Iranian Economic Review, Vol.10, No.17, Fall 2006

Determining the Degree of Development of the OIC State Members, for Establishing a Common Market

Esrafill Kasraie[*]

Abstract[1]

The rates of long run economic growth and the degree of economic interdependence among nations are related. These dependencies, linkages or spillovers are related to different aspects of development mainly to economics and geography. Adding a geography dimension, the Ordinary Least Squares models lead to inefficient estimates and invalid statistical inferences. A nonparametric[2] spatial econometric methods and a distance based weight system is used to take into account spatial covariance in terms of the long run economic growth rates of a country's unobservable characteristics rather than a country's own observable characteristics, or the cross-country spillover effects among nations. To measure the degree of development among countries, there is a need to compute these relationships. This variance-covariation reflects more than the existence of common shocks. That is, a country's growth rate is closely related to its nearby countries, and trading *alone* does not appear responsible for these linkages, but being near a large market can contribute more to growth rates.

Keywords: SAR, GWR, Spillovers, Convergence, Degree of Development, Regional Growth, Organization of the Islamic Conference, Core-Peripheral setting.

1- Introduction

The goal of this empirical investigation is to find the best way to determine the degree of "development" among the OIC --Organization of the Islamic

* Associate professor of Faculty of Economics, Tehran University.

1- This project is funded by the Institute for Trade studies and Research, Ministry of Commerce, and Ministry of Science & Higher Education.

2- I am indebted to professor James P. Lesage for his generous and helpful free domain MATLAB Toolbox: for Spatial econometrics available on Internet.

Conference member states[1], in order to rank them and to find the highest potential, most accessible geographically located countries for defining a core-periphery setting to establish a common market. Prioritization state members can lead to calibration of one or more "core" countries for polarization, whereas the remaining can be classified as semi or peripheral ones. The idea behind this core-periphery setting is to define one or more growth poles for more effective spillovers and consequently faster convergence to a steady state of growth and thus to higher productivity levels or development.

To build a spatial econometric model of the 57 OIC state members[2], more than 15 cross-sectional data sets of economics and technology over a period of twenty years (1980−2000) are pooled to estimate the GDP per capita growth rates of each country. This predicted dependent variable is assumed to be equivalent to some indices of economic development. Due to unavailability of some information on some time-series, not more than 38 observations are completed. Predictions are presented in two elementary scenarios of SAR and GWR model[3] and taking the advantage of having both a combined scenario, is being applied to estimate the covariance among countries in the region.

The applied nonparametric model uses MATLAB programming language with a distance based weight matrix leading to the estimation of different specifications and results for analyzing the regional spillover effects. Concluding, the measure of economic development of a country in a region should first underline and consider the influences of its neighbors then its geographic position and specifications. This is because a random shock of a given country such as war, ecological shocks or transitory shocks can affect and propagate primarily to the close neighbors in the region.

1- Organization of the Islamic Conference -- OIC is an inter-governmental organization grouping fifty-seven States. The state members decided to pool their resources together, combine their efforts and speak with a unified voice to safeguard thier interest to ensure the progress and well-being of their peoples and those of other Muslim countries in the world. The main objective of the organization is to strengthen solidarity and cooperation among Islamic states in the fields of political, social, economic, and technology fields.

2- except Palestine.

3- LeSage James P., "The Theory and Practice of Spatial Econometrics" , 1999: http://www.econ.utoledo.edu (Department of Economics, University of Toledo), and http://www.spatial-econometrics.com (along with a MATLAB library and functions).

A spatial covariance function of long run per capita GDP growth rates of a country is decomposed into three parts: (1)- each country's own observable characteristics due to its own potentialities, (2)- a function of unobservable characteristics (or residuals), and (3)- a function of cross-country spillovers. Calibration of the last function along with the distance-based decay functions can be used to determine the degree of development to establish a common market or a core-periphery setting in a region. This last variance-covariance feature provides a measure of linear relationship between the observable or measurable features of a country and the proportion of growth rates that are related to all other nearby countries (not directly countable for the observable characteristics), considering a distance weight among them.

To accomplish this goal, the paper is arranged in seven sections as the following:

(1) introduction to concepts of integration as a means of development to address some hypothetical related questions. (2)- establishing a hypothesized common market can help to accelerate the convergence? Using the convergence concepts and theories to figure out whether the establishing a common market can help the OIC member states to speed up the process in long run. (3)- Defining the data, datasets, distances among the countries and the variables. (4)- Prediction of the GDP per capita growth rates with the spatial autoregressive -- SAR model, as a first scenario. (5)- Prediction of the GDP per capita growth rates with the geographically weighted regression -- GWR model, as a second scenario. (6)- Combining the GWR mode; with the Conley and Ligon (2002) to calibrate the cross-country spillovers along with the economic distances among the OIC countries. (7)- Finally summarizing the findings. The functional structure and the applied models to the OIC member states are to specify the process of development. Then, on the bases of solely calculated variance-covariance, calibrate the degree of development and the core-periphery settings.

1. Why integration? Is integration a means of development?

While the degree of development can be used to distinguish one set of countries from the others, one must be more careful with the terms used to describe the development process itself and to justify the specifications. The terms economic growth and economic development sometimes are used interchangeably, leaving none fundamental distinctions aside. Economic growth refers to a rise in per capita income or product; but the key element in economic development is that the work force or people of the country must be major participants in the process that bring about these fundamental changes in structure. Thus, it always should be kept in mind that, while economic development in modern economic growth involve, much more than a rise in per capita income or product, no development could occur without economic growth. Therefore, to measure the development process, I start with the distinctions of the gross national income (GNI) per capita (defined by the World Bank Atlas method 2000) into a four-group classification for analytical purposes as the following histogram:

Low income, $735 or less;
Lower middle income, $736–2935;
Upper middle income, $2936–9075; and
High income, $9076 or more.

Diagram (1.1) shows, almost 53% of the OIC countries have the GNI per capita less than $735 and 81% less than $2935, whereas $19% or about one fifth have the GNI per capita more than $2935.

