Growth Spillovers

by Rabia Ikram

GROWTH SPILLOVERS: SEPARATING THE IMPACT OF CULTURAL DISTANCE FROM GEOGRAPHIC DISTANCE

By

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ABSTRACT

While recent advances in communications technology have effectively reduced the physical distance that knowledge and innovations have to travel between countries, cultural differences between countries still limit the ease with which innovations are transferred and adapted. So, countries with common cultural or linguistic characteristics can share technology and innovations more easily. The original contribution of this thesis is that it separates out the impact of cultural spillovers from geographic spillovers using the data on bilateral genetic distance used by Spolaore and Wacziarg (2009). The analysis finds that greater growth spillovers occur between countries that are geographically closer and also between countries that are culturally similar. Moreover, even after controlling for geographic location, common colony and language, trade weighted spillovers and relative size of the economies, the results remained unchanged. Also, the results show that there are greater growth spillovers between countries that have greater bilateral trust, even when one controls for the bilateral geographic distance.

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1. Introduction

Determining reasons for different rates of economic growth across countries has always been an important area of research. Earlier models of economic growth that included the neoclassical and endogenous growth model explained per capita growth rates across countries by focusing on the stock of human and physical capital along with distance from steady state as implied by the standard production function. On the empirical front, these growth comparisons failed to incorporate the spatial growth factors that result from the spillover effects and linkages between different nations. The reason why these spatial growth factors are important is because of the interdependence of nations as well as the recent phenomenon of globalization causing growth to spillover from one region to another. So growth in Japan boosts growth in Korea and growth in the US spurs growth in Mexico. These growth spillovers vary from knowledge spillovers, technological spillovers, and neighborhood, regional, political, economic to social spillovers. However, it is important to note that these spillover effects are primarily the result of spatial factors across nations.

Spatial factors can be absolute, pertaining to the point of location of a country, or relative, which incorporate the relative geographical distance of one country from another[1]. This study will focus on relative factors to explain the differences in growth rates between countries. Also, there is ample evidence present in the literature that explain channels of growth resulting through the relative factors. In this regards, the impact of spillovers has focused on countries that are either geographically close to

[1] See Table 1 in Appendices for the different channels and measures through which absolute location and relative location matters for growth.

each other or are in the neighborhood of the other country. For example, a country geographically close to a country that is a technology leader will have a faster pace of technology diffusion than a country which is further away from a technologically advanced nation. This is because local conditions tend to be similar across closely located nations, which may result in lower institutional and legal costs if technologies have to be transferred from one nation to the other. Technological diffusion further induces higher international trade and foreign direct investment in a country that in return leads to greater economic growth. In particular, the recent research has looked at how technological transfers from a high technology to a lower technology country can lead to growth spillovers as well as looking at what are the economic links between countries that aid in these technological transfers. The economic linkages across countries range from production externalities across regions to the impact of ethnic and social networks on trade. This research combines various strands to see how economic growth can spill over between countries that are separated both geographically and culturally.

Considering the existence of various economic linkages, geography still holds importance. As, before the advent of modern technology, innovative ideas impacting growth have traveled across borders with the physical movement of people and goods. Thus it made sense that innovations spilled over between neighboring countries or countries that were linked in terms of migration and trade. More recently, advances in communications technology have reduced the need for physical movements in the spread of innovation, since ideas can be easily transmitted vast distances. But even in this modern era of near instantaneous transfers of information, distance still plays a role: Countries that are physically closer tend to have closer historical links and share common geographic characteristics which means that spillovers in terms of innovations can be more easily transferred, absorbed and adapted. So, an innovation that takes place in the U.S. can be more easily absorbed in Canada than in Ghana.

The spillovers are not only confined to generate positive outcomes for economies, since certain linkages can also induce negative shocks that retard the growth process of different nations. Easterly and Levine (1998) explain such negative shocks through the neighborhood spillover effect, where "deteriorating economies accompanied by deteriorating infrastructure" makes it difficult for landlocked neighborhood countries(e.g. Zambia and Burundi) to trade with other nations, since these landlocked countries need to use roads and railways to reach ocean ports. Consequently, these countries have to bear high transportation costs that make tradable goods expensive and less competitive. Considering the above mentioned empirical examples, geographical distance does matter for the rate of growth across nations, which has also been proven by the research findings of Moreno and Trehan (1997), who conclude that country's long term economic growth is highly dependent on the growth rate of neighboring countries.

Despite the important role played by geographical distance in the determination of cross country variations in growth, this research paper takes a different approach to this variation where cultural distance also plays an important role. Countries with common ethnic or cultural characteristics (even if they are separated by significant distances) can transfer innovations more easily, because of common languages, common business practices, common areas of economic interest, and similar institutions. Obviously, countries that are closer geographically may tend to also be closer ethnically or culturally, but research has shown that migration has led to many countries being relatively close ethnically or culturally, but significantly separated geographically. So countries that are quite distant geographically can still be relatively close culturally. This is the idea behind this research: Is it possible to separate out the growth spillovers which occur due to physical proximity from the growth spillovers that occur from cultural and linguistic proximity?

In order to incorporate the impact of cultural distance, genetic distance is used as a proxy in our case. Where, genetic distance measures the difference in gene distribution between two populations, i.e. it takes into account the time since two populations began to diverge genetically. Intuitively it reflects the idea of a relationship that two nations are likely to share. The genetic similarities between nations are transferred from generation to generation. Genetic distance in itself comprises various characteristics, which could be sharing similar values, speaking the same language, being culturally alike and having the same norms, beliefs, conventions and traditions (Spolaore and Wacziarg 2009). All of these similarities might make some countries act in similar way in the formulation of their economic policies, introducing new strategies and adapting new reforms. Since the kinship of being alike genetically (culturally) will make the entire learning process much easier for a country, nations can easily benefit from other nations in terms of transfer of technology, knowledge, and superior economic policies regarding development of social sectors. Also, culturally similar countries can increase trust between inhabitants, thus promoting trade and investment and reducing the cost of doing business. If this is the case, the growth rates of these nations tend to be positively correlated.

By relating both geographical and genetic variables to growth rate, this thesis aims to extend the research done by Moreno and Trehan (1997) and Spolaore and Wacziarg (2009), using the set of genetic data by Spolaore and Wacziarg (2009) and geographical data from CEPII (Centre d'Etudes Prospective set d'Informations Internationales: Institute for Research on the International Economy) data series. Attempt to explaining the variations in growth rates between countries by using both genetic and geographic distance as explanatory variables is a key factor that distinguishes this study from previous ones. The importance of genetic distance has been tested by Guiso et al. (2009), where he states that “although genetic distance, geography, language and other vertically transmitted characteristics are interlinked; this does not imply that genetic distance alone cannot explain economic outcomes”. Moreover, an original contribution of this thesis is that here we are analyzing the relative genetic and geographical distance weighted growth in various empirical growth specifications. Additionally, the institutional quality variable (as measured by corruption perception index) is also included as an explanatory variable.[2] Various studies such as Naci (2004) and Pierre-Guillaume and Sekkat (2004) has used corruption perception index to measure institutional quality.

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[2] The importance of institutional quality variable in growth regressions has been discussed by Rodrik et al 2002, Easterly and Levine 2002 and Dollar and Kraay 2002.

The setup of the thesis is as follows: Chapter II reviews some of the literature on growth spillovers and Chapter III investigates the link between genetic distance and cultural, linguistic and geographic distances. Chapter IV develops the theoretical framework and estimation strategy for geographic and genetic distance weighted growth spillovers, while Chapter V discusses the basic spillovers model and discusses the empirical results from that model. Chapter VI estimates a variation of the spillovers model in which the size of economies is taken into account. Chapter VII estimates a model of trust weighted spillovers between European countries and Chapter VIII presents the conclusions.

2. Literature Review

There exists a large amount of empirical literature that explains determinants of economic growth[3]. One of these determinants is institutional quality which plays a vital role in determining variations in growth rates across various economies. The literature shows that countries that have poor institutions have bad economic policies as well as low economic growth as compare to economies that have strong institutions (Acemoglu et al. 2001). On the other hand, countries with better institutions tend to trade more and grow faster (Dollar and Kraay 2002). Similarly, once institutions are controlled for in growth regressions, geographical as well as trade variables becomes insignificant, although trade itself has a positive impact on institutions (Rodrik et al. 2002).

Moreover, over the last few decades, there have been numerous studies looking at how cross-country linkages have had an impact on economic growth. A well-explored channel of linkages is the impact of foreign R&D investments among trading partners (Coe and Helpman, 1995, Park, 1995). This literature has focused on how R&D investments in foreign countries embodied in traded goods are the main channel for technological diffusion. But eventually, the literature (Keller, 2002) found that the channel for technology diffusion is far wider than R&D spillovers only.

More recently, the literature on growth spillovers from geographic proximity has focused on regional externalities using spatial econometrics to measure the degree

[3] The focus of this research is to look at the effect of institutions, geography and culture on economic growth. Where institutions and geography are referred as the "deeper" determinants of economic growth in Rodrik et al. (2002).

of economic spillovers across national borders. Moreno and Trehan (1997) discussed the issue of location and growth. The authors' findings are based on the idea that a country's long-term growth rate is significantly dependent on the growth rate of countries nearby. Considering that spillovers can occur in various ways across countries, the authors have analyzed various aspects of these linkages through alternative specifications using a maximum likelihood estimation. The research findings suggest that "growth rates of countries located close by are more reliable predictors of a given country's growth rate" (Moreno and Trehan 1997, p23). In addition to this, they found no evidence of regional convergence levels; however, they found a high correlation between investment and the market size variable "implying that countries near large markets tend to invest higher proportion of their outputs"(p22). The cross-country spillover effect has also been analyzed by Conley and Ligon (2002), who accounted for economic interdependence amongst nations by decomposing the spatial covariance function of growth rates of a country into observable factors, unobservable factors and cross-country spillovers. Analyzing the relationship between economic distance and cross-country spillovers, they found spillovers to be very significant in explaining variations in growth rates. In similar context Vaya et al. (2004) has also found a significant impact of 'distance' on long term growth rates.

In order to test regional convergence, Rey and Montouri (1999) have performed a similar analysis for US regional income convergence. They found that "shocks originating in one state can spillover into surrounding states, potentially complicating the transitional dynamics of the converging process." This means any particular state, region or neighborhood, cannot operate in isolation; what happens nearby is also transmitted to other regions through positive or negative shocks. One such example explaining the negative spillover effect has been discussed by Behar (2008) where he mentions that election-related instability in Kenya not only affected its own growth but also the growth rate of its bordering country, Uganda. This example illustrates the concept of spillovers that are transferred through border effects[4].

