 shows the results obtained when the dependent variable is the percentage of people living on less than one dollar a day. Model 1 considers the geographical neighborhood wealth impact, while models 2 and 3 illustrate the institutional and religious neighborhood wealth impact respectively. Model 4 shows the relative estimates with respect to the three types of proximity considered simultaneously.

Models 1 and 2 demonstrate that both geographical and institutional neighborhood GDP have a significant negative effect on the proportion of people living on less than one dollar a day in a country. In model 3, we note a slight impact of the religious environment wealth on the level of inequality. From the R^2 of the robust OLS regressions, we see that geographical neighborhood income explains 44% of the inequality variations, while institutional and religious environment have an R^2 of respectively 28% and 12%. The last model in Table 37 (model 4) shows a clear negative impact of both geographical and institutional neighborhood wealth on inequality. As expected, the wealth of the religious neighbors does not appear to have a significant impact on relative poverty as is the case when the other two types of neighborhood are taken into consideration.

Table 37: Regression of relative poverty (people living on less than 1$ a day) with respect to neighborhood wealth (GDP)

	Model 1		Model 2		Model 3		Model 4	
	β	**p-Value**	***β***	**p-Value**	***β***	**p-Value**	***β***	**p-Value**
Constant	225.93	0.000	317.72	0.000	80.68	0.001	374.93	0.000
Geographical neighborhood GDP	-31.19	0.000					-24.80	0.000
Institutional neighborhood GDP			-44.90	0.000			-28.43	0.008
Religious neighborhood GDP					-8.58	0.011	-0.72	0.808
R^2	0.44		0.28		0.12		0.53	

Table 38 presents the same estimates as Table 37, but this time using the proportion of the population living on less than two dollars a day. These models do not give any further information than the results obtained in the 4 previous models.

Table 38: Regression of relative poverty (people living on less than 2$ a day) with respect to neighborhood wealth (GDP)

	Model 5		Model 6		Model 7		Model 8	
	β	**p-Value**	***β***	**p-Value**	***β***	**p-Value**	***β***	**p-Value**
Constant	349.25	0.000	466.96	0.000	142.68	0.000	555.62	0.000
Geographical neighborhood GDP	-46.24	0.000					-35.48	0.000
Institutional neighborhood GDP			-63.74	0.000			-39.40	0.012
Religious neighborhood GDP					-14.06	0.005	-2.87	0.518
R^2	0.45		0.26		0.15		0.54	

Overall, the results highlight the importance of geographical neighborhood on inequality spillover through the wealth of the environment. As explained in the previous chapter, most of the poor countries are situated in a ‘difficult’ geographic position where water supply and soil fertility is often an issue. However, the geographical position cannot be changed to increase positive influences or to decrease negative influences.

However, as the neighbor’s wealth has a negative impact on relative poverty levels, it can be said that transmission of growth from one developing country to another is pro-poor. This concurs with the findings of Dollar and Kraay (2001) who state that growth is good for the poor, an analysis that indicates that growth is pro-poor, even if it is a growth spillover from the geographical or institutional neighbors.

The geographical estimates teach us that a regional policy in favor of growth could have a positive impact on poverty alleviation. On the other hand, fighting poverty only at national level could be hampered by low wealth or by the negative results of the geographical neighbors.

The conclusions are similar when we look at the countries' institutional environment: the richer the country's neighbors, the lower the level of poverty within a country tends to be. However, it is possible for nations to adapt their institutions in order to benefit from a better institutional neighborhood. Tackling poverty may therefore be done by working on the institutions themselves in order to benefit from better neighboring wealth effects from the institutional environment.

The institutional neighborhood however seems to be less important in explaining relative poverty levels compared to geographical neighborhood. This means that tackling poverty through regional policies should be a priority. Work at institutional and national level should be done in parallel in order to get the right balance of benefit from the most effective spillovers from the outside world.

Finally, no interesting comments could be made regarding religious neighbors as the estimates were insignificant.

4.2 ***Relative poverty spillovers***

Tables 39 and 40 show the results of the regression model for the proportion of population living on less than one dollar a day and the proportion of population living on less than two dollars a day respectively. Once again, the estimates obtained from both dependent variables are similar and will therefore be commented on together.

Table 39: Regression of relative poverty (people living on less than 1$ a day) with respect to the poverty of neighbors

	Model 9		Model 10		Model 11		Model 12	
	β	**p-Value**	***β***	**p-Value**	***β***	**p-Value**	***β***	**p-Value**
Constant	-22.800	0.000	-36.353	0.004	10.532	0.014	-47.488	0.000
Geographical neighborhood	1.793	0.000					1.436	0.000
Institutional neighborhood			2.513	0.000			1.362	0.008
Religious neighborhood					0.595	0.001	0.043	0.766
R^2	0.54		0.32		0.16		0.62	

Model 9 gives the estimates for the geographical neighborhood level of relative poverty on a country's relative poverty. The results point to a highly significant impact of neighbors' poverty on the poverty of a country, suggesting that an increase in the level of poverty in the geographical environment is liable to spread into the neighboring developing countries. The institutional neighborhood estimates shown in model 10 lead to the same conclusion. We can note that the R^2 of the robust OLS regression is higher for the geographical weights. This implies that spillover due to institutional proximities fails to give a satisfactory explanation for the variation in the level of relative poverty within a country with respect to the other two spatial lags weighted with the other two proximity matrices. Model 11 presents the impact of the religious neighborhood poverty on a country's poverty. The estimates, although significant, are smaller compared to the two previous models. The R^2 is also much lower in comparison with the spatial lags obtained with both geographical and institutional neighborhood. The relative impact of the spatial lags regarding the three types of neighborhood confirm the gross impact of the spatial lags obtained from the geographical and institutional environment matrices. Nevertheless, spillover arising from the religious environment is insignificant when considering the three environments simultaneously as in model 12.

Table 40: Regression of relative poverty (people living on less than 2$ a day) with respect to neighborhood poverty

	Model 13		Model 14		Model 15		Model 16	
	β	**p-Value**	**β**	**p-Value**	**β**	**p-Value**	**β**	**p-Value**
Constant	-43.759	0.000	-71.994	0.007	19.305	0.024	-96.222	0.000
Geographical neighborhood	1.776	0.000					1.364	0.000
Institutional neighborhood			2.433	0.000			1.367	0.000
Religious neighborhood					0.636	0.000	0.107	0.473
R^2	0.51		0.30		0.19		0.59	

When estimating the poverty level spillover using the fraction of people living on less than two dollars a day as a dependent variable, we arrive at the same conclusions as for the analysis of the previous variables. Indeed, the spatial lag regarding the geographical matrix is again highly significant in the regressions, indicating that the higher the level of poverty in the physical neighborhood of a country, the more this country will suffer from poverty spillover. As the geographical position of a country cannot be changed, the main recommendations from the findings are to develop regional policy strategies to tackle poverty and to keep the policies made at national level through bad spillover from the geographical neighborhood.

The estimates obtained from the institutional environment poverty lead to the same type of conclusion. The higher the poverty among institutional neighbors, the more a country will suffer from poverty spillover. In fact, institutions can be altered and countries can monitor their institutional level in order to benefit from spillover arising from countries that have a better income distribution and less poverty. Here again, formulating an institutional strategy could be a good solution to compensate for an unfavorable geographical position.

Regarding the religious environment, the estimates do not yield any significant result. This could mean one of two things: either the religious type of proximity is not channeled for spillover in terms of poverty or the impact of religion is already included in the institutional rules.

However, as we explained in the methodology, these estimates suffer from non convergence due to the correlation of the spatial structure with the error term. The statistical solutions to this issue include both the maximum likelihood techniques and the instrumental variables. In fact, the maximum likelihood is not available in our case as the model considers only the gross effect of the spatial lag, which makes the derivation of the maximum likelihood function difficult.

We developed the instrumental variable approach in our methodology as the contribution by Kelejian and Prucha (1998), for example, showed that it is necessary to include explanatory variables in order to build the instruments. These explanatory variables are therefore the neighboring wealth of the countries or, in other words, the spatial lags of the log of income per capita. However, there is a high indication of colinearity between the spatial lag of poverty and the lag of the GDP per capita logarithm. In order to check if this is really the case, Table 41 shows the correlation matrix of the various spatial lags used in this study. It appears from this Table that the spatial lag of poverty and GDP per capita are highly negatively correlated when the lag is built with the same matrix. It is more or less normal to find that when the neighbors (whatever the neighborhood under consideration) have a high income they have a low level of poverty.

Table 41: Correlation matrix of the spatial lags of poverty (people living on less than 1$ a day) and logarithm of GDP per capita

	Geographical lag of poverty	Institutional lag of poverty	Religious lag of poverty	Geographical lag of GDP	Institutional lag of GDP	Religious lag of GDP
Geographical lag of poverty	1.00					
Institutional lag of poverty	0.43	1.00				
Religious lag of poverty	0.52	0.21	1.00			
Geographical lag of GDP	-0.95	-0.37	-0.50	1.00		
Institutional lag of GDP	-0.41	-0.97	-0.22	0.36	1.00	
Religious lag of GDP	-0.47	-0.11	-0.87	0.53	0.12	1.00

It is now easier to select the variables to be included with the final aim of instrumenting the spatial lags of poverty. If, for instance, our focus is on the geographical spatial lag of poverty, collinearity would appear to be due to the introduction of the geographical spatial lag of GDP per capita. It is therefore better to only introduce the spatial lags of the GDP per capita with respect to the institutional and religious neighborhood. Table 42 gives the estimation obtained by using the instrumental variables techniques.