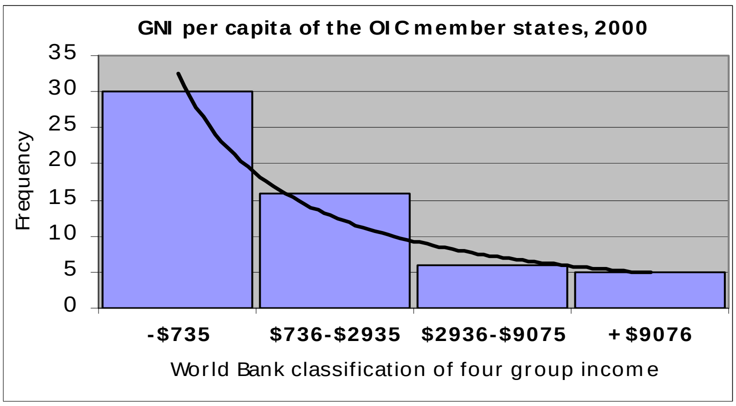


Diagram 1: the frequency of group classification of the OIC countries by their GNI

The following Table (1.1) illustrates the 1999 average per-capita GNP, similar to the previous four groups, together with average life expectancy at birth as another indicator of economic well-being. This table shows the sharp disparities in average per capita GNP in the richest economies as being almost 63 times that of the average in the poorest developing countries. Even the upper middle-income countries enjoy only about one-fifth of the per-capita GNP of the high (industrial) group. The life expectancy figures generally reflect international differences in income levels. Average life spans fall as relative poverty increases. Economists offer different indicators to show more than one influential variable such as rate of growth in product or income influence the process. There is very little doubt, in fact, that these variables are significantly associated with per-capita income.

Table 1: indicators of economic welfare in four groups of countries, 1999

Income group	GNP per capita (US$)	Life expectancy (year)▪*
Low income	410	60.0
Lower middle income	1,200	69.5
Upper middle income	4,900	70.5
High income	25,730	78.0

Source: World Bank, World Development Report 2000/2001.

▪* simple average of male and female life expectancy

(1)- Low-income economies: including India, Pakistan and their neighbors along with much of the sub-Saharan Africa.

(2)- Lower middle-income economies: including mainland China, the smaller Latin American and Caribbean countries, many former Soviet bloc countries, and most of the remaining African countries.

(3)- Upper middle-income countries: including the largest Latin American countries, Saudi Arabia, Malaysia, Turkey, South Africa, Poland, Hungary, and Czech and Slovak Republics

(4)- High-income economies: including the rich industrial market economies, and a handful of exceptionally fortunate “developing” countries, such as oil-rich Kuwait, and Singapore.

Over the last decade, there has been a significant increase in the efforts of devel oping countries to achieve regional economic integration[1] in order to alleviate the disparities between the poor and the rich. In various parts of the developing world, existing regional arrangements have been revitalized or expanded and new groupings formed. A newly developed aspect of the OIC states as common market to integrate the regions can only succeed if certain economic and non-economic preconditions are fulfilled. Important components here include structural stability (peace and security), the rule of law, good governance, and monetary stability. One or more of these preconditions were lacking in many of the OIC countries that would participate in establishing a common market. For example, if there is conflict or civil strife in one of the core members, it is hardly realistic to expect any meaningful progress towards economic integration. The OIC member states can create a single market[2] for a wide range of service industries to play a prominent role to boost the economies and to operate across borders more than before. Inadequate institutional design can contribute to too many bottlenecks. Most literature on economic integration glosses over such matters. If countries say, want to form a common market or a free trade area; they need a geographic orientation of the region and a model to

1- Economic integration is a term used to describe how different aspects aomong economies are integrated. The basics of this theory were written by the Hungarian Economist Béla Balassa in the 1960s. As economic integration increases, the barriers of trade between regional markets diminish. The degree of economic integration can be categorized into six stages:

1. Preferential trading area
2. Free trade area
3. Customs union
4. Common market
5. Economic and monetary union
6. Complete economic integration

2- A *single market* is a customs union with common policies on product regulation, and freedom of movement of all the factors of production. Sometimes a *single market* is differentiated as a more advanced form of common market. In comparison to *common* market a *single market* envisions more efforts geared towards removing the physical (borders), technical (standards) and fiscal (taxes) barriers among the member states. These barriers obstruct the freedom of movement of the all factors of production. To remove these barriers the member states need political will and they have to formulate common eco-political policies and strategies.

devise a workable scheme. However, fixing the core-periphery part of the menu might be difficult to achieve. The actual implementation is a delicate process to cover the setting of a realistic target (one or more core as a growth pole), then deployment, control and resolution of the disputes.

Considering the EU, NAFTA (or LAFTA) etc, the central question is why integration occurs in some places at certain times but not in others. The references to states' potentials, preferences and international power relations suite better to answer this question. Economic integration between states with extremely asymmetric economic sizes offers little incentive to the predominant state especially if the expansion of the size of the market constitutes the major component of the incentives for regional integration (Milner 1997).

This, the next question is what interests do states have to have in common in order to initiate a regional integration? The political economy of international economic policy literature suggests that there must be sufficient interests among different states in regional economic integration. One powerful source of integration interests is private and public businesses that anticipate gains from the expansion of the market. Consumers are also potential beneficiaries from integration because increased competition and economies of scale will supply goods and services of higher quality at more competitive prices. However, the diffusion of consumer interests promotes greater problems of collective action than certain business interests that have stakes in promoting or stalling integration.

The rationale in the OIC member states for selecting one or more "core" countries is to determine the countries which are more advanced with high potentials and spillovers to initiate the process of regional integration. Conclusively, all the OIC member states would be prioritized in a hierarchical pattern (for determining their degree of development) to select the top leading ones; and then, select groups of "peripheral" and "semi-peripheral" countries around the central (or core) ones. In other words, the result of a core-periphery ranking is to integrate the homogenized countries into three groups or clusters: (1)-core, (2)-semi peripheral and (3)-peripheral, depending on their spatial weight structure and the economic capabilities. The nature of this geographic integration then can be evaluated based on the feasibilities or the capabilities in conditions (collection of other parameters)[1]. The structure of relationship revolves around two questions.

- ✓ First, is economic growth in other countries good or bad for our nation?
- ✓ Second, is growth in a country more or less valuable when that nation is part of a closely integrated regional economy?

In assessing the effects of growth in other countries, common sense arguments can be made on either side. On the one hand, economic growth in the rest of the region may be good for our economy because it means larger markets for our exports. On the other hand, growth in other countries may mean increased competition for our exporters.

Then on the contrary, why have some countries that were poor a generation ago succeeded in making dramatic progress, while others have not? However, changing views about economic development can have major role in determining trade policies and the way to facilitate it.

Krugman and Obstfeld (2003, p668) looked at the per-capita output growth rates for different country groups between 1960 and 1992. They observed some countries enjoying a higher growth rate, while many others displaying almost none. The first set of these countries formed a club so-called “convergence", which draws many economists' attention. The point behind this observed convergence in per-capita incomes is simple. If trade is free, if capital can move to countries offering the highest returns, and if knowledge itself moves across political borders so that countries always access to cutting-edge production technologies, then there is no reason for international income differences to persist for long.

To advocate this kind of development process it is critical to reexamine very seriously the indicators in modeling of the OIC member states because of the following reasons:

(1)- The first reason, leads to a theory, or a set of contradictory theories, in which regional integration (countries of different size at different stages) has created a big debate among economists both for the opportunities and the

1- Note that, the collective strategies to overcome the possible problems or the information to offer for promoting efficiency gains in facilitating integration or cooperation among members does not address and apply here.

challenge is going to bring and for the countries is going to benefit more from each other. In other words, the major question is do development in nearby countries matter. More specifically, *does a country's long-term growth rate depend on what happens in countries that are nearby*? It is unlikely that any given measure of proximity will be appropriate for every kind of spillover. For instance, certain kind of knowledge may flow more easily across countries that trade a lot with each other, rather than countries that are next to each other.