Apart from this border effect, the spillovers can occur in terms of regional, continental and world effects. There is ample evidence regarding regional externalities in terms of policy imitation and their outcomes. One example comes from the experience of Latin American countries, which copied each others' import substitution policies in the 1960's, copied each other debt investment expansion in the 1970's and all experienced macroeconomic adjustments in the 1980's (Easterly and Levine, 1997). However, in order to investigate whether neighborhood effects are more significant than regional or world effects, Behar (2008) extends the idea of Moreno and Trehan (1997) and tests neighborhood, regional and world effects for a panel data of 134 countries for 25 years. He found that neighborhood effects were significantly higher than regional and border effects (Fingleton and Bazo (2004) has also found similar results). His continent wise analysis yielded some interesting results; Asia and America have high neighborhood effects, while Europe and Africa

[4] Chatterji and Dewhurst (1996) examined the movements in the gross domestic product (GDP) per capita of English and Welsh counties and Scottish regions to check whether the counties and regions are converging in terms of GDP per capita. The authors found no evidence of convergence over the whole period while some evidence of convergence exists within certain sub-periods.

exhibited large regional effects. Also, bilateral exports and investment proved to be a large source of spillovers whether they were neighborhood, regional or world effects. His results for Africa showed that these countries are more vulnerable to large negative shocks from their neighborhood economies as compared to positive ones, similar to the results of Easterly and Levine (1998).

Explaining the neighborhood effect across countries, Easterly and Levine (1998) discuss how nations try to imitate the policies of the governments in their neighborhood. While some governments formulate sound policies to accelerate growth, other nations tend to copy them in order to also increase growth. However, these policies can have favorable as well as unfavorable outcomes for these nations. In the case of East Asian economies, positive economic policies spilled over to neighboring countries, while in the case of Africa bad policies spilled over due to neighboring countries.

Abreu, Groot and Florax (2004) provide an overview of the empirical literature on the role of absolute as well as relative location in explaining variations in economic growth. Other papers that have highlighted the importance of relative location included studies by Easterly and Levine (2003) and Lopez-Bazo et al. (2004). Easterly and Levine (2003) found that if one country acts to improve a variable such as human capital, the countries in its neighborhood will also benefit from the spillovers. Spillover effects vary from technological spillovers to social, political and economic spillovers. Lopez-Bazo et al. (2004) have analyzed the impact of spatial variables on technological spillovers across nations and they found out that the technological progress in each region is highly dependent on the level of technology of its neighbors. The paper by Garner (2008) formulates the framework to analyze regional patterns of development that arise in the presence of regional industrializing leaders. He considers the role played by technology diffusion in stimulating such development patterns, and how geographic and cultural distance have a major impact on this diffusion process through incorporating direct and indirect cross-country political competition and income comparison effects.

More recently, studies have tried to empirically estimate the impact of genetic and cultural distance on differences across countries. Spolaore and Wacziarg (2009) have investigated the relationship between cultural distance, based solely on genetic factors, and a country's growth rate. According to various genetic studies, genetic distance measures the time since two populations have been biologically separated. As mentioned earlier, the genetic distance may include cross country similarities such as common custom, language, ethnicity, values or culture. The authors have based their interpretation on two main ideas. First, the genetic distance variable explains the changing genealogical characteristics between populations that in turn describe income differences. Second, such differences in characteristics act as cultural barriers to the diffusion of development. These ideas are proved through empirical findings: countries that are genetically related tend to grow together in the long run and that the genetic distance variable is statistically and economically significant in explaining income differences across countries. This relationship holds true even if linguistic, religious and geographical distance as well as wide array of country specific and historical factors have been controlled for. Ashraf and Galor (2008) find a significant impact of genetic diversity on development outcomes in the pre-colonial era.

Gorodnichenko and Roland (2010) construct an endogenous growth model and using genetic distance as an instrument for culture, find that individualism leads to more innovation. Garner (2008) has used a similar idea of relationship between two nations by taking genetic distance as a measure of cultural distance. In this regards he quotes Lie (1998, p59), "South Korean business people, adopted Japanese idioms and mannerisms and likewise one could find Japanese cultural practices to be common in South Korean settings." The main idea is that if two nations share a common set of beliefs or cultural values, it is much easier for them to adapt or imitate each others new technological innovations.

In a similar context, Guiso et al. (2009) look at how cultural 'trust' between countries affects the level of economic interaction and finds that lower bilateral trust leads to less trade, less portfolio investment and less direct investment[5]. He suggests that instead of focusing on objective characteristics to strengthen trust between countries, there are certain cultural factors that also affect trust such as 'religion, history of conflicts and genetic similarities'.

In contrast to various studies that emphasize the important role played by genetic distance in influencing growth rates, Giuliano et al. (2006), reject the possible role of genetics once geographical factors are controlled for. The paper attempts to test the hypothesis that genetic distance and trade flows exhibits a high correlation. However, using gravity equations the authors conclude that (p22) "genetic distance

[5] In this case Guiso et al. (2009) has measured trust using a cross-national survey collected by *Eurobarometer*, which has data on the degree of trust that European citizens have towards citizens of other countries (both in Europe and outside of Europe).

loses any significance in explaining trade once one controls geography; therefore genetic distance can only be used as a proxy for cultural distance once geography is appropriately controlled for".

On the other hand, the literature on the links between countries based on cultural or ethnic similarities has focused on how business and ethnic networks have impacted the level of interaction between and within countries. In this context, business and social networks that grow out of coethnic networks have been found to be a major source of interlinking people and overcoming informal barriers to international trade and investment. These networks can also result in spillover effects across nations through multiple channels. The first channel is the reduction of information and transaction costs by firms through immigrant networks. This is because immigrants are well aware of their domestic market buyers and sellers, and therefore act as economic agents in facilitating transactions between domestic and foreign markets[6]. Several studies document this first channel (Rauch and Trindade (2002), Rauch and Casella (1998), Rauch (2001) and Gould (1994)).

The study by Rauch and Trindade (2002) on ethnic Chinese networks shows that the Chinese tend to form a set of interlinked national networks around the world. These networks serve the purpose of information exchange for them which in turn promotes international trade by helping consumers find the right producer and suppliers finding the right distributor, hence, overcoming informal barriers to international trade (e.g. information, transaction, matching and referral services cost

[6] See Rauch (2001) for detailed discussion on business and social networks promoting bilateral trade. The author gives an example of Indian and Chinese entrepreneurs as how they are creating social structures across cultural and linguistic boundaries.

and level of trust). This is in line with the study of Rauch and Casella (2002, p1), which shows that "preferential ties to a group settled abroad facilitate an exporter's entry into the foreign market by providing information and access to distribution channels." This results in an increase in overall volume of trade for the country which has networks abroad, however, reduces trade and per capita income for those countries that do not have preferential ties.

The second channel for the impact of ethnic networks on trade is discussed by Combes, Lafourcade, and Mayer (2004). The authors find that consumers in foreign countries can also have biased preferences in favor of goods produced in their countries of ethnic origin, which can increase the overall trade volume. However, their findings indicate that the information-based impact of networks is stronger than the effect of imported preferences. Bardhan and Guhathakurta (2004), Herander and Saavedra (2005), Dunlevy (2006) and Bandyopadhyay, et al (2007) all find a significant impact of ethnic network on trade within countries.

A third channel through which ethnic networks work is through enforcement of sanctions that deter violations of contracts even in weak institutional conditions. So if a business owner violates an agreement in a particular business community, he is not only blacklisted from that community but also from all other communities where coethnic groups exist (Weidenbaum and Hughes (1996), Rauch and Trindade (2002)).

The common theme in both the theoretical and empirical literature is how cultural or ethnic links increase the probability of matching buyers and sellers (and thus completing transactions) as well as increase the probability of contract enforcement (though both formal and informal channels). This research further contributes to the literature by saying that the greater the number of transactions between countries due to ethnic or cultural links, the greater the probability of technology spillovers, which in turn leads to growth spillovers. As compare to existing literature, this research is unique because it separates out the impact of geographic spillovers and cultural spillovers using the data on genetic distance used by Spolaore and Wacziarg (2009). The question that this study asks is that controlling for geographic distance, does economic growth spill over from one country to another based on cultural links? As Spolaore and Wacziarg (2009) discuss, genetic divergence can be viewed as a divergence in beliefs, customs, habits, etc and thus genetic differences can act as a barrier to the flow of technological and institutional innovations across countries. If that is the case, then a country can benefit more from innovations occurring in countries that are genetically closer to them than countries farther away from them. Thus, this study focuses on the fact that not only physical distance weighted growth affect a country's growth rate, but also genetic distance weighted growth affects a country's growth rate, while the previous literature has either looked at geographic links or cultural links separately .

3. Measuring the Link between Genetic Distance and Cultural, Linguistic and Geographic Distances and Trade Links

One of the central ideas of this study is the link between genetic distance and cultural distance, linguistic distance and trade links. Since we argue that one of main channels through which growth spillovers occur between countries is through cultural, ethnic, linguistic and trade links. So two countries may be separated by a significant geographical distance, but may be culturally or linguistically close which would aid in the transmission of information, ideas, innovations and even people. The Chinese ethnic networks discussed above are good example of these links. So before we try to measure the significance of cultural spillovers, it would be extremely useful to establish the link between genetic distance and cultural distance, linguistic distance and trade links.

3.1 What is Genetic Distance?

Genetic distance is computed on the basis of distance in vertically-transmitted characteristics (VTC). VTC are assumed to incorporate all characteristics that are passed on from parents to children, whether through DNA or culturally.[7] In order to measure genetic distance, the basic unit of analysis is the allele that is used to construct allele frequencies, which is the proportion of population with a gene of specific variant. Cavalli-Sforza et al. (1995) has used similar allele frequencies to construct bilateral coancestor coefficients for the set of 42 populations around the world. This study uses the similar coancestor coefficient, also known as F_{st} distance.

[7] For detailed discussion on cultural and genetic characteristics, see Spolaore and Wacziarg (2009), Diamond (1992, 1997) and Cavalli-Sforza and Cavalli-Sforza (1995).