Table 42: Regression of relative poverty (people living on less than 1$ a day) with respect to neighborhood poverty – with instrumental variables

	Model 17		Model 18		Model 19	
	β	**p-Value**	**β**	**p-Value**	**β**	**p-Value**
Constant	137.338	0.036	144.879	0.001	313.176	0.000
Geographical neighborhood d	1.502	0.000				
Institutional neighborhood			1.615	0.012		
Religious neighborhood					0.430	0.085
Geographical neighborhood GDP			-23.614	0.000	-18.961	0.000
Institutional neighborhood GDP	-22.727	0.011			-27.036	0.008
Religious neighborhood GDP	-0.629	0.795	-1.089	0.692		
R^2	0.60		0.56		0.50	

The estimation procedure for the second variable of relative poverty used in this study leads to the same conclusions as those obtained without the instrumentation techniques. The spatial lag of poverty and the spatial lag of GDP per capita are highly correlated, thereby indicating collinearity when both are introduced in the model specification. Table 43 shows the correlation between the neighbors' level of relative poverty (people living on less than 2$ a day) and the neighbors' level of GDP per capita. Table 44 presents the estimation results when the percentage of the population living on less than 2$ a day is the dependent variable of the model.

Table 43: Correlation matrix of the spatial lags of poverty (people living on less than 2$ a day) and logarithm of GDP per capita

	Geographical lag of poverty	Institutional lag of poverty	Religious lag of poverty	Geographical lag of GDP	Institutional lag of GDP	Religious lag of GDP
Geographical lag of poverty	1.00					
Institutional lag of poverty	0.41	1.00				
Religious lag of poverty	0.55	0.20	1.00			
Geographical lag of GDP	-0.97	-0.36	-0.53	1.00		
Institutional lag of GDP	-0.40	-0.98	-0.21	0.36	1.00	
Religious lag of GDP	-0.50	-0.11	-0.92	0.53	0.12	1.00

Table 44: Regression of relative poverty (people living on less than 2$ a day) with respect to the neighborhood poverty – with instrumental variables

	Model 20		**Model 21**		**Model 22**	
	β	**p-Value**	***β***	**p-Value**	***β***	**p-Value**
Constant	137.338	0.036	144.879	0.001	313.176	0.000
Geographical neighborhood d	1.502	0.000				
Institutional neighborhood			1.615	0.012		
Religious neighborhood					0.430	0.085
Geographical neighborhood GDP			-23.614	0.000	-18.961	0.000
Institutional neighborhood GDP	-22.727	0.011			-27.036	0.008
Religious neighborhood GDP	-0.629	0.795	-1.089	0.692		
R^2	0.60		0.56		0.50	

It is nevertheless impossible to estimate the relative impact of neighbors' poverty regarding the various types of neighborhood. Indeed, the instrumentation of the three lags of poverty simultaneously requires the introduction of the three spatial lags of GDP per capita. These variables would obviously introduce a collinearity bias. However, as the results of the gross effects with instrumentation are similar to those obtained without instrumentation, we can conclude that the biases are not so large. The results of the relative impact of neighborhood poverty regarding geographical, institutional and religious environment obtained without instrumentation gives us insights that can subsequently be interpreted.

5. Conclusion

This chapter deals with relative poverty spillover. The analysis shows that poverty within a country (measured by means of the proportion of individuals living on less than 1 or 2 dollars a day, for instance) is not independent of the country's neighborhood. Our paper checks whether the dependences are due to physical or non physical types of proximity. The last concern is to investigate two sources of influence regarding poverty within a country: i.e., neighboring wealth and neighboring poverty.

Given the existing literature on poverty alleviation, several remarks can be made. First, it is not sufficient to simply increase growth to tackle poverty in developing countries. Nowadays, many authors are interested in the concept of pro-poor growth. This theory implies that an increase in a country's wealth needs to be coupled with fair wealth redistribution to the class within the population with the lowest level of income. Growth is not an automatic vector of poverty reduction, as both its composition and its distribution matter in terms of poverty alleviation. Secondly, looking more deeply at the different forms of capital, social capital appears to be an important growth factor. Since the 1990s, the capital taken into account in growth studies has been the physical, financial and human type of capital. Recently, the concepts of public infrastructure and social capital have also been introduced by some authors. Social capital can be defined as the set of rules and norms in society that facilitate economic exchange and trust, demonstrating that social environment matters in growth.

Our analysis therefore looks at the impact of the neighboring countries' wealth and poverty on poverty within a country. On the one hand, neighboring wealth enhances the environment's performance, leading to a general increase in wealth (see Chapters 2 and 3) and thus reducing poverty within the country. Going further, we can assert that if the neighboring wealth can reduce the proportion of individuals living on less than 1or 2 dollars a day, it can therefore be considered as a pro-poor growth effect for the countries. On the other hand, the paper also takes neighboring poverty into account as a variable that can impact on poverty within a country i.e. poverty spillover. The unemployment rate and poverty can indeed have a cross-border impact on a country through migration or the propagation of negative economic effects to the poorest members of society. Spatial dependence of the observations on poverty for the set of countries under investigation could be an issue, however, and needs to be analyzed further.

Another important contribution of the study is its investigation of various channels of spillover. The most natural way of considering poverty propagation is through physical proximity. This is why the geographical position between the entities studied is naturally used to estimate the impact of poverty spillover. The literature on social capital however tells us that rules and norms are important in building the relationship between individuals. Following this idea, the proximity of institutional levels and the proximity of the religious distribution of the populations are also investigated as a possible channel for spillover.

The main conclusions of this study are as follows: first, with regard to neighboring wealth and neighboring poverty, the geographical environment matters for poverty within a country. The relationship between neighboring wealth and poverty is obviously negative, while poverty spillovers are positive. The main message from these results is that national measures to tackle poverty can be 'polluted' by an adverse neighborhood. This leads to the recommendation to add a regional agreement to national policies so as to enhance the effectiveness of the fight against poverty.

Secondly, institutional neighbors also have a significant impact on relative levels of poverty with respect to neighboring wealth and poverty. This suggests that tackling poverty can also be done by raising the standard of institutions. Enhancing the institutions' efficiency will ensure better wealth redistribution and a better local environment for growth thanks to the benefit of both an enhanced institutional neighborhood and improved efficiency of the institutions. Increasing the institutions' efficiency brings the country closer to more productive countries and allows it to benefit from better spillover for growth. Moreover, this growth spillover impacts directly on the poverty of the country.

Finally, religious neighborhood does not provide any significant proof that it could help in tackling poverty within a country. In effect, having the same distribution of believers does not foster spillover between countries.

GENERAL CONCLUSION

Spatial econometrics was originally developed for geographers and has been widely used in other areas in the last decade, providing many interesting contributions to the economic literature. A large number of authors accept the idea that spatial autocorrelation can be adopted in economic data concerning growth, productivity and technology levels. The two main focuses of this thesis are, on the one hand, to find a method to create non-physical dimensions between countries and, on the other, to investigate whether the impact of these non-geographic distances are significant in economic matters such as growth, productivity and poverty. This section presents the most relevant conclusions of our empirical macroeconomic study on the use of institutional and cultural proximities. Geography naturally remains an important factor throughout the thesis as it is the benchmark for comparison with both the institutional and the cultural dimensions.

Geography

Since the emergence of spatial econometric methods, physical proximity has remained the most obvious relation between pairs of entities, and the idea that the observation of a variable can be affected by its environment is a generally accepted notion. However, there are different ways of modeling geographic relations, depending on the weight the authors allocate to the nearest neighbors, the distance taken into consideration between their centers (i.e. capitals, economic centers…), or the contiguity between the entities studied. In this thesis, proximity between two countries has been defined as the inverse of the distance separating their centers, with the latter defined by the most important cities or agglomerations in terms of population for each country.

Chapter 2 attempts to determine how the three types of neighborhood impact a country's growth rate. To this end, a theoretical model of growth externalities was developed to obtain an empirical specification that includes the impact of the neighbors, whether geographical, institutional or cultural. Chapter 2 shows first the replication of the Mankiw, Romer and Weil (1992) estimates using the classical spatial methods in the dataset, while considering that the growth data indeed suffers from an autocorrelation problem. The first interesting result is that the best suited spatial model is the spatial lag. This implies that a country's growth is affected by its neighbors through their explanatory variables, in contrast to the spatial error model which states that the neighbors' impact is channeled through error terms, i.e. shocks affecting the neighbors' economies. Comparing the estimates given by the spatial lag model and the classical OLS estimation, it appears that all of the estimated values are lower in the spatial estimation. This observation suggests that a country's initial wealth, share of investment, population growth rate and schooling rate affects its growth rate to a lesser degree and, simultaneously, that the same variables observed in the neighborhood compensate this diminution through the spatial effect. The last interesting result in terms of geographic weights in the spatial estimation is the value of the R^2 that can be compared to the results from the replication of the classical MRW model. The increase in R^2 value from 0.31 in the OLS estimation to 0.36 in the spatial lag model suggests that geographical proximity explains 5% of growth variation among the countries in the dataset.

The use of the specification given by the externality model determines the spillover channels. In fact, the spatial lag of the countries' growth rate is no longer significant and, as a consequence, the neighborhood effect is transferred to the neighbors' explanatory variables. It appears that investment in physical capital made by neighboring countries has a huge positive impact on a country's growth rate, while investment by the neighbors in human capital has little impact on a country's growth rate. Moreover, the neighboring countries' initial levels of income as well as the population growth rate impact negatively on a country's growth rate. The regression explanatory power, given by R^2, is also improved thanks to this specification (0.47). It seems quite natural that a physical investment made in a country also benefits the neighboring countries. The negative impact of the neighbors' initial income level can also be interpreted. As acknowledged in the economic literature, the growth rate of richer countries is relatively slow, while poorer countries are expected to experience faster growth. In fact, being surrounded by rich countries (i.e. countries with slow growth) has less effect on a country's growth rate. Finally, the negative impact of the neighbors' population growth rate can be explained by direct migration movements from the neighboring countries.