(2)- The second reason, why one may find the integration theories important is that they do not reply on "fundamental" differences across peoples or cultures. Once again, this is not the place to examine in detail fundamentalist explanations based on cultural or religious differences[1], but simply applying these theories to the ICM[2] or OIC member states, seems very convincing. This is not to say that the theory -- similar to convergence[3] -- does not play a significant role; however, considering the view of the OIC countries with similar culture and religion[4], along with several other aspects -- socioeconomic and political institutions, are all parts of some broader interactive theory in which the "first cause" is to be addressed.

1- The first perspetive of the (neo) functionalism posits that regional integration arises due to increasing technological, economic, and other complexities and problems that countries can no longer effectively solve at the nation-state level. According to this perspective, governments are likely to enter cooperative arrangements in order to cope with various functional needs, such as the improvement of economic welfare for their citizens. Once the political elite establish a cooperative arrangement, the theory predicts that integration would become self-perpetuating through a "spillover" process (Haas 1964).

2- Islamic Common Market

3- Barro J., and Xavier Sala-i-Martin (2004), Economic Growth, 2nd edition, MIT press, pp. 2−10

4- Hoping that, the idea of the cultural similarity can place a much greater weight on regional co-integraion than theories that are based on fundamentals, if it is truly believed that cultural and political initiatives can play an effective role on rates of growth to create a very cooperative role for government policies.

2- Does establishing a common market can help to accelerate the convergence among rich and poor nations?

The first critical question now is; can the economies with lower product or capital per person grow faster in per capita terms? Alternatively, does close neighboring tend to be convergence across economies? Using the convergence concepts of Barro and Sala-i-Martin (2004, p462) that appear in discussions of economic growth across countries or regions can explain how the less-advanced economies with the lower initial values of production or income per person can have higher growth rates in long run[1]. In other view, convergence applies if a poor economy tends to grow faster than a rich one, so that the poor country tends to catch up to the rich one in terms of levels of per capita income or product[2].

Following the concepts and the theory of convergence, the next question is; is there any spatial interdependency, or is the convergence possible among the OIC countries?

The spillovers among countries, or the neighborhood effects, can be identified with the model developed by Barro and Sala-i-Martin (1991) for a neoclassical (Solow and Swan version) exogenous growth[3]. Assuming preferences and steady state of GDP per capita growth rates to be almost the same in the regions within the OIC countries; the approach simply holds that countries that are actually poor in terms of per capita product or income levels

1- Some economists use the expression *balanced growth path* to describe the state in which all variables grow at a constant rate and use *steady state* to describe the particular case when the growth rate is zero.

2- This phenomenon is sometimes described as "regression toward the mean", and corresponds to the concept of β convergence.

3- One reason suggested by neoclassical growth theory is decreasing marginal productivity of capital; there may be, however, other reasons for the same mechanics derived from other growth models. Therefore, the convergence approach sketched above cannot discriminate between different growth theories:

$$\frac{1}{T}\ln\left(\frac{y_{t,T}}{y_{i,o}}\right)=\alpha+\beta\ln(y_{i,o})+\gamma X_i'+\varepsilon_i \qquad \varepsilon_i \approx i.i.d(0,\sigma_\varepsilon^2)$$

X is a vector of variables, maintaining constant the stationary-state of region i, including some state variables, like the stock of physical or human capital, and control or environment variables, like the ratio of public consumption to GDP, the ratio of domestic investment to GDP, the modification of terms of trade, the fertility rate, the degree of political instability etc.

should grow faster than richer ones in their adjustment process towards equilibrium.

$\hat{y}_{st} = \frac{1}{T}(\ln y_{st+T} - \ln y_{st}) = \beta_o + \beta_1 \ln y_{st} + u_{st}$ where, $u_{st} \sim$ i. i.d $(0, \sigma_u^2)$ (1)

or $\hat{y} = \beta_o + X\beta$ in matrix notation. y_{st} denotes per capita product or income in region s (s = 1,..., S) at time t, …,T the number of periods under consideration. β_o is a constant term reflecting characteristics of the steady state equilibrium and the rate of (exogenous) technical progress which is assumed to be the same across all regions, β_1 is the convergence parameter, and u_{st} a random error term. The model (1.1) is formally equivalent to a model of partial adjustment (towards the steady state growth path). Where, $\beta_1<0$ indicates convergence; and $\beta_1>0$ indicates divergence; $\beta_1=0$ is similar to a random walk in time-series analysis.

Applying the equation (1.1) and using the MATLAB Toolbox of LeSage (1999), results a coefficient $-\beta_1 = -0.004019$, indicating that the OIC countries can and will converge. The version of the neoclassical model is considered in the form of a univariate regression that relates the average growth rate of per capita product for a country or economy i over the interval from 0 to T years (or between period of 1980-2000) to the initial level of product (1980 and T=20), follows:

$$\hat{y} = 0.031866 - 0.004019X$$
$$(2.123904) \quad (-1.839020)$$
$$R^2 = 0.0859 \qquad \sigma^2 = 0.0003 \qquad \text{Durbin-Watson} = 2.0265$$

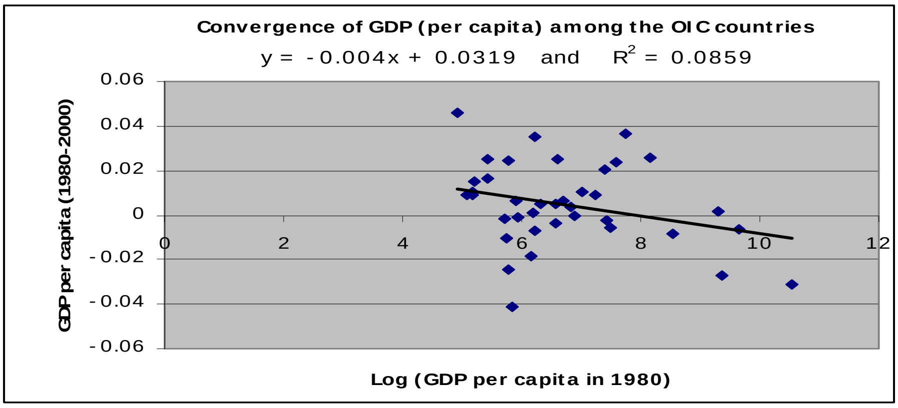
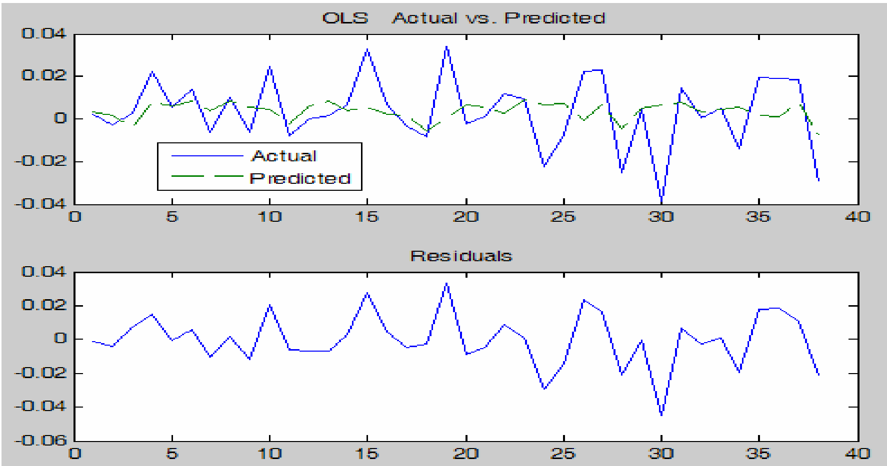