F_{st} distance is the probability that two randomly selected genes comes from the same population. If two populations are exactly same it takes value zero, otherwise for completely different populations it takes a value 1. F_{st} is also used to construct family trees of human population and is referred as a measure of "genealogical distance" between populations. Specifically, genetic distance between two populations is taken as horizontal distance separating them from next common node in the family tree (Spolaore and Wacziarg 2009). Therefore, genetic distance is related to how long two populations have been separated from each other.

3.2 Cultural and Genetic Distances

One relationship we are interested in testing is the relationship between cultural and genetic distance. Though the data on bilateral cultural distance between countries is limited, recent literature has looked at the link between cultural psychology and genetic distance: Chiao and Blizinsky (2010) and Way and Liebermann (2010) find a strong correlation between collectivism and genetic characteristics. Fincher et al (2008) find a strong correlation between pathogen prevalence and collectivism across countries and Gorodnichenko and Roland (2010) use the link between genetic data and cultural data to instrument culture with genetic data and they find evidence of a strong causal effect between individualism and income per worker.

In this analysis, the study follows Gorodnichenko and Roland in using the individualistic-collectivistic measures of culture given by Hosftede (2001) which shows the differences between countries in terms of autonomous or embedded cultures, in which people are either viewed as autonomous entities or are identified with a certain group. In order to find the relationship between cultural distance and genetic distance, the countries were divided into different genetic groups, i.e. countries with the same genetic characteristics were put into the same group. Then the average bilateral cultural distance between each group was calculated on the basis of the Hosftede index of cross country individualism. Finally, we calculated the average bilateral genetic distance between each group using the genetic distance data from Spolaore and Wacziarg (2009).

In order to check the relationship between genetic distance and cultural distance, the Mantel test is performed on matrices, which is the standard method to find the correlation between distance matrices. For example, in our case one matrix contains the bilateral cultural distance between two groups of countries, while the other matrix contains the corresponding genetic distance between the two similar groups of countries. In this case, the Mantel test will allow us to compute the relationship between the two matrices by calculating a Pearson correlation coefficient between the two sets of distances and testing its statistical significance. The procedure followed by the Mantel test is based on randomization or permutation test. If there are n countries, and the matrix is symmetrical (so the distance from country a to country b is the same as the distance from b to a) such a matrix contains n(n-1)/2 distances. Because distances are not independent from each other- since changing the "position" of one country would change (n-1) of these distances (the distance from that country to each of the others - this test computes a correlation coefficient on the basis of multiple permutations that gives high correlation. To test the significance of the relationship, the null hypothesis of no relationship between the matrices is tested against the alternative hypothesis that two matrices are correlated.

Figure 1 shows a graphical relationship between bilateral cultural distance matrix and the bilateral genetic distance matrix. The plot shows a significant positive correlation between the two matrices. Also the Mantel test gives a value for the Pearson correlation coefficient of 0.4, which is statistically significant at 1 percent level, pointing to a positive and significant relationship between bilateral cultural distance and bilateral genetic distance.

3.3 Linguistic and Genetic Distances

The second relationship to be determined is the correlation between linguistic differences and genetic differences. The literature on linguistic differences across countries is well-developed, but there a few measures of linguistic distance between countries. Recently, West and Graham (2004) employed a measure of linguistic distance between countries 51 countries from English by using a family tree of 6500 languages to form a hierarchy of languages and using this family tree to calculate linguistic distance from English. In order to check the relationship between genetic distance and linguistic distance, we have taken West and Graham's measure of linguistic distance from English.

The methodology we have followed is to first form a group of English speaking countries and then to find the bilateral linguistic distance from this group of English speaking countries and the group of 40 countries for which West and Graham have calculated linguistic distance and we have genetic distance data. The idea is to first calculate a linguistic distance score of each of the 40 countries from the English speaking countries. We then calculate the genetic distance of each of these 40 countries (again using the genetic distance data from Spolaore and Wacziarg , 2009) from the group of English-speaking countries, which is not difficult because the genetic characteristics in our dataset is identical for all the English speaking countries.

Figure 2 presents a graphical illustration of the relationship between linguistic distance of each of the 40 countries from English and the genetic distance of these same countries from English speaking countries. The plot shows a significant positive correlation between the two variables. Also, we find a Pearson correlation coefficient of 0.65, which is statistically significant at 1 percent level. So there seems to be a positive and significant relationship between genetic distance and linguistic distance.

3.4 Geographic and Genetic Distances

Since the both genetic and geographic distance spillovers are included in our growth model, it is logical to ask if they measure the same thing, i.e. does greater geographical distance between countries automatically imply greater genetic distance? Figure 3 shows the relationship between geographic distance and genetic distance, while the Mantel test leads to a Pearson correlation coefficient of 0.28, which is statistically significant at the 1% significance level. So there is a significant positive relationship between genetic distance and geographic distance.

3.5 Trade and Genetic Distances

Finally, another important relationship to test is the relationship between genetic distance and bilateral trade. As in this case, it might be assumed that the higher trade among countries could be due to the lower genetic distance amongst them and vice versa. Therefore, the correlation between genetic and bilateral trade should be significantly negative but not perfectly. Figure 4 illustrates such a relationship, in which we have found a negative relationship between bilateral genetic distance and trade matrix. Also, the Mantel test leads to a Pearson correlation coefficient of -.088, which is statistically significant at 1% significance level. Hence, there is a significant negative relationship between genetic distance and bilateral trade and the correlation coefficient is far from being perfect.

The results in this section show the significant relationships between genetic distance with both cultural and linguistic distance and bilateral trade. So, countries that are closer genetically tend to be closer culturally and linguistically, which in turn means that genetic proximity could play a positive role in the transfer of technology and innovations. Also, we have shown that though there is a significant and positive relationship between genetic and geographical distance, the correlation between them is far from perfect. So countries that are geographically distant are not automatically genetically distant and vice versa and we should be able to separate the impact of both distance and genetic distance weighted growth spillovers. Similarly, the low correlation coefficient between genetic distance and bilateral trade ensures that we can also separate the impact of both genetic and trade weighted growth spillovers.

4. Methodology

This chapter develops the theoretical framework based upon the model by Lopez-Bazo et.al (2004), details the estimation strategy for geographic and genetic distance weighted growth spillovers and lists the hypotheses to be tested.

4.1 Theoretical Framework

Our model is based on the basic Solow model in which the aggregate production per unit of labor is a function of the stock of physical capital per unit of labor (k) , the stock of human capital per unit of labor (h) and a technology parameter (A)[8]:

$$y_i = A_i k_i^{\tau_k} h_i^{\tau_h} \qquad (1)$$

where τ_k and τ_h represents internal returns to physical and human capital respectively. As in the standard model (also discussed in detail by Lopez-Bazo et.al, 2004), the returns are considered the result of the sum of a firm's internal returns and a Romer-Lucas externality. However, in this case the internal externality is not large enough to exhibit increasing returns to scale, so that we assume $\tau_k+\tau_h< 1, \tau_k>0\ \tau_h>0$.

Technology (A) in equation (1) in any country i is assumed to depend on the level of technology of its neighbor j which in turn depends on the physical and human capital stocks of the neighboring country weighted by the factor $(\gamma_1 + \gamma_2)$. The γ parameters measure the strength of each externality: γ_1 shows the degree to which

[8] The factors of production are treated as fixed endowments here as taken in various models such as Heckscher-Ohlin model. Also, in some of the literature land is also considered as a factor of production, however, in this case it is not included as a factor of production and its omission does not affect our basic results.

country *j* invests in human and physical capital or introduces new technology that will spill over to country i due to the geographic distance between country i and country j. γ_2 shows the effect of a similar externality based on the cultural distance between country i and country j. The idea behind this formulation is that the amount of technological spillovers between country i and j depend on the physical distance between both countries (because a country will absorb technology more easily from a geographically closer country as opposed to a country farther away) and on the cultural distance between countries (since countries that are closer culturally will have a greater chance to sharing common languages, cultures, business practices, etc and thus a greater chance of technology spillovers). If $\gamma_1 + \gamma_2$=0, this means spillovers are not transferred between country i and country j and we are only taking into account internal externalities. Note that φ is an exogenous technological shock parameter.

$$A_i = \varphi(k_{ij}^{\tau_k} h_{ij}^{\tau_h})^{\gamma_1+\gamma_2} \qquad (2)$$

Equation (3) expresses the output level of a country i by combining (1) and (2). The equation shows that spillovers have a positive effect on the level of output of country i even if country i keeps its level of human and physical capital stock constant.

$$y_i = \varphi k_i^{\tau_k} h_i^{\tau_h} (k_{ij}^{\tau_k} h_{ij}^{\tau_h})^{\gamma_1+\gamma_2} \qquad (3)$$

Using a capital accumulation equation and substituting the in for the value of y_i, the growth rates of human and physical capital stock for country i are:

$$g_{\breve{k}} = \frac{\dot{\breve{k}}}{\breve{k}} = s_k \breve{k}^{-(1-\tau_k)} \breve{h}^{\tau_h} (\breve{k}_{ij}^{\tau_k} \breve{h}_{ij}^{\tau_h})^{\gamma_1+\gamma_2} - (n+g+d) \quad (4a)$$

$$g_{\breve{h}} = \frac{\dot{\breve{h}}}{\breve{h}} = s_h \breve{k}^{\tau_k} \breve{h}^{-(1-\tau_h)} (\breve{k}_{ij}^{\tau_k} \breve{h}_{ij}^{\tau_h})^{\gamma_1+\gamma_2} - (n+g+d) \quad (4b)$$

where s_k and s_h are saving rates for the accumulation of human and physical capital and n, g and d are rates of population growth, technological growth and the rate of depreciation, respectively. The equation assumes decreasing returns for the country's own capital accumulation but positive returns for spillovers transmitted by other economies. This means that economies that are closely located and also are biologically closer to the i^{th} country will have a more pronounced effect on growth as compared to economies that are located further away as well as have fewer cultural links.