The third chapter investigates whether countries have different spillovers with respect to their environmental wealth level. By using quintile regression techniques, the neighborhood impact is identified for the different quintiles of the conditional income distributions. The gross impact of the geographical neighborhood is positive and significant for all quintiles of the GDP per capita distribution. Conversely, looking at the relative impact of geographical neighbors with respect to the non-physical environment, it seems that the richer countries in the conditional distribution of income are less sensitive to their geographical neighbors. This suggests that these countries are little affected by an adverse geographical position. However, the estimates given by the specification are obviously biased. The estimate of the neighbor's income per capita indeed appears to have an explosive relation with the income per capita levels of a given country. Several sources can be identified for the bias. First, the fact that the estimates are not performed using the classical maximum likelihood techniques introduces a simultaneity bias to the spatial lag. Second, the specification is made to determine the gross impact of the neighbors on levels of productivity and so only considers the spatial lag of income per capita as an explanatory variable, thereby introducing a bias of omitted variable *de facto*. Both biases were dealt with, first, by using instrumental variables to avoid simultaneity between productivity and the spatial lag of productivity and, second, by introducing the independent variables of the MRW model to deal with the bias due to omitted variables. All of the results confirm that richer countries are not especially sensitive to the physical neighborhood, while poorer countries are highly dependent on the performance of their neighbors.

The last chapter investigates poverty spillover among the developing countries. The interdependence on levels of poverty between countries is analyzed by means of two different factors: on the one hand, the wealth level of the neighbors which is represented by the GDP per capita, and on the other hand, the relative poverty level of the neighborhood, which is measured by the proportion of individuals living on less than either one or two dollars a day. The gross effect of the neighbors' income appears to be negatively correlated to the two measures of level of poverty. The relative impact of geographic neighbors regarding the other types of proximity remains significantly negative. These outcomes from the regressions indicate that the wealth of the regional neighborhood matters in the poverty level of the countries in question. Poverty level related to the geographical environment is also significant and is positively correlated with the internal poverty of the surrounding countries. This last result suggests that poverty spreads across regions.

Overall, the explorative results and the regression estimates imply that geographical neighborhood is important in the three empirical studies performed in the thesis. The geographical environment not only impacts on a country's growth, but also impacts on a country in different ways according to its GDP level. Moreover, the GDP levels of the geographical neighbors also affect the level of inequality in developing countries. Finally, the geographical environment is a channel of poverty spillover.

Institution

One of the goals of the thesis is to look beyond the physical space in order to see whether interdependencies can arise from other types of proximity. In fact, it is possible to consider that two countries which are physically close to one another may have certain institutional barriers that stop the spillover between them. On the other hand, two geographically distant countries may have enough institutional similarities to facilitate spillover.

The starting point of this analysis is to create an institutional type of matrix that captures the pairwise relationships between countries and accounts for the institutional proximity between the countries in the dataset. To this end, the Kaufmann et al (2008) governance indicators were used to compute an institutional type of distance with the help of the Kogut and Singh formula. The institutional distances between countries was computed by taking six indexes that represent the quality of the institution into account, namely, voice and accountability, political stability and the absence of violence, government effectiveness, regulatory quality, the rule of law and control of corruption. A principal component analysis was performed on the six indexes in order to justify their use in the computation of institutional distance between countries. From the PCA, it appears that the six indices differentiate developing countries (with a poor standard of institutions) from the developed countries (with a high standard of institutions). However, the six indices are necessary to compute a precise distance between the developing and the developed countries.

The first chapter in the exploratory study on the institutional proximity matrix shows that the institutional dimension indeed differs from the geographical dimension. While some clusters of similar institutional levels regroup some geographical neighbors, they also include overseas countries that share the same properties. For instance, a clear cluster of countries with similar institutional levels appears to be composed of developed countries such as most of the European countries, the United States, Canada, Australia, Japan and South Korea. A cluster of developing countries contains most of the sub-Saharan countries, apart from South Africa, and is part of a cluster in which we find countries such as Bangladesh and Nicaragua.

Chapter 2 suggests that the use of the institutional weight in a classical economic study is relevant. We therefore introduce the institutional weight matrix in a spatial econometrics study using the MRW model, keeping in mind that the data suffers from spatial autocorrelation problems. The explorative results show that both growth and production per capita are subject to spatial autocorrelation with respect to the institutional environment. Furthermore, the estimations yield significant results for the spatial term when using both the spatial error model and the spatial lag model. The spatially lagged model appears to fit the data best. This means that the spillover between countries is due to the explanatory variables of the neighboring countries. Compared to the classical OLS results, the impact from the introduction of the spatial term into the estimate is different: the population growth estimate is no longer significant; the importance of initial wealth is lower, while that of investment share is higher. The explanatory power is also enhanced when the institutional weight is introduced.

The externality model, developed as a theoretical framework in Chapter 2, allows us to study the effects of a country’s neighborhood on its growth rate in more depth. This model indeed contains the neighborhood explanatory variables of growth. It appears from the estimation that countries are positively impacted by their institutional neighbors’ investment in human capital, and negatively by investment in physical capital. As the institutional neighbors are not systematically their geographical neighbors, we can easily understand why investment in physical capital is of little importance. It is indeed obvious that the construction of public infrastructures, for instance, will have no impact on overseas territories. However, our results show a significant negative impact of physical investment by the neighbors. Moreover, the positive impact of investment in human capital in the neighborhood indicates that when a country’s neighborhood accumulates human capital, it increases the level of technology in this neighborhood, which in return impacts on the country’s level of technology.

In Chapter 3, the institutional weights were used to test the spatial spillover of countries according to their wealth level. To this end, a quintile regression approach was applied to give the gross impact of the institutional neighbors on the quintile of the conditional distribution of GDP per capita. Afterwards, the relative impact of the institutional weights compared to the geographical and cultural weights was measured in a common regression. The wealth of the institutional neighbors impacts on all of the quintile estimates in both gross and relative terms. The robustness analysis confirms these results despite some insignificancy in the estimates when dealing with both the simultaneity bias and bias due to omitted variables.

The last chapter presents an analysis of the poverty spillovers with respect to the different types of proximity. As for geography, income per capita and the poverty of the neighbors were taken into account to explain relative poverty in developing countries. It appears that, on the one hand, the gross effect of the institutional neighborhood wealth is negatively related to poverty inside the countries and, on the other hand, the gross effect of the poverty of the neighbors is positively linked to poverty within countries, regardless of the way relative poverty is defined (the proportion of individuals living on less than one or two dollars a day).

Religion/Culture

Based on the idea of testing diverse dimensions to understand the ways in which countries are linked, a cultural weight matrix is defined in Chapter 1. The cultural weights take into account the official language of countries, the legal system origin, the religious profile and the cultural indexes as defined by Hofstede (2001). The explorative study based on the cultural type of relation between countries appears to be quite different from both the geographical and the institutional types of distance.

The differences between the cultural dimension and the two other dimensions are explored in the economic analysis in Chapter 2. The cultural weights are added to the MRW specification in which spatial methods are applied. Although the explorative study shows a slight spatial autocorrelation problem with respect to the cultural links, it seems that cultural weights have no significant impact on the estimates in either the spatial error model or the spatial lag model. Despite this, the externality model shows interesting results for the religious neighbors. Indeed, the impact of investment in physical capital and the initial income levels of the neighbors are significant factors in a country's growth rate.

Chapter 3 focuses on the religious link between countries, and takes the distribution of Catholics, Muslims, Protestants and other religions into account to build a religious type of proximity between countries. The gross spillover effect of income per capita of religious neighbors on the quintile of GDP distribution per capita is estimated using a quintile regression approach. It is clear from this study that religious neighborhood has no direct impact whatever on the level of wealth. The robustness analysis fully confirms these results. However, to ensure that religion has no indirect effect via the institutional level, we proceeded with the regression of the quality of institutions with respect to the religious neighborhood. The results suggest that religion plays a significant role in poor countries but not in rich ones.

Chapter 4 investigated whether countries that are close from a religious point of view have an impact on the relative poverty of a given country. The neighbors' wealth and inequalities are considered as possible sources of poverty spillover, but the estimates show that a country's religious environment does not influence the relative poverty in our set of developing countries.

What can we learn from the results? – a political economics perspective

The first main conclusion of this thesis confirms the title of a paper by Beck, Gleditsh and Beardsley (2006): “Space is more than geography.” In effect, geographical entities are linked to each other by channels other than simply the physical type of proximity. The first chapter in this thesis clearly demonstrates the validity of the dimension built, and that both the institutional and the cultural dimensions differ from the geographical one. Furthermore, the explorative studies using the three dimensions in the different chapters show that sources of spatial autocorrelation are due not only to geography but also to institutions and culture. These non-physical proximities can therefore propagate economic impacts.

A country’s geographical environment is something that cannot be changed. When a country has an adverse location in terms of its economic development, it is impossible to alter the physical disadvantage. The results indicate that the richer countries in the conditional income distribution do not react to physical neighbors in the same way as poorer ones. Indeed, while the top quintile of the conditional income distribution is not significantly impacted by geographical neighbors’ wealth, the other quintiles have significant estimates for the geographical neighborhood GDP. This implies that countries in the lower quintiles of the income distribution are extremely sensitive to their direct environment. Furthermore, poorer countries are clustered in similar regions, where soils are unfertile and there is a lack of water. This means that they not only have an adverse location but that they also have an adverse neighborhood. This factor shows the interest of applying regional policy measures to help tackle poverty. Reducing poverty at national level is critical, but it may be that the effort made at national level is jeopardized by the negative spillover arising from the adverse neighborhood.