Diagram2: $\beta_1 < 0$ indicates a convergence among the OIC member states



There is β –convergence when β is negative and statistically significant. Since in this case

The estimated speed of convergence in 38 states of the OIC members is about 0.0042 or 0.42 percent per year, which is almost one tenth of Barro, Sala-i-Martin (2002), finding for the USA. Comparatively, the OIC member states will converge 20 times slower than the advanced countries[1].

the average growth rate of per capita GDP between dates 0 and T is negatively correlated with the initial level of per capita GDP, then the estimated of β makes it possible to compute the speed of convergence: $\theta = -\ln(1+T\beta)/T$. The time necessary for the regions to fill half of the variation, which separates them from the stationary state, is called the half-life: $\tau= -\ln(2)\ln(1+\beta)$. Therefore the half way time between $\log[\hat{y}(0)]$ and $\log(\hat{y}^*)$ that satisfy the condition $e^{-\beta^* t}=1/2.$ is $\log(2)/\beta^*=0.69/\beta^*$ ($\beta^*=0.004019$) or 0.4 percent per year, or $\tau=172$ years.[2]

1- Note: the regression should be nolinear to estimate equation. Barro, Sala-i-Martin (2002), for the different periods: 1880-2000, 1880-1900, 1990-2000 (with 47 obsevations) estimated β as 0.0172, 0.0101, 0.0016 with R^2 as 0.92, 0.36, 0.01 repectively. The estimated speed of convergence in 47 states of the U.S.A implied by his relation is 2.1 percent per year (See, Barro, Sala-i-Martin 2002, p 468); whereas in the OIC countries (n=38) this speed is: $\theta=\ln(T\beta+1)/T= \ln(1+20*0.004019)/20 \approx 0.004$ (for the 20 years) is about 0.4 percent per year.

2- The estimated coefficient by Baumont, Ertur and Le Gallo (2001) model in a sample of 138 European regions over the 1980-1995 period associated with the initial per→

3- Definition of variables[1], dataset and distances among the OIC countries.

Recent theoretical and empirical work generally ignores the impact of location on growth. Moreno and Trehan (1997) studies show that distance matters for variables that are generally thought to matter for growth. Thus, distance is an important explanatory variable in empirical models of trade and foreign direct investment. They find strong evidence that a country's growth rate is positively influenced by the growth rate of countries nearby, and that this reflects more than just the influence of common shocks to the region. It helps to be near a large market, where size is measured by a country's real output. The results are robust to conditioning on a set of variables commonly used to predict growth rates, a finding that provides information about the channels of the spillovers[2].

To implement a model, two different measures of distances are applied[3]. The first one is a weighting matrix of the distances whose elements are given by $w_{ij} = \frac{1/d_{ij}}{\sum_j 1/d_{ij}}$, ($w_{ii} = 0$), where d_{ij} is the distance between (the capitals of) two countries and normalized the matrix so that each row sums to one. This can link all the countries in the data set with each other.

←capita GDP is significant and negative, $\hat{\beta} = -0.0079$, which confirms the hypothesis of convergence for the European regions. The speed of convergence associated with this estimation is 0.84% and the half-life is 88 years. These results indicate that the process of convergence is weak , $R^2 = 0.13$ and are in conformity with other empirical studies on the convergence of the European regions (Barro and Sala-I-Martin, 1995).

1- The main official sources of data for period of 1980-2000 are as the following:

(a)- World Bank--World Development Indicators 2003, CR-Rom compilation about development,

(b)- SESRTCIC--The Statistical, Economic and Social Research and Training Centre for Islamic Countries, and (c)- CEPII's distance measures

(Source: Guilaume Gaulier, Thierry Mayer and Soledad Zianago, 2004, Note on CEPII's distances measures).

2- Moreo, R and B. Trehan (1997, Location and the Growth of Nations, p3.

3- Guilaume Gaulier, Thierry Mayer and Soledad Zianago, 2004, Note on CEPII's distances measures

In another sense, each country belongs to the neighborhood of every other county. However, the relative importance of each country in a particular neighborhood varies inversely with its distance from the country whose neighborhood it is. The following histogram shows the frequency distribution of the d_{ij} and some other specifications:

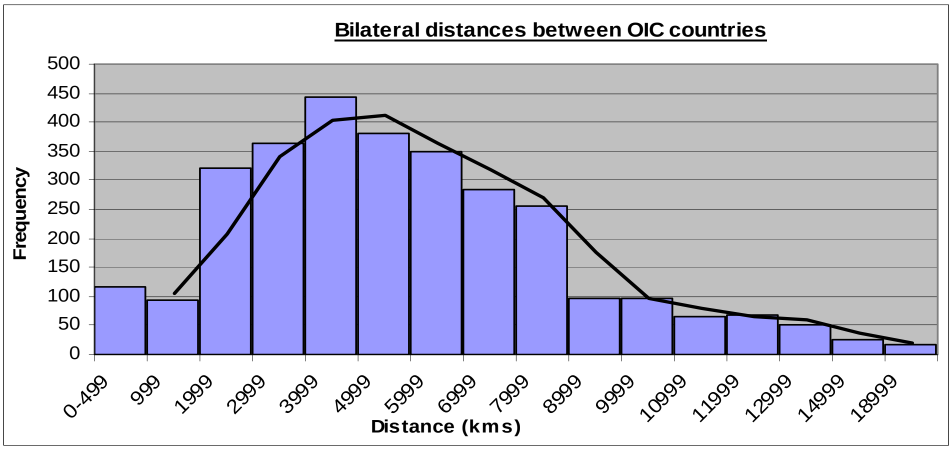


Diagram3: Histogram of Distances by their frequencies among the OIC state members

Max. = 18541 kilometers

Min. = 86 kilometers

Average = 5000 kilometers

Standard deviation=3000 kilometers (right skewed)

The second type of measure is a vector of distances rather than a matrix that is called the latitude-longitude coordinates. This measurement defines the distance from a central observation i as: $d_i = \sqrt{(Z_{xi} - Z_{xc})^2 + (Z_{yi} - Z_{yc})^2}$ where Z_{xc} , Z_{yc} denote the latitude-longitude coordinates of the centrally located observation and Z_{xi} , Z_{yi} denote the latitude-longitude coordinates for observation i in the data sample. This approach allows one to ascribe different weights to observations based on their distance from the central place of origin.