Combining equation (4a) and (4b) we can obtain the steady state level of human and physical capital and output per effective labor as:

$$\breve{k}^* = \left(\frac{s_k^{1-\tau_h} s_h^{\tau_h} (\breve{k}_j^{\tau_k} \breve{h}_j^{\tau_h})^{\gamma_1+\gamma_2}}{n+g+d}\right)^{\frac{1}{1-\tau_k-\tau_h}} \quad (5a)$$

$$\breve{h}^* = \left(\frac{s_k^{\tau_k} s_h^{1-\tau_k} (\breve{k}_j^{\tau_k} \breve{h}_j^{\tau_h})^{\gamma_1+\gamma_2}}{n+g+d}\right)^{\frac{1}{1-\tau_k-\tau_h}} \quad (5b)$$

$$\breve{y}^* = \left(\frac{s_h^{\tau_h} s_k^{\tau_k} (\breve{k}_j^{\tau_k} \breve{h}_j^{\tau_h})^{\gamma_1+\gamma_2}}{(n+g+d)^{\tau k + \tau h}}\right)^{\frac{1}{1-\tau_k-\tau_h}} \quad (5c)$$

Using the capital accumulation equation given in (4) and applying the first order Taylor expansion around the steady state, the growth between periods 0 and T can be expressed as:

$$g_i = \tau_k g_k + \tau_h g_h + \gamma_1 \left(\tau_k g_{k_j} + \tau_h g_{h_j}\right) + \gamma_2 \left(\tau_k g_{k_j} + \tau_h g_{h_j}\right)$$

Based upon the methodology followed by Mankiw et al. (1992) the derivation of this equation can be expressed in terms of rate of convergence, country's internal factors and spillover effects as:

$$g_i = \varepsilon - \left(1 - e^{-\beta T}\right) lny_o + \frac{(1-e^{-\beta T})\gamma_1}{1-(\tau_k+\tau_h)} lny_{o_j} + \frac{(1-e^{-\beta T})\gamma_2}{1-(\tau_k+\tau_h)} lny_{o_j} + \gamma_1 g_{y_j} + \gamma_2 g_{y_j} + \frac{(1-e^{-\beta T})}{1-(\tau_k+\tau_h)} [\tau_k(lns_k - \ln(n+g+d)) + \tau_h(lns_h - \ln(n+g+d))] \quad (6)$$

where

$$\varepsilon = (1+\gamma_1)g + (1+\gamma_2)g - \left(1 - e^{-\beta T}\right)\left(1 - \frac{\gamma_1}{1-(\tau_k+\tau_h)}\right)(ln\Delta_o + gT) - \left(1 - e^{-\beta T}\right)\left(1 - \frac{\gamma_1}{1-(\tau_k+\tau_h)}\right)(ln\Delta_o + gT)$$

Note that $\beta = \left(1 - (\tau_k + \tau_h)\right)(n + g + d)$ is the convergence rate, $y_0$is initial output per unit of labor in country i and y_{o_j} is the initial output per unit of labor of the other country, j. Equation (6) shows that growth in country i is a function of the county's own initial level of output, the initial level of output of its neighbor j weighted by $\gamma_1$and γ_2, the weighted growth rates of neighboring countries and the country's own factors of production[9]. According to this expression, two countries having a similar level of economic and technological conditions and starting from the same initial conditions can differ in their growth rates, if they have different neighbors. That means γ_1 and $\gamma_2$are important in terms of the effect of technology

[9] The growth in this case is taken as Solow-style transitional to a new higher level of income.

spillovers from country i to j: If country i is closely located high growth countries geographically as well as culturally, there will be significant technological (and growth) spillovers from these countries to country i (assuming that $\gamma_1 > 0$ and $\gamma_2 > 0$). In terms of separating out channels of technological spillovers, the model also implies that technology will spillover between countries based on the physical distance between the countries as well as the cultural distance between countries.

4.2 Estimation Strategy

In this section we will develop a regression model based on the empirical counterpart of equation (6). Equation (6) can be written as:

$$g_i = constant - \propto_o \, lny_o + \delta_1 s_k + \delta_2 s_h + \theta_{1w_i} lnW_1 y_o + \theta_{2wi} lnW_2 y_o + \gamma_1 W_d + \gamma_2 W_{gen} + u \quad (7)$$

However, due to lack of data for depreciation rates, the effect of *ln(n+g+d)* in equation (7) has been included in the constant term[10]. The regression model will be further modified by including other explanatory variables such as institutional quality and continent dummies. The construction and description of distance weighted variables, $W_1 y_o$, $W_2 y_o$, W_d, and W_{gen} has been explained in the section 5.

In order to estimate equation (7) we will use the standard growth regressions as done by Cohen and Soto (2001). Cohen and Soto's (2001) study is based on checking the effect of human capital (based on a new dataset) under three different sets of specifications taken from Benhabib and Spiegel (1994), Pritchett (2001) and

[10] Adding the effect of variables in the constant term is the standard econometric assumption in growth regressions.

Krueger and Lindahl (2001). The three approaches differ in the way they constructed the human capital variable. Benhabib and Spiegel (1994) use the standard growth regression implied by an aggregate production function based upon Cobb-Douglas technology. Years of schooling are taken as the measure of human capital in this study. Pritchett (2001) also uses the conventional growth regression to estimate the effect of human capital on growth, where the stock of human capital in this case is defined as the discounted wage premium of education over raw labor. Using the same set of standard growth variables, Krueger and Lindahl's (2001) income-growth regression differs in terms of the schooling variable. The measure of schooling in their paper is based on the wage regressions estimated through the Mincerian approach (1974). The standard equation estimated by all of these economists can be written as follows:

$$\Delta ln(GDP) = \pi_0 + \pi_1 \Delta(ln(k)) + \pi_2 \Delta(ln(h)) + X_i B + e_t \quad (8)$$

The above mentioned specification does not take into account the spatial impacts generated through geographical and genetic distance. Therefore, in order to incorporate spillovers generated through spatial factors, we will modify equation (8) by combining it with equation (7), together with an institutional quality variable, *cpi*. Thus, the three specifications that we will estimate will be[11]:

1) Basic cultural and geographic spillover model:

[11] In all of the mentioned specifications the impact of spillovers on growth will be measured while the exact mechanism through which these spillovers are transferred (transfer of technology, innovations, similar policies etc) can be investigated in further research.

$$g_i = \pi_0 - \propto_o lny_o + \delta_1 \Delta(ln(k)) + \delta_2 \Delta(ln(h)) + \gamma_1 W_d + \gamma_2 W_{gen} + \delta_3 cpi + X_i B + e_i \quad (9a)$$

where the dependent variable g_i is the annualized change in the growth rate of a country between 1960 and 2000, k is investment in physical capital, h is human capital measured by the educational attainment of the total population aged 25 and over, W_d is the geographical distance weighted growth variable, W_{gen} is the genetic distance weighted growth variable, *cpi* measures the institutional quality, and X is the set of standard variables that includes various convergence and endogenous growth factors (initial level of GDP, initial level of physical capital, initial level of human capital, etc).

2) Income weighted cultural and geographic spillovers model:

$$g_i = \pi_0 + \propto_o lny_o + \delta_1 \Delta(ln(k)) + \delta_2 \Delta(ln(h)) + \gamma_3 W_{yd} + \gamma_4 W_{ygen} + \delta_3 cpi + X_i B + e_i \quad (9b)$$

Where W_{yd} and W_{ygen} measure the impact of income weighted genetic and geographic spillovers and the other variables are defined as above.

3) Trust weighted spillovers model:

$$g_i = \pi_0 + \propto_o lny_o + \delta_1 \Delta(ln(k)) + \delta_2 \Delta(ln(h)) + \gamma_1 W_d + \gamma_5 W_{trust} + \delta_3 cpi + X_i B + e_i \quad (9c)$$

Where, W_{trust} measures the impact of trust spillovers.

Spatial variables (W_d, W_{gen}, W_{yd}, W_{ygen} and W_{trust}) in the growth regression show that growth in country i depends on the growth of all other countries in the sample weighted by the average distance between the two countries. Also, it is hypothesized that countries that are closer geographically or genetically have a greater influence on a country's growth rate than countries that are farther away. This relationship is quite similar to a time series autoregressive process where error terms are serially correlated and OLS estimates are not consistent. However, in this case it is not the nearby time periods that matter rather it is the influence of spatial variables that will cause the residuals to be spatially correlated, resulting in inconsistent OLS estimates. Therefore, we will maximize the likelihood function with the growth equations (9a, 9b and 9c), where the general form of maximum likelihood function can be represented as:

$$lnL = -\frac{N}{2}ln(2\pi) - \frac{N}{2}ln(\sigma^2) + \ ln|I - \gamma W| - \frac{1}{2\sigma^2}u'u(8)$$

4.3 Hypotheses

In this study various hypotheses will be tested in different specifications using a standard cross-country growth regression framework. The hypotheses to be tested are:

Hypothesis 1: *The geographical and cultural distance weighted growth rates of other countries have a significant impact on a country's growth rate once country-specific factors are controlled for.*

This means that cross-country growth is affected by growth spillovers from countries that are geographically closer as well as from countries that are culturally closer. Thus, countries that are closely located to high growth economies will have higher level of positive spillovers as compare to nations that are further away from these economies. Also, countries that are closely linked to each other biologically or in other words countries that share common cultural backgrounds (languages, beliefs, values, culture or traits) tend to have greater growth spillovers. The positive growth spillovers could be the result of similar policies as well as transfers of technology between culturally similar countries.

Hypothesis 2: *The growth rates of other countries weighted by income and geographic distance both and growth rates of other countries weighted by income and genetic distance both have a significant impact on a country's growth rate once country-specific factors are controlled for.*

For this case the relative sizes of the economies are incorporated in both geographic and cultural distance weighted spillovers. This means that even if the relative sizes of the countries are taken into account still the geographic as well as genetic distance of that country has an impact on growth spillovers of that country. The country that is relatively smaller in size can have a significant impact on growth rate of the other country if its geographically or culturally closer to that nation as compare to a large but distant economy.

Hypothesis 3: *The trust weighted spillovers has a significant impact on the growth rate of country.*

In order to test this hypothesis, we will limit our analysis to European countries only. For this case the bilateral trust amongst nations should have a significant impact on the amount of growth spillovers between countries. The similar proposition has been tested by Guiso et al. (2009), who looked at how cultural 'trust' between countries affects the level of economic interaction and found out that lower bilateral trust leads to less trade, less portfolio investment and less direct investment.

5. Basic Cultural and Geographic Spillovers Model

The basic cultural and geographic spillovers model is created to test the hypothesis that not only geographic proximity affects the growth rate of a country but cultural distance also plays a significant role. In this section it is assumed that countries are affected by growth spillovers that decrease as the cultural and geographical distances between countries increases. Therefore, in order to incorporate this effect the geographical and cultural distance weighted growth variable is created and is tested in the growth regression.

5.1 Construction of Spillover Variables

The effect of genetic and geographic spillovers can be estimated as follows:

$$g_i = \pi_0 - \propto_o lny_o + \delta_1 \Delta(ln(k)) + \delta_2 \Delta(ln(h)) + \gamma_1 W_d + \gamma_2 W_{gen} + \delta_3 \, cpi + X_i B + e_i \quad (9a)$$

where W_d and W_{gen} measure the impact of genetic and geographic spillovers and the other variables are defined as above.