The institutional neighborhood estimates appear to be significant for several variables in the different chapters of the present thesis. Growth, production per capita and poverty are sensitive to the institutional neighbors. The main difference between this result and the geographic neighborhood results is that countries are able to modify their institutions. Thus, the spillover they suffer from is not necessarily a fatality. Increasing the standard of the institutions can increase the benefits of having good institutional neighbors and thus generate greater positive spillover.

From the relative impact of neighbors regarding their geographical and institutional environments, we learn that countries show growth spillover with respect to both types of neighborhood. However, while the quintile regressions showed that institutional neighbors impact on all the GDP distribution levels in the same way, the conclusion is different for the geographic neighbors. Indeed, the richer countries in the conditional income distribution are not sensitive to their geographical position. On the one hand, richer countries produce enough added value to cope with their environment. On the other hand, poor countries have to deal with two problems; first, they have an adverse location and their productivity is affected negatively by their physical neighbors. Second, they do not usually have the required institutional level that can allow them to benefit from their institutional neighbors positive spillover. These results highlight the need to help developing regions rather than developing countries if we are to avoid a counterproductive effect from the neighbors. Moreover, the help that is required at national level would be more effective if it raises the level of the country’s institutions.

The religious and cultural matrices used in this thesis did not really give convincing results. Indeed, they never had a significant impact on the three measures used: growth, productivity and poverty. Chapter 3 investigated potential indirect effects of religion via the institutional impact. From the findings, it appears that religions play a positive role in the level of institutions. However, the link is not yet clear enough to explain how religion affects the neighbors or the institutional level of the countries studied.

The last chapter in the thesis offers a final recommendation for tackling poverty. To increase a region or country’s growth rate or productivity does not necessarily mean that the whole population in the region or country will increase its resources. Therefore, it is also important to focus on redistribution within the different entities. The results in Chapter 4 show that the level of poverty in developing countries, represented by the proportion of individuals living on less than one dollar a day, is impacted by neighborhood spillover as well. On the one hand, neighboring wealth reduces a country’s poverty and, on the other hand, neighboring poverty appears to cross the border. The previous recommendations are therefore backed up in view of this last outcome.

Recommendations for future studies

This thesis investigates the possibility to use other types of distance than physical ones in economic spatial studies. The results led to the conclusion that similar institutional levels are sources of spillover that are comparable to the geographical type of proximity. Whether economist or statistician, the findings suggest that doors are open to further research in this specific field

The first challenge for economists is to deal with the fact that non-physical matrices can be endogenous in the models. Using institutional proximities as a spatial determinant, for instance, could give rise to several problems when estimating growth. In fact, the institution chosen can also explain growth. For instance, North and South Korea evolved in separate ways after opting for different institutions. The same was true for East and West Germany before the unification of the country. Moreover, the level of institutions can change over time. Some countries have to deal with revolutions or critical modifications to their institutions which can also change their relations with other countries. The fall of communism at the end of the 80s changed the institutions in most Eastern European countries, for example.

Economists should be aware of the different dimensions they can take into consideration in their models. Geography is the most obvious and most often used relation between countries. Our thesis shows that other types of proximity such as culture or institution are also sources of spillover. How many other relations are relevant in a study on growth? One can imagine that proximity in public infrastructures could also be a channel of spillover between countries as connections between countries, whether by road, by air, by rail or by sea could all induce spillover.

From our point view, spatial econometrics methods lack a statistical test that can compare the efficiency of weight matrices in a model. Dealing with non-physical proximities justifies the interest of incorporating this kind of tool into a spatial analysis. However, even studies that use physical proximities would need to test the different ways of building a geographical relationship between entities.

Finally, the use of non-physical relations for building the weight matrices raises the issue of the stability of such relations over time. Variables used to compute the relations can change dramatically from one year to another. For instance, the revolutions in the Arabic world in 2011 totally changed the institutional relations in Tunisia, Egypt and Libya, and thus their neighborhood. These changes to the relational dimension over time should be taken into account in a panel study. Unfortunately, to my knowledge, there are as yet no studies on how to integrate a spatial matrix that moves over time. If this could be developed, we could investigate the impact of space movement on an economic model.

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ANNEX 1: Definition and sources of the variables

Variable	Definition	Source
GDP per capita	GDP per capita, PPP (constant 2005 international $)	World Development Indicators 2009
Institutional indicators (perception of interviewees)		Kaufmann et al. (2002)
Voice and accountability	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.	
Political stability	The likelihood that the government will **not** be destabilized or overthrown by unconstitutional or violent means, including politically motivated violence and terrorism.	
Government effectiveness	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	The ability of the government to formulate and implement sound policies and regulations that permits and promotes private sector development.	
Rule of law	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 absence of crime and violence.	
Control of corruption	The extent to which public power is **not** exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.	
Religious indicators		La Porta et al. (1999)
Catholics	Percentage of Catholics in total population	
Muslims	Percentage of Muslims in total population	
Protestants	Percentage of Protestants in total population	
Other religions	Percentage of other religions in total population	

ANNEX 2: Sources of Governance Data[21]

Sources of Governance Data

Source	Publication	Code	Type 1/	Country Coverage 2/	Repre-sentative	1996	1998	2000	2002
Afrobarometer	Afrobarometer Survey	AFR	S	12					x
Business Environment Risk Intelligence	Business Risk Service	BRI	P	50		x	x	x	x
Business Environment Risk Intelligence	Qualitative Risk Measure in Foreign Lending	QLM	P	115	x	x	x	x	x
Columbia University	State Capacity Project	CDU	P	98	x			x	x
Economist Intelligence Unit	Country Risk Service	EIU	P	115	x	x	x	x	x
European Bank for Reconstruction and Development	Transition Report	EBR	P	26		x	x	x	x
Freedom House	Nations in Transition	FHT	P	27		x	x	x	x
Freedom House	Freedom in the World	FRH	P	192	x	x	x	x	x
Gallup International	Gallup Millennium Survey	GMS	S	60				x	
Gallup International	50th Anniversary Survey	GALLUP	S	44			x		
Gallup International	Voice of the People Survey	GAL	S	46					x
Heritage Foundation/Wall Street Journal	Economic Freedom Index	HER	P	161	x	x	x	x	x
Institute for Management and Development	World Competitiveness Yearbook	WCY	S	49		x	x	x	x
Latinobarometro	Latinobarometro Surveys	LBO	S	17		x		x	x
Political Risk Services	International Country Risk Guide	PRS	P	140	x	x	x	x	x
PriceWaterhouseCoopers	Opacity Index	PWC	S	35				x	
Reporters Without Borders	Reporters Without Borders	RSF	P	138	x				x
Global Insight's DRI McGraw-Hill	Country Risk Review	DRI	P	111	x	x	x	x	x
State Department / Amnesty International	Human Rights Report	HUM	P	159	x	x	x	x	x
World Bank	Business Enterprise Environment Survey	BPS	S	18				x	x
World Bank	World Business Environment Survey	WBS	S	81	x		x	x	
World Bank	Country Policy and Institutional Assessments	CPIA	P	136		x	x	x	x
World Economic Forum	Global Competitiveness Report	GCS	S	75		x	x	x	x
World Economic Forum	Africa Competitiveness Report	GCSA	S	23			x		
World Markets Research Center	World Markets Online	WMO	P	186	x				x

1/ P=Poll, S=Survey
2/ Countries included most recently available version of source

ANNEX 3: The five nearest institutional neighbors

Countries	First	Second	Third	Fourth	Fifth
Algeria	Burundi	Rwanda	Cameroon	Pakistan	Nigeria
Argentina	Thailand	Korea, Rep.	Panama	Greece	Jamaica
Australia	Portugal	Ireland	Barbados	Austria	Germany
Austria	Germany	Luxembourg	Sweden	Finland	Netherlands
Bangladesh	Venezuela	Nicaragua	India	Honduras	Dominican Rep.
Barbados	Portugal	France	Australia	Belgium	Ireland
Belgium	United States	France	Luxembourg	Ireland	Barbados
Belize	Mali	Benin	Jamaica	Mauritius	Costa Rica
Benin	Belize	Mali	Jamaica	Panama	Mauritius
Bolivia	Panama	Philippines	Argentina	Thailand	Jamaica
Brazil	Philippines	Dominican Rep.	Mexico	India	Ghana
Burkina Faso	Ghana	Romania	Senegal	Dominican Rep.	Madagascar
Burundi	Rwanda	Nigeria	Cameroon	Algeria	Iran, Islamic Rep.
Cameroon	Nigeria	Chad	Pakistan	Congo	Syrian Arab Rep.
Canada	Finland	Norway	Germany	Sweden	Denmark
Chad	Congo	Kenya	Zimbabwe	Cameroon	Syrian Arab Rep.