The Gauss-Markov view of a stepwise regression is used to verify the data and variables in the form of $y = \alpha + X\beta + \varepsilon$. y represents a vector of GDP per capita (annual percentage) growth rates averaged over 20 years as a dependent variable, X denotes a 38x5 matrix of explanatory variables[1]. These five variables are the only five statistically significant variables verifying by an OLS mode:

X1, HDI Index[2] ,

X4, GNI/cap. PPP (current international $), as an initial income for 1981,

X5, Manufacturing Value Added (annual % growth),

X9, Market potentials[3],

X11, Domestic credit provided by banking sector (% of GDP)

4- SAR -- Spatial autoregressive model

Using the preprogrammed functions by LeSage (1999) for the spatial econometrics functions, a *spatial autoregressive model*-- ***SAR*** (sometimes called mixed regressive) implemented as a first scenario to produce maximum likelihood estimates for the OIC's countries. This model can be represented with traditional matrix notation Xβ, to be able to modify and take the form shown below as equation (1.3). This is the extension of the *first-order spatial autoregressive* – **FAR** model

$$y_i = \rho \sum_{j=1}^{n} w_{ij}\, y_j + \varepsilon_i = \rho\, wy + \varepsilon_i \qquad , \qquad \varepsilon_i \sim N(0, \sigma^2) \qquad (2)$$

then, to include a matrix X of explanatory variables such as those used in traditional regression models, with a maximum likelihood method for estimating the parameters as the following :

$$y = \rho Wy + X\beta + \varepsilon \text{ [where } \varepsilon = \rho W\varepsilon + u \text{ and } y = X\beta + \varepsilon] \ \varepsilon \sim N(0, \sigma^2_{In}) \qquad (3)$$

Where y contains an nx1 vector of dependent variables, X represents the usual (nxk) data matrix containing explanatory variables and W is the distance matrix. The parameter ρ is a coefficient on the spatially lagged dependent variable. Wy, and the parameters β reflect the influence of the explanatory

1- Running the 15 explanatory variables by a multiple regression model indicates that in spite of a satisfactory measure of $R^2 = 0.8810$, ten of them are not statistically significant and cannot be used further for the analysis.

2- Sourc: Technical Note 1: Calculating the Human Development Indices, 2004: http://hdr.undp.org/statistics/faq.cfm#1

3- Source of data: TradeSim (second version), a gravity model for the calculation of trade potentials for developing countries and economies in transition, Market Analysis Section--MAS, (May 2003), by Lionel Fontagné and Jean-Michel Pasteels, under the supervision of Friedrich von Kirchbach, edited by the International Trade Centre UNCTAD/WTO.

variables on variation in the dependent variable y. The model is termed a mixed regressive because it combines the standard regression model with a spatially lagged dependent variable, reminiscent of the lagged dependent variable model from time-series analysis. The function **SAR** is similar to the **FAR** function in manipulation and results[1].

To apply the data to the SAR function running with the MATLAB, where it can be explain the variation in average rate of per capita GDP growth for the 38 member of the OIC states in period of 1980-2000 with the result as the following:

$$\hat{y} = 29.888429 + 32.373008X_1 - 8.216441X_4 + 2.085886X_5 - 4.313375X_9 - 1.307717X_{11} - 0.463976Wy$$
(6.498133) (9.908590) (-10.441162) (2.575134) (-3.541942) (-2.270868) (-1.456746)

R^2 =0.8243 σ^2 =0.5318 log-likelihood=–29.016409 # of iteration =15

The independent variables on the right hand side approximate the estimation of development, $\hat{y}$ (growth plus other related effects and the initial income, $\hat{y}$ = X*b + p*W*y). The **SAR** model, as it stands, precludes any other relationship between the per capita GDP growth rates of different countries, except to the extent that the right-side variables estimate a growth rates for each states $\hat{y}$ (as scenario#1). To test the assumptions in a straightforward manner, using the matrix of distances among countries -- a hypothesis that the distance-weighted average growth rate of countries does not belong to equation -- H_o : ρ=0, cannot be rejected easily. The results indicate, most of the explanatory variables exhibit significant effects on the variable to explain. The result also

1- Maximum likelihood estimation of this model is based on a concentrated likelihood function, as was the case with the FAR model. Anselin (1988) along with a uni variate parameter optimization of the concentrated likelihood function over values of the autoregressive parameter ρ, enumerated the following steps as:

1. perform OLS for the model: $y = X\beta_0 + \varepsilon_0$
2. perform OLS for the model: $Wy = X\beta_L + \varepsilon_L$
3. compute residuals $e_0 = y + X\hat{\beta}_o$ and $e_L = Wy + X\hat{\beta}_l$
4. given e_0 and e_L, find ρ that maximizes the concentrated likelihood function:

$$L_C = -\left(\frac{n}{2}\right)\ln(\pi) - \left(\frac{n}{2}\right)\ln\left(\frac{1}{n}\right)(e_0 - \rho e_L)'(e_0 - \rho e_L) + \ln|I - \rho W|$$

5. given $\hat{\rho}$ that maximizes L_C, compute $\hat{\beta} = (\hat{\beta}_O - \rho\,\hat{\beta}_L)$ and

$$\hat{\sigma}^2_\varepsilon = \left(\frac{1}{n}\right)(e_0 - \rho e_L)'(e_0 - \rho e_L)$$

shows that the dependent variable y exhibits some spatial dependence among the states, ρ= − 0.463976, even after taking the effects of the explanatory variables in X into account. The estimation indicates that spatial distance exerts some influences on the GDP per capita growth rates in OIC member states.