In order to construct genetic and geographic spillover variables, first the genetic and geographical distances are used to construct two weighting matrices, $W_{1_{ij}}$and $W_{2_{ij}}$. The definitions of each matrix are given below:

For geographical distance:

$$W_{1_{ij}} = \frac{\frac{1}{d_{ij}}}{\Sigma_j 1/dij} \qquad i \neq j$$

$$W_{1_{ii}} = 0$$

For genetic distance:

$$W_{2_{ij}} = \frac{\frac{1}{gen_{ij}}}{\sum_j 1/gen_{ij}} \qquad i \neq j$$

$$W_{2_{ii}} = 0$$ 7

Where d_{ij} is the geographical distance between country *i* and *j* and gen_{ij} is the genetic distance between country *i* and *j* (gen_{ij} represents the F_{st} index). These weighting matrices link every country to all other countries in the sample both geographically and genetically. However, the relative importance of any country *i* is inversely proportional to its geographical and genetic distance from country *j*.

In order to construct the geographic distance weighted growth (W_d) and genetic distance weighted growth variables (W_{gen}) for each country, the weighting matrices W_{1ij} and W_{2ij} are multiplied by the column matrix G, which consists of cross-country growth rates:

$$W_d = \sum_{j=1}^{n} w_{1ij}\, g_j$$

and

$$W_{gen} = \sum_{j=1}^{n} w_{2ij}\, g_j$$

W_d and W_{gen} represent the geographic and genetic distance weighted growth spillovers from all other countries *j* to country *i*.

5.2 Data

Our sample contains 80 countries over the period 1960-2000[12]. The data on index for genetic distance F_{st} is taken from Spolaore and Wacziarg (2009). As discussed in Spolaore and Wacziarg's (2009) paper "Fst measures the average genetic distance between two countries. It takes a value equal to zero only if there is no difference between the allele distributions between two countries, however, higher value is associated with larger differences in their vertical characteristics." The vertical transmitted characteristics are the ones that are genetically transferred from parents to their generations. Hence, such characteristics are carried from generations to generations biologically. The bilateral geographical distance data is taken from CEPII and our GDP data is taken from the Madison World data series. We took physical capital data from the WPD-UNIDO datasets and human capital from the Barro and Lee data series (where the average number of years of schooling has been used for measuring human capital). Moreover, the data for the institutional quality variable (cpi) has been taken from Transparency International

5.3 Results

Table 2 shows the maximum likelihood estimates of the impact of geographic distance weighted growth (W_d) and genetic distance weighted growth (W_{gen}) of other countries on cross country growth rates. Across the various specifications, the results show that both geographic and genetic distance weighted growth spillovers coefficients are significant. Thus cross-country growth is affected by growth

[12] This time period has been chosen because of data availability..

spillovers from countries that are geographically closer as well as from countries that are culturally closer.

While Table 2 shows the simplest specification, Table 3 shows the results from a standard growth specification for all the countries in the sample. The results show that both geographic distance and cultural distance weighted growth spillovers have a significantly positive impact on cross-country growth. If one was to compare the geographic distance weighted spillovers coefficient from the baseline specification (given in column (A) of the tables) to the geographic distance weighted spillovers coefficient after the inclusion of the genetic distance weighted spillovers variable, one finds that the coefficient falls in size, though it remains significant. Also, one notices that the genetic distance weighted growth spillovers coefficient is smaller than the geographic distance weighted spillovers coefficient, which implies that geographic distance has a greater impact on growth spillovers than cultural distance.

5.4 Robustness Checks

In order to check the robustness of our results, we replicated the methodology of Cohen and Soto (2001) to test various growth specifications. Besides the basic specification used above (which is similar to the one used by Benhabib and Spiegel, 1994), we used the specifications of Pritchett (2001) (denoted in the results as PR) and Krueger and Lindhal (2001) (denoted in the results as KL). Pritchett (2001) and Krueger and Lindhal (2001) both used two different specifications, both of which were estimated (and denoted as *PR1*, *PR2*, *KL1 and KL2* for the two Pritchett and two Krueger and Lindahl specifications, respectively).

Tables 4-7 show the results from the various growth specifications for all the countries in the sample. The baseline results shown in the first column of each table shows the models without the inclusion of the spillover variables, and the results are similar to the results obtained by Moreno and Trehan (1997), who performed the original analysis. Again, across the various specifications, after the inclusion of the spillover variables, it is found that both geographic distance and genetic distance weighted growth spillovers have a significantly positive impact on cross-country growth. Also, as before, the geographic distance weighted spillovers coefficient decreases after the inclusion of the genetic distance weighted spillovers variable, though it remains significant. Finally, across specification, one finds that the genetic distance weighted growth spillovers coefficient is smaller than the geographic distance weighted spillovers coefficient, which implies that geographic distance has a greater impact on growth spillovers than genetic or cultural distance.

Another important issue is to consider the impact of geography, common colony and common language. Is it possible that the results are being driven by geographical location, common colony or common language between pair of countries? In other words, is it possible that the results are capturing the impact of country's location, common language or colony weighted growth instead of capturing the impact of geographic and genetic distance weighted growth spillovers. For this reason, we included latitude, common colony and language weighted growth in our basic specifications (as well as running separate regressions with continent dummies). Tables 8 show the results of the basic spillovers model after including country latitude. Even after controlling for geographic location, the geographic and genetic distance weighted growth spillovers remain significant. Table 9-10 shows the effect of common colony and language weighted growth variables. Again, across the various specifications, after the inclusion of the these variables, it is found that both geographic distance and genetic distance weighted growth spillovers have a significantly positive impact on cross-country growth, whereas both of the other weighted variables (common colony and language weighted growth) appear to be in insignificant.

Finally, the most important argument to be considered is that the genetic distance weighted growth might be capturing the impact of trading links between countries. This means that genetic distance is incorporating the effect of higher trade amongst nations and that is leading to greater growth spillovers. Therefore, in order to test this proposition we will add trade weighted growth variable in our basic specification. Table 11 shows that even after inclusion of trade weighted growth variable, genetic distance and geographical distance growth spillovers remains significant. Also, the results in column C ensures that genetic spillovers are affecting cross-country growth rates purely due to cultural similarities amongst various nations and not due to their trading links.

Therefore, even if a country is located further away from a high growth country, it can still grow more if it is genetically similar to some other fast growing country. For example, country A is located further away from fast growing country B, however, it is culturally closer to country B. In this case country A can still grow at a higher rate, since there will be large growth spillovers from a genetically similar country regardless of the geographic distance amongst them. This means that the amount of growth spillovers significantly increases for the culturally similar economies.

6. Income Weighted Cultural and Geographic Spillovers

In the model above, it is assumed that countries are affected by growth spillovers that decrease as the geographical and cultural distances between countries increases. But the relative size of the country from which the spillover is occurring is ignored, i.e. growth spillovers from Denmark and Germany are assumed to be equal if a country is equidistant from them both geographically and culturally. In this section, we incorporate the relative size of economies into both geographic and cultural distance weighted spillovers, by weighting the relative size of these spillovers by relative GDP (ratio of foreign output to domestic output). The argument is that the relative size of a country as well as the geographic and genetic distance of that country has an impact on growth spillovers from that country.

6.1 Construction of Spillover Variables

The effect of income weighted genetic and geographic spillovers can be estimated as follows:

$$g_i = \pi_0 + \propto_o \ln y_o + \delta_1 \Delta(\ln(k)) + \delta_2 \Delta(\ln(h)) + \gamma_3 W_{yd} + \gamma_4 W_{ygen} + \delta_3\, cpi + X_i B + e_t \qquad \text{(9b)}$$

where W_{yd} and W_{ygen} measure the impact of income weighted genetic and geographic spillovers and the other variables are defined as above.

The genetic and geographical distances and the ratios of foreign to domestic output are used to construct two weighting matrices, $W_{3_{ij}}$ and $W_{4_{ij}}$. The definition and construction of each matrix is given below:

For income weighted geographical distance:

$$W_{3_{ij}} = \frac{\frac{1}{d_{ij}} * \frac{y_f}{y_d}}{\sum_j \frac{1}{d_{ij}} * \frac{y_f}{y_d}} \qquad i \neq j$$

$W_{3_{ii}} = 0$

For income weighted genetic distance:

$$W_{4_{ij}} = \frac{\frac{1}{gen_{ij}} * \frac{y_f}{y_d}}{\sum_j \frac{1}{gen_{ij}} * \frac{y_f}{y_d}} \qquad i \neq j$$

$W_{4_{ii}} = 0$

Where d_{ij} is the geographical distance between country i and j, gen_{ij} is the genetic distance between country i and j and $\frac{y_f}{y_d}$ is the ratio of foreign output to domestic output (income weighted factor).

In order to construct the income weighted geographical distance weighted growth (W_{yd}) and income weighted genetic distance growth variable (W_{ygen}) for each country, the weighting matrices W_{3ij} and W_{4ij} are multiplied by the column matrix G, which consists of cross-country growth rates:

$$W_{yd} = \sum_{j=1}^{n} w_{3ij}\, g_j$$

and

$$W_{ygen} = \sum_{j=1}^{n} w_{4ij}\, g_j$$

So, W_{yd} and W_{ygen} represent the income weighted geographic and genetic distance weighted growth spillovers from all other countries *j* to country *i*.

6.2 Results

Tables 12 and 13 show the results for the specification in which the distance matrices are weighted by income. Again, geographic distance weighted growth spillovers and genetic distance weighted growth spillovers are significant. But what makes these results interesting is the fact that the coefficient of genetic distance weighted growth spillovers is significantly larger than the geographic distance weighted growth spillovers, which is the reverse of the results of the unweighted case. This implies that genetic distance weighted growth spillovers may outweigh the geographic distance weighted growth spillovers when one takes the sizes of economies into account. In other words, cultural links may be more important that geographical proximity in the transfer of technology across countries and the resulting growth spillovers when the size of economies is taken into account.

6.3 Robustness Checks

In order to check the robustness of our income weighted results, we again replicate the methodology of Cohen and Soto (2001) in various growth regressions as mentioned in previous section. Tables 14-17 show the results for various growth specifications to see the impact of income weighted geographic and genetic growth spillovers. Again, across the specifications, income weighted geographic and genetic distance growth spillovers have a significant impact on growth and the size of the genetic distance growth spillovers is larger than the impact of geographic distance growth spillovers.