[21] Kaufmann, Daniel, Kraay, Aart and Mastruzzi, Massimo,Governance Matters III: Governance Indicators for 1996-2002, World Bank Policy Research Working Paper, p43

Countries	First	Second	Third	Fourth	Fifth
Chile	Hong Kong	Spain	Portugal	Greece	Barbados
China	Indonesia	Cote d'Ivoire	Tunisia	Morocco	Egypt, Arab Rep.
Colombia	Peru	Turkey	Mexico	Sri Lanka	Egypt, Arab Rep.
Comoros	Lesotho	Romania	Madagascar	Mali	Burkina Faso
Congo	Chad	Honduras	Cameroon	Zimbabwe	Bangladesh
Costa Rica	Uruguay	Poland	Mauritius	Italy	Belize
Cote d'Ivoire	Morocco	Tunisia	Ghana	China	Senegal
Denmark	Netherlands	Finland	Norway	Sweden	Luxembourg
Dominican Rep.	Nicaragua	Venezuela	Ecuador	Brazil	Bangladesh
Ecuador	Venezuela	Dominican Rep.	Guinea-Bissau	Nicaragua	Bangladesh
Egypt	Indonesia	Turkey	Morocco	Peru	Colombia
Finland	Sweden	Norway	Germany	Denmark	Netherlands
France	Barbados	Japan	Belgium	Ireland	Australia
Gambia	Niger	Iran	Zimbabwe	Syrian Arab Rep.	Chad
Germany	Austria	Finland	Sweden	Luxembourg	Norway
Ghana	Burkina Faso	Senegal	Guinea-Bissau	Zambia	Brazil
Greece	Italy	Poland	Korea, Rep.	Argentina	Mauritius
Guatemala	Pakistan	India	Colombia	Ecuador	Bangladesh
Guinea-Bissau	Zambia	Ecuador	Venezuela	Honduras	Ghana
Honduras	Venezuela	Guinea-Bissau	Bangladesh	Dominican Rep.	Ecuador
Hong Kong	Chile	Israel	Spain	Greece	Ireland
Iceland	France	Barbados	Japan	Australia	Canada
India	Bangladesh	Brazil	Nicaragua	Ecuador	Venezuela
Indonesia	Egypt, Arab Rep.	China	Morocco	Togo	Colombia
Iran	Chad	Niger	Syrian Arab Rep.	Cameroon	Rwanda
Ireland	United States	Austria	Germany	Australia	Luxembourg
Israel	Hong Kong	Spain	Chile	Greece	Korea, Rep.
Italy	Poland	Greece	Korea, Rep.	Mauritius	Japan
Jamaica	Panama	Argentina	Thailand	Belize	Bolivia
Japan	France	Barbados	Italy	Spain	Iceland
Kenya	Chad	Pakistan	Guinea-Bissau	Honduras	Bangladesh
Korea, Rep.	Greece	Italy	Poland	Thailand	Argentina
Lesotho	Senegal	Romania	Burkina Faso	Nepal	Ghana
Luxembourg	Austria	Germany	United States	Netherlands	Denmark
Madagascar	Romania	Burkina Faso	Dominican Rep.	Mali	Nicaragua
Malaysia	Lesotho	Cote d'Ivoire	Senegal	Comoros	Zimbabwe
Mali	Belize	Romania	Benin	Madagascar	Jamaica
Mauritius	Poland	Italy	Costa Rica	Korea, Rep.	Greece
Mexico	Philippines	Peru	Brazil	Colombia	Turkey
Morocco	Cote d'Ivoire	Egypt, Arab Rep.	Ghana	Indonesia	Mexico
Mozambique	Nepal	Zimbabwe	Senegal	Bangladesh	Congo
Nepal	Mozambique	Senegal	Zimbabwe	Bangladesh	Honduras
Netherlands	Denmark	Sweden	Finland	Norway	Luxembourg
New Zealand	Netherlands	Denmark	Luxembourg	Norway	Finland
Nicaragua	Dominican Rep.	Venezuela	Bangladesh	Ecuador	Brazil

Countries	First	Second	Third	Fourth	Fifth
Niger	Chad	Zimbabwe	Iran	Congo	Gambia
Nigeria	Burundi	Cameroon	Rwanda	Iran	Syrian Arab Rep.
Norway	Sweden	Finland	Denmark	Netherlands	Switzerland
Pakistan	Kenya	Guatemala	Bangladesh	Cameroon	Chad
Panama	Jamaica	Bolivia	Paraguay	Thailand	Argentina
Paraguay	Panama	Philippines	Brazil	Bolivia	Mexico
Peru	Turkey	Mexico	Colombia	India	Egypt, Arab Rep.
Philippines	Brazil	Mexico	Thailand	Bolivia	Panama
Poland	Italy	Greece	Mauritius	Korea, Rep.	Uruguay
Portugal	Australia	Barbados	Ireland	France	Belgium
Romania	Madagascar	Burkina Faso	Mali	Senegal	Ghana
Rwanda	Burundi	Nigeria	Cameroon	Iran	Algeria
Senegal	Nepal	Ghana	Burkina Faso	Bangladesh	Honduras
South Africa	India	Brazil	Philippines	Peru	Korea, Rep.
Spain	France	Japan	Barbados	Belgium	Chile
Sri Lanka	Colombia	Turkey	Peru	Guatemala	Egypt, Arab Rep.
Sweden	Finland	Norway	Germany	Denmark	Netherlands
Switzerland	Sweden	Norway	Finland	Netherlands	Germany
Syria	Chad	Kenya	Iran	Cameroon	Zimbabwe
Thailand	Argentina	Philippines	Korea, Rep.	Panama	Bolivia
Togo	Zambia	Guinea-Bissau	Indonesia	Ghana	Kenya
Tunisia	Cote d'Ivoire	Morocco	China	Indonesia	Thailand
Turkey	Peru	Colombia	Egypt, Arab Rep.	Mexico	Sri Lanka
United Kingdom	Ireland	United States	Denmark	Luxembourg	Germany
United States	Luxembourg	Ireland	Austria	Germany	Belgium
Uruguay	Costa Rica	Poland	Jamaica	Greece	Italy
Venezuela	Ecuador	Bangladesh	Honduras	Nicaragua	Dominican Rep.
Zambia	Guinea-Bissau	Togo	Ghana	Ecuador	Kenya
Zimbabwe	Nepal	Mozambique	Chad	Senegal	Bangladesh

ANNEX 4: The five nearest cultural neighbors

Countries	First	Second	Third	Fourth	Fifth
Algeria	Egypt	Syria	Tunisia	Morocco	Turkey
Argentina	Colombia	Ecuador	Italy	Mexico	Venezuela
Australia	Jamaica	New Zealand	South Africa	United Kingdom	United States
Austria	Germany	Japan	Italy	Switzerland	Brazil
Bangladesh	Malaysia	Nepal	Sri Lanka	Pakistan	Gambia
Barbados	Ghana	Zambia	Zimbabwe	Thailand	Kenya
Belgium	France	Brazil	Luxembourg	Morocco	Colombia
Belize	Bolivia	Dominican Rep.	Guatemala	Nicaragua	Panama
Benin	Togo	Burkina Faso	Cote d'Ivoire	Mauritius	Burundi
Bolivia	Dominican Rep.	Guatemala	Nicaragua	Panama	Colombia
Brazil	Italy	Belgium	Luxembourg	Poland	Colombia

Countries	First	Second	Third	Fourth	Fifth
Burkina Faso	Cote d'Ivoire	Togo	Mali	Niger	Senegal
Burundi	Congo	France	Rwanda	Togo	Mali
Cameroon	Mali	Niger	Senegal	Congo	Cote d'Ivoire
Canada	Lesotho	United States	Jamaica	Australia	Ireland
Chad	Comoros	Mali	Niger	Senegal	Cote d'Ivoire
Chile	Costa Rica	Dominican Rep.	Guatemala	Nicaragua	Panama
China	Hong Kong	Romania	Nepal	Sri Lanka	Greece
Colombia	Ecuador	Mexico	Venezuela	Dominican Rep.	Guatemala
Comoros	Chad	Mali	Niger	Senegal	Cote d'Ivoire
Congo	Burundi	Cameroon	France	Rwanda	Mali
Costa Rica	Chile	Dominican Rep.	Guatemala	Nicaragua	Panama
Cote d'Ivoire	Burkina Faso	Mali	Niger	Senegal	Togo
Denmark	Finland	Iceland	Norway	Sweden	Netherlands
Dominican Rep.	Guatemala	Nicaragua	Panama	Bolivia	Honduras
Ecuador	Mexico	Venezuela	Colombia	Guatemala	Nicaragua
Egypt	Syria	Tunisia	Algeria	Morocco	Turkey
Finland	Iceland	Norway	Denmark	Sweden	Netherlands
France	Belgium	Burundi	Brazil	Luxembourg	Congo
Gambia	Nigeria	Bangladesh	Ghana	Zambia	Zimbabwe
Germany	Austria	Japan	Switzerland	Italy	Lesotho
Ghana	Zambia	Zimbabwe	Barbados	Nigeria	Kenya
Greece	Mozambique	Brazil	Thailand	Nepal	Sri Lanka
Guatemala	Nicaragua	Panama	Bolivia	Dominican Rep.	Honduras
Guinea-Bissau	Indonesia	Mozambique	Burkina Faso	Cote d'Ivoire	Turkey
Honduras	Paraguay	Peru	Nicaragua	Panama	Bolivia
Hong Kong	Nepal	Sri Lanka	China	Malaysia	India
Iceland	Norway	Denmark	Finland	Sweden	Netherlands
India	New Zealand	South Africa	United Kingdom	Nepal	Sri Lanka
Indonesia	Guinea-Bissau	Mozambique	Burkina Faso	Cote d'Ivoire	Malaysia
Iran	Syria	Tunisia	Algeria	Egypt	Chad
Ireland	Lesotho	India	New Zealand	South Africa	United Kingdom
Israel	Thailand	Japan	India	New Zealand	South Africa
Italy	Brazil	Luxembourg	Austria	Spain	Argentina
Jamaica	Australia	New Zealand	South Africa	United Kingdom	United States
Japan	Germany	Austria	Korea, Rep.	Israel	Greece
Kenya	Nepal	Sri Lanka	Thailand	Zambia	Zimbabwe
Korea, Rep.	Japan	Thailand	Romania	Israel	Greece
Lesotho	Ireland	New Zealand	South Africa	United Kingdom	Canada
Luxembourg	Italy	Brazil	Belgium	Austria	Spain
Madagascar	Mauritius	Rwanda	Cameroon	New Zealand	South Africa
Malaysia	Nepal	Sri Lanka	Bangladesh	India	Guinea-Bissau
Mali	Niger	Senegal	Burkina Faso	Cote d'Ivoire	Chad
Mauritius	Rwanda	Madagascar	Togo	Benin	Mozambique
Mexico	Venezuela	Colombia	Ecuador	Nicaragua	Panama
Morocco	Syria	Tunisia	Algeria	Egypt	Belgium