Scenario#1: Ranking of the OIC countries based on the SAR model:

Using w_{ij}, as a *Normalized* distance matrix among capitals of the OIC states:

$y_t = \alpha + \rho Wy + X\beta + \varepsilon$ where $\varepsilon \approx N(0, \sigma^2 I_n)$

Ranking	Country	y_t, (GDP/c, A % g)	$\hat{y}_t = \alpha + \rho Wy + X\beta$ Forecasted GDP growth rates
1	Indonesia	3.8209	4.2694
2	Malaysia	3.8911	3.1831
3	Pakistan	2.4003	2.3909
4	Bangladesh	2.6802	2.3264
5	Syrian Arab Rep.	1.0083	1.9671
6	Egypt, ArabRep.	2.8153	1.8524
7	Tunisia	0.3014	1.6739
8	Jordan	2.2224	1.5283
9	Oman	0.8293	1.2814
10	Albania	2.1468	1.2493
11	Benin	2.232	1.2031
12	Uganda	0.8789	1.1211
13	Turkey	2.6384	1.1041
14	Chad	0.916	1.0226
15	Bahrain	1.1874	1.0222
16	Morocco	1.179	1.0184
17	Cameroon	-0.6239	0.9728
18	Burkina Faso	-0.3983	0.9558
19	Iran, Islamic Rep.	0.2851	0.9006
20	Guyana	1.3968	0.8709
21	Mozambique	1.5894	0.8678
22	Comoros	0.3133	0.7374
23	Sudan	-0.8326	0.6778
24	Nigeria	0.8471	0.4546
25	Senegal	0.254	0.1459

26	Guinea-Bissau	-1.0044	-0.0625
27	Togo	0.3591	-0.192
28	Suriname	-0.294	-0.369
29	Mali	0.0822	-0.4066
30	Algeria	-0.3515	-0.4312
31	Mauritania	0.156	-0.6924
32	Gambia, The	-0.6015	-0.9473
33	Gabon	0.1021	-1.0639
34	Kuwait	-1.9278	-1.704
35	Niger	-2.4053	-2.0542
36	Saudi Arabia	-2.3034	-2.229
37	Sierra Leone	-3.4367	-2.8614
38	United Arab Emir	-3.1488	-3.244

Note that, the estimated pattern of the growth rates of the GDP per capita of the OIC, $\hat{y}_t$ does not differ much with the original trend, y_t .

5- GWR -- Geographically Weighted Regression of locally linear spatial model

To examine whether the presented regional growth pattern reflects the distribution of some (well-understood) determinants of the growth rates, a more general version of the previous equations will be examined. Where this specification allows growth in country i to depend on growth rates in other countries as well as a set of variables contained in X. To explain this very important model called the *locally linear spatial models* and to discuss a method that attempts to accommodate spatial heterogeneity[1] a nonparametric locally linear regression model labeled as GWR will be introduced in the following section.

Locally linear regression methods introduced by McMillen (1996), Brunsdon, Fotheringham and Charlton (1996), labeled as BFC is applied as a second scenario, because of its unique specifications. The main contribution of

1- The term spatial heterogeneity refers to variation in relationships over space. In a most general case, one might expect a different relationship to hold for every point in space. Where, a linear relationship depicting this relationship can be written as:
$y_i = X_i\beta_i + \varepsilon_i$.

the **GWR** methodology is the use of *distance-weighted sub samples of the data to produce locally linear regression estimates for every point in space (every country)*. Each set of estimated parameter is based on a distance-weighted sub-sample of “neighboring observations”, which has a great deal of intuitive appeal in spatial econometrics[1].

The very important term in this model is the spatial heterogeneity that refers to variation in relationships over space. In the most general case, we might expect a different relationship to hold for every point (every country in relation to all others) in space. Formally, we write a linear relationship presenting this model as $y_i = X_i\beta_i + \varepsilon_i$

Where i indexes observations collected at i = 1, ... , n points in space, X_i represents a vector of explanatory variables with an associated set of parameters β_i , y_i is the dependent variable at observation (or location) i and ε_i denotes a stochastic disturbance in the linear relationship.

A slightly more complicated way of expressing this notion is to allow this function f() to vary with the observation index i, that is: $y_i = f_i\,(X_i\,\beta_i + \varepsilon_i)$

Restricting attention to this simpler formation, we could not hope to estimate a set of n parameter vectors β_i given a sample of n data observations. We simply do not have enough sample data information with which to produce estimates for every point in space, a phenomenon referred to as a “*degrees of freedom*” problem. To proceed with the analysis we need to provide a specification for variation over space. This specification must be parsimonious, that is, only a handful of parameters can be used in the specification.

In non-parametric models, the distance-based weights used by BFC for data, at observation i take the form of a vector W_i determined using a vector of distances d_i between observation i and all other observations in the sample. This distance vector along with a distance decay parameter is used to construct a weighting function that places relatively more weight on neighboring sample observations from the far away spatial data sample.

1- While this approach has a definite appeal, it also presents some problems but a Bayesian approach called BGWR can be used to correct these problems. The BCWR model is also applied and tested in this investigation and the outcome showed the almost the same results

Three different approaches have been used for constructing the weight function[1]: One approach suggested by BFC is $W_i = \sqrt{\exp(-d_i / \theta)}$.

The parameter θ is a decay parameter that BFC label as "bandwidth." Changing the bandwidth results in a different exponential decay profile, which in turn produces estimates that vary more or less rapidly over space. Another weighting scheme is the tri-cube function proposed by McMillen (1997):
$W_i = (1 - (d_i / q_i)^3)^3$ and $I(d_i < q_i)$.

Where q_i represents the distance of the qth nearest neighbor to observation i and I() is an indicator function that equals one when the condition is true and zero otherwise. Still another approach is to rely on a Gaussian function φ: $W_i = \varphi (d_i / \sigma \theta)$. Where φ denotes the standard normal density and σ represents the standard deviation of the distance vector d_i (do not confuse the notation, since we usually rely on subscripted variables to denote scalar elements of a vector). The *subscripted variable d_i is to represent a vector of distances between observations i and all other sample data observations*. BFC use a single value of θ, the bandwidth parameter for all observations. This value is determined using a cross-validation (CV) procedure often used in locally linear regression methods. Cross-validation relies on a score function taking the following form to determine a value for θ: $\sum_{i=1}^{n} [y_i - \hat{y}_{\neq i}(\theta)]^2$
Where $\hat{y}_{\neq i} = (\theta)$ denotes the fitted value of y_i with the observations for point i omitted from the calibration process. A value of θ that minimizes this score function is used as the distance-weighting bandwidth to produce **GWR** estimates. Note that for the case of the tri-cube weighting function, the computed value for q denotes the number of nearest neighbors beyond which zero weights is imposed (a sub-function called score would be used to evaluate using alternative values of q to find a value that minimizes the function).
The model posits the parameters to vary as a function of the latitude and longitude coordinates (or real distance). The only parameters that need to be estimate are the parameters in β_o that are denoted as β_x and β_y. This represents a set of 2k parameters. Recall the discussion about spatial heterogeneity and the need to utilize a parsimonious specification for variation over space. This is one approach to this type of specification. Note that the parameter vector β in the following equation (1.4) represents an nkx1 matrix in this model that contains

1- James P. LeSage (1999), The Theory and Practice of Spatial Econometrics, Department of Economics, University of Toledo, p 204.

parameter estimates for all k explanatory variables at every observation. The parameter vector β_o contains the 2k parameters to be estimated.