The issue of incorporating the impact of location is revisited for this specification as well. Tables 18 show the results of the income weighted spillovers model after including country latitude. Again, even after controlling for geographic location, the income weighted geographic and genetic distance growth spillovers remain significant.

On the whole, the results show that when relative sizes are taken into account, the growth spillovers due to genetic similarities are more significant than due to geographic distance between two countries. Suppose, we take a three country model, where country C is bigger in size than country B and both are equidistant genetically as well as geographically from home country A. Since, country C is bigger in size there will be greater amount of growth spillovers from country C to country A than from country B to country A due to genetic similarities as compare to geographic distance.

7. Trust Weighted Spillovers

Another aspect of cultural links that was investigated by Guiso et al (2009) was the impact of bilateral trust between European countries on the level of economic interaction between these countries. The authors found that lower bilateral trust led to less trade for differentiated goods. Also, less portfolio investment is titled towards countries whose citizens are considered less trustworthy and finally, lower trust leads to less direct investment between countries. The authors also mention that the results they found are not just driven by preferences but are based on historical and priori records of trust among countries. Bottazzi et al. (2006) analyzed the similar relationship and found out that venture capitalists are more likely to invest in a company they trust more. If this is the case, the degree of bilateral trust can also impact the amount of growth spillovers between countries, which can be tested in our framework.

In order to test the impact of trust weighted growth spillovers, we create a matrix of trust distance weighted growth (similar to our genetic distance weighted growth) which allows us to measure the impact on the growth rate of country i of the trust weighted growth rates of all other countries j. Using a simple model, we can separate the impact of distance weighted growth from trust weighted growth. Because of data limitations, we will limit the analysis to European countries, which will restrict us from also including genetic distance weighted growth rates into our model because of the genetic similarity (and resulting lack of genetic distance) between the European countries.

7.1 Construction of Spillover Variables

The effect of trust spillovers can be estimated as follows:

$$g_i = \pi_0 + \propto_o lny_o + \delta_1 \Delta(ln(k)) + \delta_2 \Delta(ln(h)) + \gamma_1 W_d + \gamma_5 W_{trust} + \delta_3 cpi + X_i B + e_t \quad (9c)$$

Where, W_{trust} measures the impact of trust spillovers.

The bilateral trust distance between European countries is used to construct a trust weighted growth spillover variable W_{trust}. The construction of the trust weighted variable is given below:

The trust weighting matrix is:

$$W_{5_{ij}} = \frac{trust_{ij}}{\Sigma_j trust_{ij}} \qquad i \neq j$$

$$W_{5_{ii}} = 0$$

Where $trust_{ij}$ is the level of trust between country i and j. In this case the weighting matrix links every country to all other countries in the sample on the basis of the bilateral trust index. So, the relative importance of any country i is directly proportional to its trust distance from country j.

In order to construct the trust weighted growth variable for each country, the weighting matrices W_{5ij} is multiplied by the column matrix G, which consists of cross-country growth rates:

$$W_{trust} = \sum_{j=1}^{n} w_{5ij}\, g_j$$

So, W_{trust} represent the trust distance weighted growth spillovers from all other countries *j* to country *i*.

We use the same data as Guiso et al (2009) who use measures of trust from a set of surveys conducted by Eurobarometer (and sponsored by the European Commission). The data (replicated in the Guiso et al paper) shows the average level of trust that citizens from each European country have toward citizens from another European country.

7.2 Results

Table 19 shows the results for the subsample of European countries when one looks at the impact of geographic distance weighted growth spillovers and 'trust' distance weighted growth spillovers. As discussed above, we have not included the genetic distance weighted growth spillovers also into this regression because the genetic distance between the European countries was small which led to insignificant results. The table shows that trust distance weighted growth spillovers are significant showing that there are greater growth spillovers between countries that have a greater level of bilateral trust. Another interesting result is the fact that the geographic distance weighted growth spillovers coefficient are insignificant, which implies that geographic distances are not a barrier to growth spillovers in Europe. Also, the trust distance weighted growth variable remains highly significant when regressed along with the geographic distance weighted growth variable. This means that in case of genetically similar groups, bilateral trust amongst countries is more important than the geographic distance between them.

Therefore, the analysis in this chapter shows that if there is high trust between any two countries from the same genetic group than regardless of the geographical distance between them, the two countries will have a higher amount of growth spillovers.

8. Conclusions

The analysis is in this thesis attempts to separate the impact of physical distance and cultural distance on growth spillovers. Over the last 50 years, migration patterns have resulted in a far more diversified global population. So it is natural to ask if traditional patterns of technology transfers and growth spillovers, which occurred between countries that were geographically closer to each other, have changed. In particular, the question that arises is whether one can test to see if technology transfers and growth spillovers can occur between countries that are culturally and linguistically closer and separate this channel from the traditional geographically dependent growth spillovers.

The analysis began by showing the significant relationship between genetic distance and cultural and linguistic distances and bilateral trade between countries. Thus, in order to see if the impact of cultural and linguistic differences on the level of growth spillovers between countries, we focus on the genetic distance between countries. After this, our results show that greater technological transfers and growth spillovers occur between countries that are both geographically closer to each other and also between countries that are genetically closer to each other. Also, geographic distance based growth spillovers outweigh genetic distance weighted growth spillovers. But this result is reversed when one takes the size of the countries into account: In this case, genetic distance weighted growth spillovers outweigh geographic distance weighted growth spillovers. So, cultural and linguistic links between countries are critical route for the transfer of innovations and technology between countries. The study also checks to see if after controlling for geographic location (latitude), common colony and language, and trade weighted spillovers the geographic distance weighted growth variables and genetic distance weighted growth variables are still significant. In this regards, the results remained unchanged for genetic and geographic distance weighted variables as well as for income weighted geographic and genetic distance weighted variables. Moreover, the analysis shows that trust between countries plays a role in growth spillovers. Using a sample of European countries, the research finds that there are greater growth spillovers between European countries that trust each other more, even when one controls for geographic distance weighted spillovers.

On the whole, the results support the theory that greater cultural links between countries increase growth spillovers. Also, the more countries trust each other, the more they interact, which in turn leads to greater growth spillovers. These spillovers are in addition to the spillovers that occur between countries due to geographical proximity. So, as technological innovations reduce the effective geographic distance between countries, the cultural and linguistic differences between countries in the transfer of innovations and growth will occupy a far more central role.

The existing literature so far has only looked at the effect of geographical distance on growth rates of countries or it has either analyzed the impact of genetic distance or ethnic networks in determining cross country growth variations or greater interaction between countries. However, this thesis combines the two different strands of literature by combining the effect of geographical as well as genetic distance to explain growth spillovers which occur between different nations. Also, rather than looking at spatial factors determining absolute differences in growth rates, this study is looking at how all countries are related through these spillovers, where degree of this relatedness depends upon the cultural distance. Also, rather than incorporating how one country affects the other country's growth rate, the study has considered how the weighted growth rates of all other countries in our sample affect a particular country's growth rate.

Figures

Figure 1: Relationship between the Bilateral Cultural Distance Matrix and Bilateral Genetic Distance Matrix

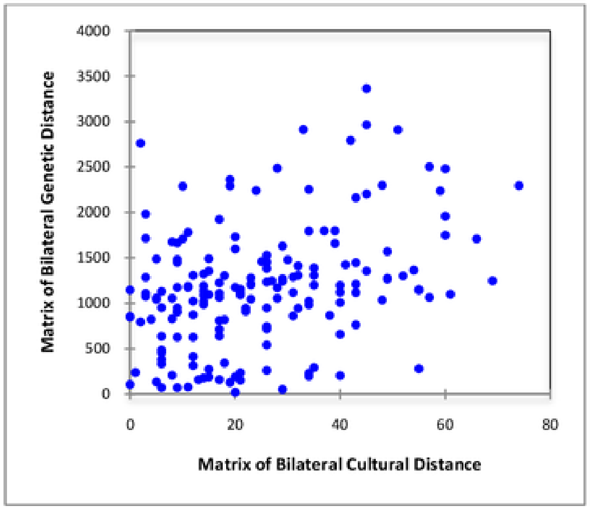


Figure 2: Relationship between Linguistic Distance from English Speaking Countries and Genetic Distance from English Speaking Countries

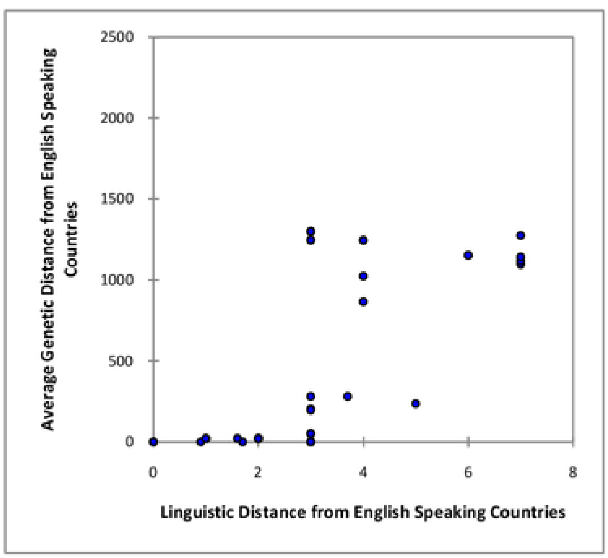


Figure 3: Relationship between the Bilateral Geographic Distance Matrix and Bilateral Genetic Distance Matrix