Countries	First	Second	Third	Fourth	Fifth
Mozambique	Guinea-Bissau	Indonesia	Greece	Mauritius	Togo
Nepal	Sri Lanka	Malaysia	India	Thailand	Kenya
Netherlands	Italy	Spain	Portugal	Norway	Denmark
New Zealand	South Africa	United Kingdom	Australia	Jamaica	Lesotho
Nicaragua	Panama	Bolivia	Dominican Rep.	Guatemala	Paraguay
Niger	Senegal	Mali	Burkina Faso	Cote d'Ivoire	Chad
Nigeria	Gambia	Zambia	Zimbabwe	Ghana	Cameroon
Norway	Denmark	Finland	Iceland	Sweden	Netherlands
Pakistan	Bangladesh	Ireland	Malaysia	Lesotho	South Africa
Panama	Bolivia	Dominican Rep.	Guatemala	Nicaragua	Paraguay
Paraguay	Peru	Honduras	Bolivia	Dominican Rep.	Guatemala
Peru	Honduras	Paraguay	Bolivia	Dominican Rep.	Guatemala
Philippines	Honduras	Paraguay	Venezuela	Colombia	Ecuador
Poland	Brazil	Italy	Austria	Belgium	Luxembourg
Portugal	Italy	Honduras	Paraguay	Peru	Spain
Romania	Thailand	Greece	Mozambique	Korea, Rep.	Poland
Rwanda	Mauritius	Burundi	Philippines	Congo	Honduras
Senegal	Mali	Niger	Burkina Faso	Cote d'Ivoire	Chad
South Africa	United Kingdom	New Zealand	Australia	Jamaica	India
Spain	Italy	Argentina	Honduras	Paraguay	Peru
Sri Lanka	Nepal	Malaysia	India	Thailand	Kenya
Sweden	Denmark	Finland	Iceland	Norway	United Kingdom
Switzerland	Germany	Austria	Lesotho	Luxembourg	Canada
Syria	Tunisia	Algeria	Egypt	Morocco	Turkey
Thailand	Nepal	Sri Lanka	Romania	Kenya	Greece
Togo	Benin	Burkina Faso	Cote d'Ivoire	Mauritius	Mozambique
Tunisia	Algeria	Egypt	Syria	Morocco	Turkey
Turkey	Algeria	Egypt	Syria	Brazil	Tunisia
United Kingdom	New Zealand	South Africa	Australia	Jamaica	India
United States	Australia	Jamaica	New Zealand	South Africa	Lesotho
Uruguay	Chile	Costa Rica	Bolivia	Dominican Rep.	Guatemala
Venezuela	Colombia	Ecuador	Mexico	Bolivia	Dominican Rep.
Zambia	Zimbabwe	Ghana	Barbados	Kenya	Nigeria
Zimbabwe	Ghana	Zambia	Barbados	Kenya	Nigeria

ANNEX 5: The governance indicators values

Country Name	Voice	RuleOfLaw	RegQua	PolSta	GovEFF	Corruption
Algeria	-1,36	-1,21	-0,94	-2,44	-0,39	-0,37
Argentina	0,39	0,11	0,79	0,11	0,42	-0,18
Australia	1,34	1,81	1,04	1,10	1,43	1,85
Austria	1,32	1,91	1,16	1,23	2,06	1,98
Bangladesh	-0,23	-0,77	-0,22	-0,89	-0,64	-0,48
Barbados	1,21	-0,24	0,87	1,05	1,45	1,44

Country Name	Voice	RuleOfLaw	RegQua	PolSta	GovEFF	Corruption
Belgium	1,44	1,55	0,97	0,94	2,02	1,40
Belize	0,99	0,79	0,14	0,77	-0,38	-0,09
Benin	0,68	-0,30	0,17	1,05	0,01	-0,75
Bolivia	0,34	-0,29	0,81	-0,16	0,07	-0,94
Brazil	0,18	-0,21	0,31	-0,57	-0,30	-0,18
Burkina Faso	-0,23	-0,31	-0,08	0,04	-0,68	-0,33
Burundi	-1,54	-0,88	-1,55	-2,00	-0,97	-1,30
Cameroon	-1,24	-1,50	-0,79	-1,35	-1,17	-1,15
Canada	1,48	1,76	0,92	0,94	2,07	2,22
Chad	-0,90	-0,88	-0,96	-0,74	-0,65	-1,00
Chile	0,77	1,22	1,29	0,44	0,96	1,29
China	-1,66	-0,25	0,15	-0,26	0,14	-0,15
Colombia	-0,43	-0,47	0,52	-1,42	0,25	-0,52
Comoros	-0,04	-1,28	-0,82	1,05	-0,71	-1,23
Congo	-0,47	-1,38	-0,90	-0,83	-1,22	-0,87
Costa Rica	1,13	0,57	0,62	0,84	-0,01	0,73
Cote d'Ivoire	-0,79	-0,69	-0,04	-0,14	0,08	0,38
Denmark	1,46	1,87	1,22	1,03	2,16	2,29
Dominican Republic	0,23	-0,56	0,00	-0,48	-0,78	-0,37
Ecuador	0,14	-0,42	0,16	-0,85	-0,90	-0,83
Egypt, Arab Rep.	-1,04	0,08	0,24	-1,27	-0,03	0,06
Finland	1,39	1,90	1,09	1,19	2,12	2,30
France	1,01	1,47	0,76	0,91	1,77	1,45
Gambia	-1,30	0,40	-1,77	0,11	-0,38	0,37
Germany	1,28	1,79	1,08	1,14	2,08	2,09
Ghana	-0,29	-0,39	0,11	-0,18	-0,37	-0,50
Greece	0,72	0,94	0,74	0,37	0,83	0,38
Guatemala	-0,21	-0,92	0,16	-1,61	-0,48	-1,03
Guinea-Bissau	-0,32	-1,68	0,13	-0,59	-0,63	-1,04
Honduras	-0,13	-0,75	-0,36	-0,46	-0,82	-1,03
Hong Kong, China	0,21	1,14	1,54	-0,01	1,20	1,52
Iceland	1,33	1,64	0,35	1,07	1,52	1,82
India	0,12	0,29	-0,01	-1,12	-0,20	-0,36
Indonesia	-1,17	-0,37	0,35	-0,81	0,14	-0,55
Iran, Islamic Rep.	-1,35	-0,98	-1,72	-0,69	-0,75	-0,91
Ireland	1,19	1,71	1,23	0,97	1,78	1,85
Israel	0,80	1,22	1,01	-0,68	1,31	1,47
Italy	0,90	0,98	0,64	0,54	0,96	0,49
Jamaica	0,78	-0,30	0,61	0,25	-0,22	-0,37
Japan	0,87	1,53	0,50	0,90	1,38	1,14
Kenya	-0,82	-1,06	-0,36	-0,67	-0,26	-1,11
Korea, Rep.	0,50	0,70	0,46	0,15	0,92	0,32
Lesotho	-0,21	-0,30	-0,62	0,56	0,14	-0,21
Luxembourg	1,38	1,61	1,20	1,08	2,20	1,95
Madagascar	0,38	-0,97	-0,52	0,08	-0,97	-0,37