$y = X\beta + \varepsilon \qquad \beta = Z\,J\,\beta_o \qquad$ where,

$$y = \begin{pmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{pmatrix} \quad X = \begin{pmatrix} x'_1 & 0 & \dots & 0 \\ 0 & x'_2 & & \\ \vdots & & \ddots & \\ 0 & & & x'_n \end{pmatrix} \quad \beta = \begin{pmatrix} \beta_1 \\ \beta_2 \\ \vdots \\ \beta_n \end{pmatrix} \quad \varepsilon = \begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_n \end{pmatrix} \tag{4}$$

$$Z = \begin{pmatrix} Z_{x1} \otimes I_k & Z_{y1} \otimes I_k & 0 & \dots \\ 0 & \ddots & \ddots & \\ \vdots & & Z_{xn} \otimes I_k & Z_{yn} \otimes I_k \end{pmatrix} \quad J = \begin{pmatrix} I_k & 0 \\ 0 & I_k \\ \vdots & \\ 0 & I_k \end{pmatrix}$$

$$\beta_0 = \begin{pmatrix} \beta_x \\ \beta_y \end{pmatrix}$$

See Appendix "A" for the detailed 38 equations of the OIC's

This model can be estimated using least-squares to produce estimates of the 2k parameters β_x and β_y. Given these estimates, the remaining estimates for individual points in space can be derived using the second equation in (1.4). This process is referred to as the "expansion process". To see this, substitute the second equation into the first part of equation in (1.4), to produce:

$$\hat{y} = \alpha + XZJ\beta_0 \tag{5}$$

Here, it is clear that X, Z and J represent available information or data observations and only β_o represent parameters in the model that need be estimated. This model would capture spatial heterogeneity by allowing variation in the underlying relationship such that ***clusters of nearby or neighboring observations*** measured by latitude-longitude coordinates take on similar parameter values. As the location varies, the regression relationship changes to accommodate *a linear fit through clusters of observations in close proximity to one another*.

This non-parametric **GWR** model relies on a sequence of locally linear regressions to produce estimates for every point in space by using a sub-sample of data information from nearby observations (such as bootstrapping techniques).

The formulation of the model would result in a distance vector that increases with distance from the central observation. This would be suitable if one were modeling a phenomenon reflecting a "***hollowing out***" of the central city or a decay of influence with distance from the central point. In this type of spatial structure, heterogeneity often occurs jointly with spatial autocorrelation, where the standard econometric techniques are no longer appropriate[1]. In addition, a single cross-section, spatial autocorrelation and spatial heterogeneity may be observationally equivalent[2]. For example, a spatial cluster (i.e., observed in locations that are in close proximity) of extreme residuals may be interpreted as due to spatial heterogeneity (e.g., group wise heteroscedasticity) or as due to spatial autocorrelation (e.g., a spatial stochastic process yielding clustered values). This requires that both aspects of the problem be structured very carefully to obtain identifiably of the model parameters and that one aspect never be considered in isolation from another.

Table 2: The ranking results of the OIC countries based on – GWR model

Rank	Country	y_t , (GDP/c, A % g)	$\hat{y}_t = \alpha + XZJ\beta_0$
1	Indonesia	3.8209	4.3785
2	Malaysia	3.8911	3.2842
3	Bangladesh	2.4003	2.491
4	Pakistan	2.6802	2.4426
5	Syrian Arab Rep.	1.0083	2.0403
6	Egypt, Arab Rep.	2.8153	1.8491
7	Jordan	0.3014	1.6614
8	Tunisia	2.2224	1.622
9	Albania	0.8293	1.4842
10	Turkey	2.1468	1.2202
11	Uganda	2.232	1.2147
12	Benin	0.8789	1.2007
13	Oman	2.6384	1.1599
14	Chad	0.916	1.0254
15	Morocco	1.1874	0.92
16	Mozambique	1.179	0.8973

1- Tests for heteroscedasticity may be misleading, as illustrated in Anselin and Griffith (1988).

2- For similar concerns in time series context, see e.g., Heckman (1991).

17	Comoros	-0.6239	0.8897
18	Cameroon	-0.3983	0.8703
19	Burkina Faso	1.3968	0.8141
20	Iran, Islamic Rep.	0.2851	0.8134
21	Sudan	1.5894	0.7473
22	Bahrain	0.3133	0.6776
23	Nigeria	-0.8326	0.5778
24	Guyana	0.8471	0.5548
25	Senegal	0.254	0.1372
26	Togo	-1.0044	-0.0808
27	Guinea-Bissau	0.3591	-0.2992
28	Algeria	-0.294	-0.3243
29	Suriname	0.0822	-0.3618
30	Mali	-0.3515	-0.4491
31	Mauritania	0.156	-0.6238
32	Gabon	-0.6015	-0.9347
33	Gambia, The	0.1021	-1.0326
34	Kuwait	-1.9278	-1.7358
35	Niger	-2.4053	-1.8515
36	Saudi Arabia	-2.3034	-2.176
37	Sierra Leone	-3.4367	-2.827
38	United Arab Emir	-3.1488	-3.029

Note that again, the estimated pattern of the growth rates of the GDP per capita of the OIC, $\hat{y}_t$ does not differ much with the original trend, y_t .

6- Calibration of cross-country spillovers and the role of economic distance

As explained before, Chua (1993) has argued that countries can benefit from increased economic activity in their close geographical neighbors. The benefits could come from increased supplies of technological knowledge, managerial talent, skilled labor, capital and so on. It is hard to find formal models that directly address such spillovers. However, one can find models that are indirectly related. For instance, Barro and Sala-i-Martin (1997), developed a model in which growth depends on the discovery of new products or technologies in a few leading economies. Growth in the “follower” countries takes place because of technology diffusion, as these countries imitate new technologies created by the leader countries. Technological spillovers are key in the model of Goodfriend and McDermott (1994 p.3) as well. In their model, "the degree of convergence or divergence of national per worker products depends upon how well technical knowledge can be absorbed without the hands-on experience that comes with local production. Countries near each other geographically, with active commercial relations and a common language and culture, readily can absorb technical knowledge from each other".

There is a large body of evidence demonstrating trade depends on distance and distance really matter for trade and technological diffusion. Most of the recent papers estimate a "gravity equation," where bilateral trade is explained in terms of size of countries and the distance between them. Bergstrand (1985) presents a general equilibrium model to motivate such a specification as well as some empirical evidence. A more recent study by Frankel and Wei (1993) illustrate that, since distance is essential matter for trade, it will hold significance for technological diffusion through trade as well. Indeed, Frankel and Romer (1996) exploit the relationship between distance and trade to estimate the relationship between trade and economic growth. Since distance appears to be an important determinant of trade, applied models suggest that location is likely to matter because it helps determine the effective size of the market available to producers. In other words, it seems preferable to be close to a big economy than a small one. Therefore, the covariance between two countries' growth rates is taken to be a function of their distance, which separates the two countries in the space. Close countries are allowed to have highly correlated variables while variables from countries far away from each other are uncorrelated. Spillovers within this framework can be measured by looking at the relationship between a country's growth rate and the characteristics of its neighbors in the space. In particular, it is attempted to measure a country's neighbors' characteristics to predict its long-term economic growth once its own characteristics have been controlled for[1].