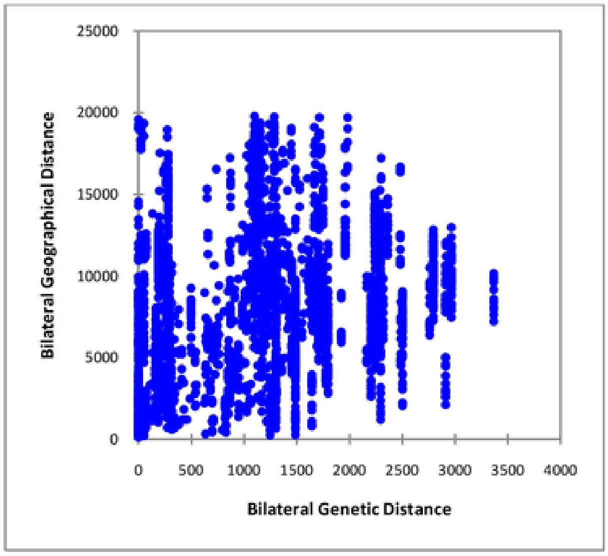
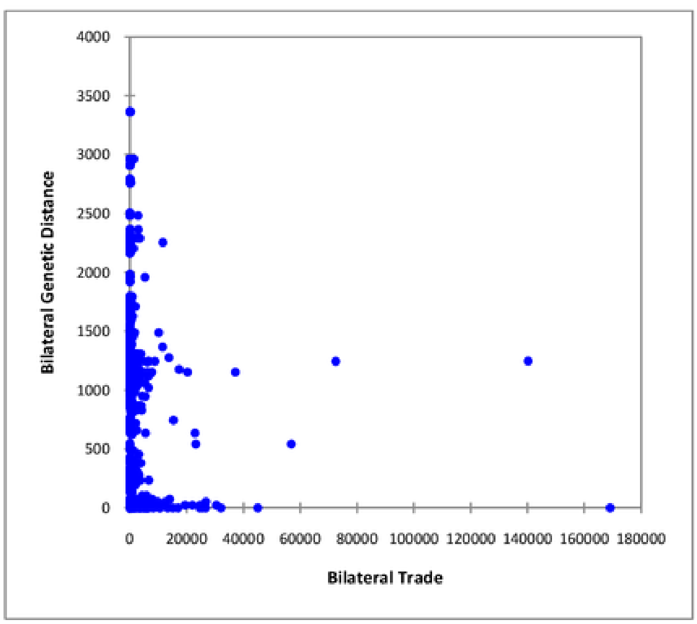


Figure 4: Relationship between the Bilateral Trade Matrix and Bilateral Genetic Distance Matrix



Tables

Table 1: Summary Table of Literature Review

Absolute Location

Channel	Effect on Growth	Measures	Examples
Disease	Incidence of malaria and other diseases has a geographical dimension.	Climate zone, latitude, average temperature.	Bloom and Sachs (1998), Gallup and Sachs (2001), McArthur and Sachs (2001).
Agriculture	Agricultural production depends on soil quality, topology and climate. Technology developed in temperate climates is not suitable for tropical climates.	Climate zone, soil type, average days of winter frost.	Gallup and Sachs (2000), Sachs (2000), Masters and McMillan (2001).
Policy	Abundance of natural resources discourages industrial production and results in rent seeking. Natural openness reduces corruption.	Mineral wealth, landlocked dummy, natural obstacles.	Gallup et al. (1999), Wei (2000).
Institutions	Long-run view. Institutions are a result of initial conditions (climate, location, natural resource abundance).	Climate zone, ecological diversity, latitude, landlocked dummy, natural obstacles, land mass.	Diamond (1997), Hall and Jones (1999), Acemoglu et al. (2001), Rodrik et al. (2002), Easterly and Levine (2003).
Trade	Natural openness encourages trade, lowers corruption and allows access to foreign technology.	Landlocked dummy, distance to the coast, navigable rivers, natural obstacles, land mass.	Sachs and Warner (1997), Frankel and Romer (1999).
Spatial heterogeneity	Parameters in growth models differ across economies. Countries and regions are converging to different steady states.	Latitude, climate zone, regional dummies.	Barro (1991), Armstrong (1995), Bivand and Brunstad (2002), Baumont et al. (2000), Roberts (2004).

Table 1 Continued

Relative Location

Channel	Effect on Growth	Measures	Examples
Technology diffusion	The rate of technology diffusion depends on distance to the technology leaders.	Geographical distance, cultural distance, transport costs.	Coe and Helpman (1995), Coe et al. (1997), Keller (2002), López-Bazo et al. (2004).
Spillovers	Political, social and economic factors in neighboring countries can have an impact on growth.	Contiguity, length of the border, geographical distance.	Ades and Chua (1997), Easterly and Levine (1998), Lall and Yilmaz (2001), Murdoch and Sandler (2002).
Spatial convergence clubs	Countries and regions are converging within groups.	Contiguity, geographical distance, cultural distance.	Baumont et al. (2003), Carrington (2003), Ramajo et al. (2003).
Standard spatial econometric analysis	Exploratory spatial data analysis, LISA, spatial lag and spatial error models, cross regressive, term, spatial regimes. Genetic distance significantly impact income differences across countries.	Contiguity, geographical distance, nearest neighbors, spheres of influence, genetic distance.	Moreno and Trehan (1997), Rey and Montouri (1999), Le Gallo et al. (2003), Spolaore, E. Wacziarg, R. (2009)
Fractionalization	Difficult to evaluate size of these effects due to high correlations of ethno linguistic measures with other explanatory variables	Ethnic, linguistic and religious fractionalization.	Alesina, Alberto, Arnaud Devleeschauwer, William Easterly, Sergio Kurlat and Romain Wacziarg (2003).
Human Capital	Significant results for schooling and accumulation of physical capital.	Years of schooling, physical and human capital accumulation, capital per worker.	Benhabib, J. and Spiegel, M.M. (1994), Pritchett, L. (2001), Krueger, A. and Lindahl, M. (2001),Cohen, D. and Soto, M. (2001)

Note: Table 1 is the modification of Table formulated by Abreu, Groot and Florax (2004).

Table 2

Basic Model of Growth Spillovers-MAX Likelihood Estimates-Dependent variable: Annualized change in log (GDP)

	(A)	(B)	(C)
W_d	1.31**		1.07***
	(0.28)		(0.31)
Cpi	0.002**	0.002**	0.002***
	(0.0005)	(0.0006)	(0.0005)
W_{gen}		0.95**	0.52*
		(0.28)	(0.29)
Countries	80	80	80

Notes: Standard errors are reported in parenthesis. Coefficient is statistically significant at the ***1%, **5% and *10% level.

Table 3

Basic Model of Growth Spillovers--MAX Likelihood Estimates - Dependent variable: Annualized change in log (GDP)

	(A)	(B)	(C)	(D)
Δ(log(k))	0.33**	0.32**	0.31**	0.27***
	(0.06)	(0.06)	(0.06)	(0.06)
Δ(log(ys))	0.21**	0.19**	0.17**	-0.19**
	(0.08)	(0.08)	(0.08)	(0.08)
$\log(y_0)$	0.01	0.007	-0.005	-0.004
	(0.01)	(0.013)	(0.01)	(0.01)
W_d	0.94**	0.92**		0.76***
	(0.24)	(0.24)		(0.24)
Δ(log(L)	0.007	0.07	-0.08	0.02
	(0.14)	(0.15)	(0.15)	(0.15)
Cpi		0.0008	0.001**	0.0009
		(0.0007)	(0.0007)	(0.0007)
W_{gen}			0.75**	0.52**
			(0.24)	(0.24)
Countries	69	69	69	69

Notes: Standard errors are reported in parenthesis. Coefficient is statistically significant at the ***1%, **5% and *10% level.

Table 4

PR1 Model of Simple Growth Spillovers-MAX Likelihood Estimates -

Dependent variable: Annualized change in log (GDP)

	(A)	(B)	(C)	(D)
Δ(log(k))	0.33**	0.31**	0.33**	0.30***
	(0.05)	(0.05)	(0.05)	(0.05)
$\Delta((\log(e^{0.1*ys}-1)$	-0.23**	-0.09	-0.03	0.07
	(0.08)	(0.08)	(0.09)	(0.08)
W_d	1.25**	0.93**		0.76***
	(0.245)	(0.25)		(0.27)
Cpi		0.001**	0.002**	0.001
		(0.0005)	(0.0005)	(0.0005)
W_{gen}			0.68**	0.37***
			(0.24)	(0.26)
Countries	76	76	76	76

Notes: Standard errors are reported in parenthesis. Coefficient is statistically significant at the ***1%, **5% and *10% level.

Table 5

PR2- Model of Simple Growth Spillovers-MAX Likelihood Estimates -

Dependent variable: Annualized change in log (GDP)

	(A)	(B)	(C)	(D)
Δ(log(k))	0.36**	0.30**	0.30	0.27***
	(0.05)	(0.06)	(0.06)	(0.06)
$\Delta((\log(e^{0.1*ys}-1)$	-0.14	-0.05	-0.10	0.09
	(0.09)	(0.09)	(0.09)	(0.08)
$\log(y_0)$	0.02	-0.01	-0.004	0.01
	(0.01)	(0.01)	(0.01)	(0.01)
W_d	1.06**		0.94**	0.77***
	(0.26)		(0.25)	(0.27)
Cpi		0.002**	0.001**	0.002***
		(0.0007)	(0.0007)	(0.0007)
W_{gen}		.78**		0.48*
		(0.27)		(0.28)
Countries	76	76	76	76

Notes: Standard errors are reported in parenthesis. Coefficient is statistically significant at the ***1%, **5% and *10% level.

Table 6

KL1 Model of Simple Growth Spillovers--MAX Likelihood Estimates -

Dependent variable: Annualized change in log (GDP)

	(A)	(B)	(C)	(D)
Δ(log(k))	0.32**	0.27**	.25**	0.24***
	(0.05)	(0.05)	(0.05)	(0.05)
Δ(ys)	0.17**	0.16**	.18**	0.16***
	(0.04)	(0.04)	(0.03)	(0.03)
ys_{60}	0.002**	0.001	0.001	0.001
	(0.0007)	(0.0008)	(0.0008)	(0.0008)
$log(y_0)$	-0.017	-0.02	-.04**	-0.03**
	(0.017)	(0.01)	(0.018)	(0.01)
W_d	0.63**	0.57**		0.37
	(0.25)	(0.24)		(0.25)
Cpi		0.001**	.002**	0.002***
		(0.0007)	(0.0007)	(0.0007)
W_{gen}			.68**	0.54**
			(0.24)	(0.25)
Countries	76	76	76	76

Notes: Standard errors are reported in parenthesis. Coefficient is statistically significant at the ***1%, **5% and *10% level.