Country Name	Voice	RuleOfLaw	RegQua	PolSta	GovEFF	Corruption
Malaysia	-0,31	0,80	-0,68	0,64	0,88	0,49
Mali	0,71	-0,60	-0,01	0,60	-0,69	-0,33
Mauritius	0,85	0,76	0,12	0,70	0,47	0,45
Mexico	-0,16	-0,51	0,64	-0,82	-0,04	-0,39
Morocco	-0,63	0,12	0,15	-0,61	-0,05	0,22
Mozambique	0,05	-0,90	-1,00	-0,83	-0,27	-0,39
Nepal	-0,06	-0,15	-0,72	-0,55	-0,25	-0,31
Netherlands	1,45	1,81	1,30	1,23	2,21	2,22
New Zealand	1,59	1,97	1,58	1,09	2,20	2,29
Nicaragua	0,17	-0,33	-0,17	-0,68	-0,92	-0,21
Niger	-1,00	-0,89	-1,19	-0,03	-1,07	-0,33
Nigeria	-1,82	-1,35	-1,13	-1,63	-1,36	-1,25
Norway	1,51	2,03	1,07	1,22	2,19	2,30
Pakistan	-0,71	-0,59	-0,38	-1,45	-0,52	-1,04
Panama	0,24	-0,15	0,61	0,21	-0,29	-0,52
Paraguay	0,06	-0,46	0,83	-0,26	-0,77	-0,52
Peru	-0,27	-0,58	0,57	-1,28	-0,17	-0,14
Philippines	0,17	-0,02	0,53	-0,49	-0,02	-0,27
Poland	0,98	0,64	0,62	0,55	0,77	0,39
Portugal	1,27	1,14	1,03	1,06	1,06	1,57
Romania	0,18	-0,15	-0,24	0,39	-0,69	-0,24
Rwanda	-1,33	-1,45	-1,79	-2,00	-1,24	-0,87
Senegal	-0,12	-0,39	-0,36	-0,26	-0,16	-0,42
South Africa	0,80	0,26	0,04	-1,24	0,42	0,62
Spain	1,15	1,35	0,88	0,34	1,57	1,08
Sri Lanka	-0,24	-0,12	0,46	-2,10	0,44	-0,27
Sweden	1,42	1,84	1,08	1,24	2,14	2,27
Switzerland	1,39	2,08	1,09	1,37	2,43	2,20
Syrian Arab Rep.	-1,61	-0,49	-0,91	-0,82	-0,15	-0,79
Thailand	0,29	0,58	0,45	0,05	0,46	-0,31
Togo	-1,04	-1,36	0,58	-0,54	-0,68	-1,04
Tunisia	-0,85	-0,20	0,56	0,16	0,51	-0,10
Turkey	-0,44	-0,01	0,54	-1,48	-0,14	0,01
United Kingdom	1,02	1,83	1,48	0,93	2,03	2,21
United States	1,29	1,75	1,26	0,94	2,15	1,75
Uruguay	0,94	0,56	0,86	0,68	-0,08	0,43
Venezuela	0,08	-0,68	-0,10	-0,83	-0,93	-0,83
Zambia	-0,55	-0,60	0,34	-0,51	-0,59	-1,04
Zimbabwe	-0,63	-0,69	-0,81	-0,60	-0,36	-0,17

ANNEX 6: The religions of the countries

Country Name	Catholic	Muslim	Prtotestant	Other
Algeria	0	1	0	0
Argentina	1	0	0	0
Australia	0	0	1	1
Austria	1	0	0	0
Bangladesh	0	1	0	0
Barbados	0	0	1	1
Belgium	1	0	0	0
Belize	1	0	0	0
Benin	0	0	0	1
Bolivia	1	0	0	0
Brazil	1	0	0	0
Burkina Faso	0	1	0	1
Burundi	1	0	0	0
Cameroon	0	1	1	0
Canada	1	0	1	0
Chad	0	1	0	0
Chile	1	0	0	0
China	0	0	0	1
Colombia	1	0	0	0
Comoros	0	1	0	0
Congo	1	0	1	0
Costa Rica	1	0	0	0
Cote d'Ivoire	0	1	0	1
Denmark	0	0	1	0
Dominican Republic	1	0	0	0
Ecuador	1	0	0	0
Egypt, Arab Rep.	0	1	0	0
Finland	0	0	1	0
France	1	0	0	0
Gambia	0	1	0	0
Germany	0	0	1	0
Ghana	0	0	1	1
Greece	0	0	0	1
Guatemala	1	0	0	0
Guinea-Bissau	0	1	0	1
Honduras	1	0	0	0
Hong Kong, China	0	0	0	1
Iceland	0	0	1	0
India	0	0	0	1
Indonesia	0	1	0	1
Iran, Islamic Rep.	0	1	0	0
Ireland	1	0	0	0
Israel	0	0	0	1

Country Name	Catholic	Muslim	Prtotestant	Other
Italy	1	0	0	0
Jamaica	0	0	1	1
Japan	0	0	0	1
Kenya	0	0	1	1
Korea, Rep.	0	0	0	1
Lesotho	1	0	1	0
Luxembourg	1	0	0	0
Madagascar	0	0	1	1
Malaysia	0	1	0	1
Mali	0	1	0	0
Mauritius	0	0	0	1
Mexico	1	0	0	0
Morocco	0	1	0	0
Mozambique	0	0	0	1
Nepal	0	0	0	1
Netherlands	1	0	1	0
New Zealand	0	0	1	1
Nicaragua	1	0	0	0
Niger	0	1	0	0
Nigeria	0	1	1	0
Norway	0	0	1	0
Pakistan	0	1	0	0
Panama	1	0	0	0
Paraguay	1	0	0	0
Peru	1	0	0	0
Philippines	1	0	0	0
Poland	1	0	0	0
Portugal	1	0	0	0
Romania	0	0	0	1
Rwanda	1	0	0	0
Senegal	0	1	0	0
South Africa	0	0	1	1
Spain	1	0	0	0
Sri Lanka	0	0	0	1
Sweden	0	0	1	1
Switzerland	1	0	1	0
Syrian Arab Republic	0	1	0	0
Thailand	0	0	0	1
Togo	0	0	0	1
Tunisia	0	1	0	0
Turkey	0	1	0	0
United Kingdom	0	0	1	1
United States	0	0	1	0
Uruguay	1	0	0	1
Venezuela	1	0	0	0

Country Name	Catholic	Muslim	Prtotestant	Other
Zambia	0	0	1	1
Zimbabwe	0	0	1	1

ANNEX 7: The languages of the countries

Country Name	English	Arabic	Chinese	Spanish	French	Russiane	Other
Algeria	0	1	0	0	0	0	0
Argentina	0	0	0	1	0	0	0
Australia	1	0	0	0	0	0	0
Austria	0	0	0	0	0	0	1
Bangladesh	0	0	0	0	0	0	1
Barbados	1	0	0	0	0	0	0
Belgium	0	0	0	0	1	0	0
Belize	1	0	0	1	0	0	0
Benin	0	0	0	0	1	0	0
Bolivia	0	0	0	1	0	0	0
Brazil	0	0	0	0	0	0	1
Burkina Faso	0	0	0	0	1	0	0
Burundi	0	0	0	0	1	0	0
Cameroon	1	0	0	0	1	0	0
Canada	1	0	0	0	1	0	0
Chad	0	1	0	0	1	0	0
Chile	0	0	0	1	0	0	0
China	0	0	1	0	0	0	0
Colombia	0	0	0	1	0	0	0
Comoros	0	1	0	0	1	0	0
Congo	0	0	0	0	1	0	0
Costa Rica	0	0	0	1	0	0	0
Cote d'Ivoire	0	0	0	0	1	0	0
Denmark	0	0	0	0	0	0	1
Dominican Republic	0	0	0	1	0	0	0
Ecuador	0	0	0	1	0	0	0
Egypt, Arab Rep.	0	1	0	0	0	0	0
Finland	0	0	0	0	0	0	1
France	0	0	0	0	1	0	0
Gambia	1	0	0	0	0	0	0
Germany	0	0	0	0	0	0	1
Ghana	1	0	0	0	0	0	0
Greece	0	0	0	0	0	0	1
Guatemala	0	0	0	1	0	0	0
Guinea-Bissau	0	0	0	0	0	0	1
Honduras	0	0	0	1	0	0	1
Hong Kong, China	0	0	1	0	0	0	0
Iceland	0	0	0	0	0	0	1

Country Name	English	Arabic	Chinese	Spanish	French	Russiane	Other
India	1	0	0	0	0	0	1
Indonesia	0	0	0	0	0	0	1
Iran, Islamic Rep.	0	1	0	0	0	0	0
Ireland	1	0	0	0	0	0	1
Israel	0	1	0	0	0	0	1
Italy	0	0	0	0	0	0	1
Jamaica	1	0	0	0	0	0	0
Japan	0	0	0	0	0	0	1
Kenya	0	0	0	0	0	0	1
Korea, Rep.	0	0	0	0	0	0	1
Lesotho	1	0	0	0	0	0	1
Luxembourg	0	0	0	0	1	0	1
Madagascar	1	0	0	0	1	0	1
Malaysia	0	0	0	0	0	0	1
Mali	0	0	0	0	1	0	0
Mauritius	1	0	0	0	1	0	1
Mexico	0	0	0	1	0	0	0
Morocco	0	1	0	0	1	0	0
Mozambique	0	0	0	0	0	0	1
Nepal	0	0	0	0	0	0	1
Netherlands	0	0	0	0	0	0	1
New Zealand	1	0	0	0	0	0	1
Nicaragua	0	0	0	1	0	0	0
Niger	0	0	0	0	1	0	0
Nigeria	1	0	0	0	0	0	0
Norway	0	0	0	0	0	0	1
Pakistan	1	0	0	0	0	0	1
Panama	0	0	0	1	0	0	0
Paraguay	0	0	0	1	0	0	1
Peru	0	0	0	1	0	0	1
Philippines	1	0	0	1	0	0	1
Poland	0	0	0	0	0	0	1
Portugal	0	0	0	0	0	0	1
Romania	0	0	0	0	0	0	1
Rwanda	1	0	0	0	1	0	1
Senegal	0	0	0	0	1	0	0
South Africa	1	0	0	0	0	0	1
Spain	0	0	0	1	0	0	1
Sri Lanka	0	0	0	0	0	0	1
Sweden	0	0	0	0	0	0	1
Switzerland	0	0	0	0	1	0	1
Syrian Arab Republic	0	1	0	0	0	0	0
Thailand	0	0	0	0	0	0	1
Togo	0	0	0	0	1	0	0
Tunisia	0	1	0	0	0	0	0

Country Name	English	Arabic	Chinese	Spanish	French	Russiane	Other
Turkey	0	0	0	0	0	0	1
United Kingdom	1	0	0	0	0	0	1
United States	1	0	0	0	0	0	0
Uruguay	0	0	0	1	0	0	0
Venezuela	0	0	0	1	0	0	0
Zambia	1	0	0	0	0	0	0
Zimbabwe	1	0	0	0	0	0	0

ANNEX 8: The origin of law of the countries

Country Name	British	French	Socialist	German	Scandivanian
Algeria	0	1	0	0	0
Argentina	0	1	0	0	0
Australia	1	0	0	0	0
Austria	0	0	0	1	0
Bangladesh	1	0	0	0	0
Barbados	1	0	0	0	0
Belgium	0	1	0	0	0
Belize	1	0	0	0	0
Benin	0	1	0	0	0
Bolivia	0	1	0	0	0
Brazil	0	1	0	0	0
Burkina Faso	0	1	0	0	0
Burundi	0	1	0	0	0
Cameroon	0	1	0	0	0
Canada	1	0	0	0	0
Chad	0	1	0	0	0
Chile	0	1	0	0	0
China	0	0	1	0	0
Colombia	0	1	0	0	0
Comoros	0	1	0	0	0
Congo	0	1	0	0	0
Costa Rica	0	1	0	0	0
Cote d'Ivoire	0	1	0	0	0
Denmark	0	0	0	0	1
Dominican Republic	0	1	0	0	0
Ecuador	0	1	0	0	0
Egypt, Arab Rep.	0	1	0	0	0
Finland	0	0	0	0	1
France	0	1	0	0	0
Gambia	1	0	0	0	0
Germany	0	0	0	1	0
Ghana	1	0	0	0	0
Greece	0	1	0	0	0

Country Name	British	French	Socialist	German	Scandivanian
Guatemala	0	1	0	0	0
Guinea-Bissau	0	1	0	0	0
Honduras	0	1	0	0	0
Hong Kong, China	1	0	0	0	0
Iceland	0	0	0	0	1
India	1	0	0	0	0
Indonesia	0	1	0	0	0
Iran, Islamic Rep.	0	1	0	0	0
Ireland	1	0	0	0	0
Israel	1	0	0	0	0
Italy	0	1	0	0	0
Jamaica	1	0	0	0	0
Japan	0	0	0	1	0
Kenya	1	0	0	0	0
Korea, Rep.	0	0	0	1	0
Lesotho	1	0	0	0	0
Luxembourg	0	1	0	0	0
Madagascar	0	1	0	0	0
Malaysia	1	0	0	0	0
Mali	0	1	0	0	0
Mauritius	0	1	0	0	0
Mexico	0	1	0	0	0
Morocco	0	1	0	0	0
Mozambique	0	1	0	0	0
Nepal	1	0	0	0	0
Netherlands	0	1	0	0	0
New Zealand	1	0	0	0	0
Nicaragua	0	1	0	0	0
Niger	0	1	0	0	0
Nigeria	1	0	0	0	0
Norway	0	0	0	0	1
Pakistan	1	0	0	0	0
Panama	0	1	0	0	0
Paraguay	0	1	0	0	0
Peru	0	1	0	0	0
Philippines	0	1	0	0	0
Poland	0	0	1	0	0
Portugal	0	1	0	0	0
Romania	0	0	1	0	0
Rwanda	0	1	0	0	0
Senegal	0	1	0	0	0
South Africa	1	0	0	0	0
Spain	0	1	0	0	0
Sri Lanka	1	0	0	0	0
Sweden	0	0	0	0	1

Switzerland	0	0	0	1	0
Syrian Arab Republic	0	1	0	0	0
Thailand	1	0	0	0	0
Togo	0	1	0	0	0
Tunisia	0	1	0	0	0
Turkey	0	1	0	0	0
United Kingdom	1	0	0	0	0
United States	1	0	0	0	0
Uruguay	0	1	0	0	0
Venezuela	0	1	0	0	0
Zambia	1	0	0	0	0
Zimbabwe	1	0	0	0	0

ANNEX 9: The Hofstede's dimension of the countries

Country Name	Power distance	Individualism	Masculinity	Uncertainty Av.
Algeria	1	1	1	1
Argentina	0	1	1	1
Australia	0	1	1	0
Austria	0	1	1	1
Bangladesh	1	0	1	0
Barbados	1	0	0	1
Belgium	1	1	1	1
Belize	1	0	0	1
Benin	1	0	0	0
Bolivia	1	0	0	1
Brazil	1	1	1	1
Burkina Faso	1	0	0	0
Burundi	1	0	0	0
Cameroon	1	0	0	0
Canada	0	1	1	0
Chad	1	0	0	0
Chile	0	0	0	1
China	1	0	1	0
Colombia	1	0	1	1
Comoros	1	0	0	0
Congo	1	0	0	0
Costa Rica	0	0	0	1
Cote d'Ivoire	1	0	0	0
Denmark	0	1	0	0
Dominican Republic	1	0	0	1
Ecuador	1	0	1	1
Egypt, Arab Rep.	1	1	1	1
Finland	0	1	0	0
France	1	1	0	1

Country Name	Power distance	Individualism	Masculinity	Uncertainty Av.
Gambia	1	0	0	0
Germany	0	1	1	1
Ghana	1	0	0	0
Greece	1	0	1	1
Guatemala	1	0	0	1
Guinea-Bissau	1	0	0	0
Honduras	1	0	0	1
Hong Kong, China	1	0	1	0
Iceland	0	1	0	0
India	1	1	1	0
Indonesia	1	0	0	0
Iran, Islamic Rep.	0	1	0	0
Ireland	0	1	1	0
Israel	0	1	0	1
Italy	0	1	1	1
Jamaica	0	1	1	0
Japan	0	1	1	1
Kenya	1	0	0	0
Korea, Rep.	0	0	0	1
Lesotho	0	1	1	0
Luxembourg	0	1	1	1
Madagascar	0	0	0	0
Malaysia	1	0	1	0
Mali	1	0	0	0
Mauritius	1	0	0	0
Mexico	1	0	1	1
Morocco	1	1	1	1
Mozambique	1	0	0	0
Nepal	1	0	1	0
Netherlands	0	1	0	0
New Zealand	0	1	1	0
Nicaragua	1	0	0	1
Niger	1	0	0	0
Nigeria	1	0	0	0
Norway	0	1	0	0
Pakistan	0	0	1	1
Panama	1	0	0	1
Paraguay	1	0	0	1
Peru	1	0	0	1
Philippines	1	0	1	0
Poland	1	1	1	1
Portugal	0	0	0	1
Romania	1	0	0	1
Rwanda	1	0	0	0
Senegal	1	0	0	0

Country Name	Power distance	Individualism	Masculinity	Uncertainty Av.
South Africa	0	1	1	0
Spain	0	1	0	1
Sri Lanka	1	0	1	0
Sweden	0	1	0	0
Switzerland	0	1	1	0
Syrian Arab Republic	1	1	1	1
Thailand	1	0	0	1
Togo	1	0	0	0
Tunisia	1	1	1	1
Turkey	1	1	0	1
United Kingdom	0	1	1	0
United States	0	1	1	0
Uruguay	0	0	0	1
Venezuela	1	0	1	1
Zambia	1	0	0	0
Zimbabwe	1	0	0	0

ANNEX 10: from equation 5 to equation 6 in chapter 2

If $\gamma \neq 0$ and if $1/\gamma$ is not an eigenvalue:

$$A = (I - \gamma W)^{-1}\Omega + \phi_1 (I - \gamma W)^{-1} k + \phi_2 (I - \gamma W)^{-1} h \tag{5}$$

Where the variables are taken in logarithms and written in matrix form.

The Neumann development for matrix inversion gives the following expression:

$$B^{-1} = \sum_{i=0}^{\infty} (I - B)^i .$$

In our case:

$$(I - \gamma W)^{-1} = \sum_{i=0}^{\infty} \big(I - (I - \gamma W)\big)^i = \sum_{i=0}^{\infty} (\gamma W)^i = (\gamma W)^0 + \sum_{i=1}^{\infty} (\gamma W)^i$$
$$= 1 + \sum_{i=1}^{\infty} (\gamma W)^i$$

Hence:

$$A = \left(1 + \sum_{i=1}^{\infty} (\gamma W)^i\right)\Omega + \phi_1 \left(1 + \sum_{i=1}^{\infty} (\gamma W)^i\right) k + \phi_2 \left(1 + \sum_{i=1}^{\infty} (\gamma W)^i\right) h$$

And

$$A = \Omega + \left(\sum_{i=1}^{\infty} (\gamma W)^i\right)\Omega + \phi_1 k + \phi_1 \left(\sum_{i=1}^{\infty} (\gamma W)^i\right) k + \phi_2 h + \phi_2 \left(\sum_{i=1}^{\infty} (\gamma W)^i\right) h$$

For a country i, we can write the expression without the matrix forms and the logarithms:

$$A_{i,t} = \Omega_{\mathrm{t}}\ \Omega_{\mathrm{t}}^{\sum_{r=1}^{\infty}\gamma^{r}w_{ij}^{r}} k_{i,t}^{\phi_1} k_{i,t}^{\phi_1\sum_{r=1}^{\infty}\gamma^{r}w_{ij}^{r}} h_{i,t}^{\phi_2} h_{i,t}^{\phi_2\sum_{r=1}^{\infty}\gamma^{r}w_{ij}^{r}}$$

And finally:

$$A_{i,t} = \Omega_{\mathrm{t}}^{\frac{1}{1-\gamma}} k_{i,t}^{\phi_1} h_{i,t}^{\phi_2} \prod_{i\neq j}^{N} k_{j,t}^{\phi_1\sum_{r=1}^{\infty}\gamma^{r}w_{ij}^{(r)}}\ h_{j,t}^{\phi_2\sum_{r=1}^{\infty}\gamma^{r}w_{ij}^{(r)}} \tag{6}$$