Table 7

KL2 Model of Simple Growth Spillovers--MAX Likelihood Estimates -

Dependent variable: Annualized change in log (GDP)

	(A)	(B)	(C)	(D)
Δ(log(k))	0.56**	0.52**	0.53**	0.52***
	(0.05)	(0.05)	(0.06)	(0.06)
Δ(ys)	0.02	0.02	0.03	0.03
	(0.03)	(0.03)	(0.03)	(0.03)
ys_{60}	0.0002	-0.0002	-0.0002	-0.0002
	(0.0006)	(0.0007)	(0.0007)	(0.0007)
$log(k_{60})$	0.01**	0.009**	0.01**	0.009***
	(0.001)	(0.001)	(0.001)	(0.001)
$log(y_0)$	-0.09**	-0.09**		-0.09***
	(0.01)	(0.01)		(0.01)
W_d	0.25	0.23		0.22
	(0.19)	(0.19)		(0.20)
Cpi		0.001**	0.001**	0.001*
		(0.0006)	(0.0006)	(0.0006)
W_{gen}			0.09	0.021
			(0.20)	(0.21)
Countries	76	76	76	76

Notes: Standard errors are reported in parenthesis. Coefficient is statistically significant at the ***1%, **5% and *10% level

Table 8

Basic Model of Growth Spillovers with Latitude-Dependent variable: Annualized change in log (GDP)

	(A)	(B)	(C)
Δ(log(k))	.29***	.29***	.26***
	(.06)	(.06)	(.06)
Δ(log(ys))	-.15*	-.13	-.147
	(.095)	(.09)	(.09)
$log(y_0)$	-.001	-.003	-.002
	(.002)	(.002)	(.002)
W_d	.95***		.78***
	(.26)		(.27)
Cpi	.002***	.002***	.002***
	(.0007)	(.0007)	(.0007)
Lat	1.94e-06	.00002	-7.10e-06
	(.00004)	(.00004)	(.00004)
W_{gen}		.77***	.50*
		(.27)	(.27)
Countries	76	76	76

Notes: Standard errors are reported in parenthesis. Coefficient is statistically significant at the ***1%, **5% and *10% level.

Table 9

Basic Model of Growth Spillovers with common colony and language-Dependent variable: annualized change in log (GDP)

	(A)	(B)	(C)
W_d	1.25***		.98***
	(.30)		(.32)
Cpi	.002***	.002***	.002***
	(.0006)	(.0005)	(.0006)
W_{gen}		.97***	.62**
		(.29)	(.29)
W_{lang}	-.003	-.008	-.002
	(.006)	(.006)	(.006)
W_{col}	.009	.02**	.012
	(.008)	(.008)	(.008)
Countries	80	80	80

Notes: Standard errors are reported in parenthesis. Coefficient is statistically significant at the ***1%, **5% and *10% level.

Table 10

Basic Model of Growth Spillovers with common colony and language-Dependent variable: annualized change in log (GDP)

	(A)	(B)	(C)
Δ(log(k))	.32***	.32***	.27***
	(.06)	(.07)	(.07)
Δ(log(ys))	-0.22**	-.19**	-.204**
	(.08)	(.08)	(.081)
log(y_0)	.0008	-.0004	-.0006
	(.001)	(.002)	(.002)
W_d	0.13	.0004	.065
	(0.16)	(.1645)	(0.16)
Δ(log(L)	.85***		.69***
	(.25)		(.25)
Cpi	.001	.001*	.001
	(.0007)	(.0007)	(.0007)
W_{gen}		.75***	.55**
		(.25)	(.24)
W_{lang}	-.005	-.007	-.004
	(.005)	(.005)	(.005)
W_{col}	.005	.011*	.006
	(.007)	(.007)	(.006)
Countries	69	69	69

Notes: Standard errors are reported in parenthesis. Coefficient is statistically significant at the ***1%, **5% and *10% level.

Table 11
Basic Model of Growth Spillovers with common colony and language with Trade Spillover Dependent variable: annualized change in log (GDP)

	(A)	(B)	(C)
Δ(log(k))	0.32***	.31***	.27***
	(.06)	(.07)	(.06)
Δ(log(ys))	-0.19**	-.22**	-.20**
	(.08)	(.08)	(.08)
log(y_0)	.0003	-.0011	-.001
	(.001)	(.002)	(.001)
W_d	.07	-.05	.03
	(.16)	(.15)	(.15)
Δ(log(L)	1.02***		.86***
	(.28)		(.28)
Cpi	.0009	.001	.001
	(.0007)	(.0007)	(.0007)
W_{gen}		.65***	.50**
		(.22)	(.21)
W_{trade}	-.15	.42	-.06
	(.35)	(.32)	(.34)
Countries	69	69	69

Notes: Standard errors are reported in parenthesis. Coefficient is statistically significant at the ***1%, **5% and *10% level.

Table 12
Income Weighted Growth Spillovers-MAX Likelihood Estimates-
Dependent variable: Annualized change in log (GDP)

	(A)	(B)	(C)
W_{yd}	1.38***		0.98***
	(0.31)		(0.33)
Cpi	0.002***	0.003***	0.002***
	(0.0005)	(0.0005)	(0.0005)
W_{ygen}		2.12***	1.49***
		(0.49)	(.51)
Countries	80	80	80

Notes: Standard errors are reported in parenthesis. Coefficient is statistically significant at the ***1%, **5% and *10% level.

Table 13
Income Weighted Growth Spillovers--MAX Likelihood Estimates
BS-Dependent variable: Annualized change in log (GDP)

	(A)	(B)	(C)
Δ(log(k))	.31***	.28***	.27***
	(.06)	(.06)	(.06)
Δ(log(ys))	-.16*	-.11	-.14
	(.09)	(.09)	(.09)
log(y_0)	.0004	-.001	-.001
	(.002)	(.002)	(.002)
W_{yd}	.85***		.57*
	(.29)		(.32)
Cpi	.002**	.002***	.002***
	(.0007)	(.0007)	(.0008)
W_{ygen}		1.40***	1.01**
		(.46)	(.50)
Countries	76	76	76

Notes: Standard errors are reported in parenthesis. Coefficient is statistically significant at the ***1%, **5% and *10% level.

Table 14
PR1 Model of Income Weighted Growth Spillovers -MAX Likelihood Estimates-Dependent variable: Annualized change in log (GDP)

	(A)	(B)	(C)
Δ(log(k))	.30***	.31***	.28***
	(.05)	(.05)	(.05)
Δ((log($e^{0.1*ys}$-1)	-.11	-.04	-.08
	(.09)	(.09)	(.09)
W_d	.82***		.57*
	(.30)		(.31)
Cpi	.002***	.002***	.002***
	(.0005)	(.0005)	(.0005)
W_{gen}		1.31***	.98**
		(.44)	(.47)
Countries	76	76	76

Notes: Standard errors are reported in parenthesis. Coefficient is statistically significant at the ***1%, **5% and *10% level.

Table 15
PR2 Model of Income Weighted Growth Spillovers -MAX Likelihood Estimates-Dependent variable: Annualized change in log (GDP)

	(A)	(B)	(C)
$\Delta(\log(k))$	0.31***	.28***	.27***
	(0.06)	(.06)	(.06)
$\Delta((\log(e^{0.1*ys}-1)$	-0.10	-.05	-.09
	(0.09)	(.09)	(.09)
$\log(y_0)$	0.0008	-.001	-.0007
	(0.002)	(.002)	(.002)
W_d	0.83***		.55*
	(0.30)		(.32)
Cpi	0.002***	.003***	.002***
	(0.0008)	(.0007)	(.0008)
W_{gen}		1.41***	1.04**
		(.46)	(.50)
Countries	76	76	76

Notes: Standard errors are reported in parenthesis. Coefficient is statistically significant at the ***1%, **5% and *10% level.

Table 16
KL1 Model of Income Weighted Growth Spillovers -MAX Likelihood Estimates -Dependent variable: Annualized change in log (GDP)

	(A)	(B)	(C)
$\Delta(\log(k))$	.28***	.25***	.24***
	(.05)	(.05)	(.05)
$\Delta(ys)$	.18***	.18***	.17***
	(.04)	(.03)	(.03)
ys_{60}	.001*	.001	.001
	(.0009)	(.0008)	(.0008)
$\log(y_0)$	-.003	-.005**	-.004*
	(.002)	(.002)	(.002)
W_d	.38		0.14
	(.27)		(0.29)
Cpi	.002**	.002***	.002***
	(.0008)	(.0008)	(.0008)
W_{gen}		1.05**	.96**
		(.42)	(.46)
Countries	76	76	76

Notes: Standard errors are reported in parenthesis. Coefficient is statistically significant at the ***1%, **5% and *10% level.

Table 17
KL2 Model of Income Weighted Growth Spillovers -MAX Likelihood Estimates -Dependent variable: Annualized change in log (GDP)

	(A)	(B)	(C)
$\Delta(\log(k))$	.53***	.53***	.53***
	(.05)	(.05)	(.055)
$\Delta(ys)$	.02	.037	.02
	(.03)	(.03)	(.03)
ys_{60}	-.00008	-.00007	-.00008
	(.0006)	(.0007)	(.0007)
$\log(k_{60})$	.01***	.01***	.01***
	(.001)	(.001)	(.001)
$\log(y_0)$	-.01***	-.01***	-.01***
	(.002)	(.002)	(.002)
W_d	.22		.22
	(.20)		(.22)
Cpi	.001**	.001**	.001*
	(.0006)	(.0006)	(.0006)
W_{gen}		.15	.007
		(.34)	(.37)
Countries	76	76	76

Notes: Standard errors are reported in parenthesis. Coefficient is statistically significant at the ***1%, **5% and *10% level.

Table 18
Income Weighted Model of Growth Spillovers with Latitude- Dependent variable: Annualized change in log (GDP)

	(A)	(B)	(C)
$\Delta(\log(k))$	.31***	.28***	.27***
	(.06)	(.06)	(.06)
$\Delta(\log(ys))$	-.17	-.12	-.15
	(.09)	(.09)	(.09)
$\log(y_0)$	.0001	-.002	-.001
	(.002)	(.002)	(.002)
W_d	.81***		.53*
	(.307)		(.33)
Cpi	.001**	.002***	.002***
	(.0008)	(.0007)	(.0008)
Lat	.00002	.00004	.00002
	(.00004)	(.00004)	(.00004)
W_{gen}		1.36***	1.02**
		(.46)	(.50)
Countries	76	76	76

Notes: Standard errors are reported in parenthesis. Coefficient is statistically significant at the ***1%, **5% and *10% level

Table 19
Trust Spillovers-MAX Likelihood Estimates-Dependent variable: Annualized change in log (GDP)

	(A)	(B)	(C)
W_d	-0.22		-1.88
	(1.55)		(1.21)
Cpi	-0.002**	-.001	-.001
	(.001)	(.0008)	(.0008)
W_{trust}		.01***	.01***
		(.004)	(.004)
Countries	14	14	14

Notes: Standard errors are reported in parenthesis. Coefficient is statistically significant at the ***1%, **5% and *10% level.

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