Trying to construct some measures of economic distance for the OIC countries, which can help to determine the degree to which countries share a common market(s), the Conley and Ligon (2002) model has been adapted. Given some measure of geographic *distance such as distancebased weight in GWR model*, and following the Conley and Ligon (2002) model, the spatial covariance functions to characterize the statistical dependence of variables across countries can be defined and estimated. The model presents a simple decomposition of the spatial covariance in growth rates into three parts:

(1)- that attributable to each country's own observable characteristics,

(2)- that due to each country's unobservable characteristics, and

(3)- that due to covariance between a country's unobservable and its neighbors' observable characteristics. The **focus here is on** the last component of their model *as a measure of spillovers that are associated with a given observable characteristic.*

A simple nonparametric method of estimating covariances is used across countries as a function of economic distance similar to Conley and Ligon (2002) model. In contrast to Conley and Ligon (2002) approach, the econometric models that are being used to allow for dependence in cross country observations (and thus, at least implicitly, to measure what is called spillovers) involve some strong parametric assumptions. Similar to group effects models and spatial analogs to *auto-regressive moving average* (ARMA) models are so called *spatial auto regressions*[2].

1- Although the key ingredient in this analysis is the measure of economic distance; however, geographic distance per se may be a poor measure of economic distance for the OIC countries. Unfortunately, due to the unavailability of the required data, there is no other choices for the most of the OIC countries.

2- In SAR model, the disturbance term corresponding to a cross-sectional unit is a weighted average of disturbances corresponding to other cross-sectional units, plus an innovation. This weighted average involves a scalar parameter, say ρ, and a set of weights that describe the spatial interactions. The innovations are typically assumed to be i.i.d. $N(0, \sigma^2)$. In a regression framework, the parameters of interest would then be ρ, σ^2 and the vector of regression coefficients. Typically, the spatial weights do not involve unknown parameters.

The OIC states are modeled[1] as though they reside at locations in the metric space (Λ, d), with each country i located at a distinct point ($s_i \in \Lambda$). Random variables associated with each country are indexed by position s_i and are called random fields. The idea behind this model of dependence is that the distance between countries' positions, corresponding to their geographic distances, characterizes the dependence between their random fields[2]. If two locations s_i and s_j are close together, then their random fields, say Z_{si} and Z_{sj} may be very highly correlated.

The measurement of the operational definition of cross-country spillovers is based on a simple decomposition of growth rates into predicted values given a country's own characteristics and residuals. Let y_s denotes the rate of long-run economic growth for a country at location s, and let $\hat{y}_s = f(X_s, \beta)$ denote some prediction of the growth rate of that country, based on only its observable information X_s, particular to that country (i.e., information which doesn't depend on its neighbors), and on some unknown vector of parameters β. Then the growth rates can decompose into two components of

$$\hat{y}_s = f(X_s, \beta) \quad \text{where,} \quad y_s = \hat{y}_s + u_s = X'_S\beta + u_s \tag{6}$$

Here we regard $\hat{y}_s$ as the component of growth rates, which can be explained by its own observed characteristics, and u_s as a residual (where $cov(u_s, X_S) = 0$).

Any measure of the importance of spillovers must relate variables in the country at *s* to some other country located at t. By considering the spatial covariance in growth rates, the covariance function can be written as:

$$cov(y_s, y_t) = cov(\hat{y}_s, \hat{y}_t) + cov(u_s, u_t) + 2cov(u_s, \hat{y}_t) \tag{7}$$

1- The distance between two countries is measured as the distance between key cities (capitals) in the countries.

2- The assumption that the random field Z_s is stationary, mixing, and isotropic: stationarity and mixing for random fields are straightforward generalizations of their time series counterparts. Stationarity simply means that the joint distribution of Z_s for any collection of locations $\{s_i\}_{i=1}^{m}$ (i.e., $\{Z_{s1}, Z_{s2}, \dots Z_{sm}\}$) is invariant to shifts in the entire set of locations $\{s_i\}_{i=1}^{m}$, and mixing means that the random fields Z_{si} and Z_{sj} become asymptotically independent as the distance between s_i and s_j goes to infinity. The final assumption is that Z_s is isotropic, which (combined with stationarity) implies that the covariance function cov(Z_{si} , Z_{sj}) depends only on the distance between si and sj, not the direction.

Thus decomposing the spatial covariance of y_s into covariance of observables, unobservable (residuals), and a third term, $2cov(u_s,\ \hat{y}_t)$. All covariance in this expression can be written as functions of the distance between s and t. The focus of attention is on the last term in equation (1.7) which provides a measure of linear relationship between the observable features of country t and the portion of growth rates of country *s*, which cannot be accounted for the observable characteristics of s (accordingly, the quantity of $cov(u_s,\ \hat{y}_t)$ will be the same as spillover between s and t). Note that since (1.6) is interpreted as a prediction equation, not a structural economic model. Therefore, the definition of spillovers should be regarded as a measure of covariances, not necessarily as something causal.

The measure of cross-country spillovers is obtained by estimating predicted values and residuals in (1.6) and then using them to estimate the covariance functions in equation (1.7)[1].

To describe the covariance function estimators, the method of inference, and the properties of these estimators, an estimator of the cross-covariance function for two scalar random fields Zs and Y_s has to be computed (already calculated by the GWR model). An auto covariance estimator is then a special case where $Z_s = Y_s$ and $cov(u_s, X_s)=0$. Since it is assumed that Z_s and Y_s are jointly stationary and isotropic, the covariance function $cov(Z_s, Y_t)$ depends only on the distance d(s, t). It is assumed that the covariance function is continuous at all distances greater than zero, and using the usual nonparametric estimator of spatial covariance, the final equation can be obtained:

$$\hat{C}(\mathrm{k}) = \sum_{i=1}^{T_N} \sum_{j \neq i} W_N (|\mathrm{k} - \mathrm{d}(s_i,\ s_j)|)\,(Z_{s_i} - \bar{Z})(Y_{s_j} - \bar{Y}) \qquad (8)$$

1- To formalize the notion of the statistical properties of the estimators, the following assumptions about how the data is sampled are made. To model the data as consisting of a set of observations of random fields at points within one of a sequence of regions $\{\Lambda_N\}$ with $\Lambda_N \subset \Lambda_{N+1}$. Within Λ_N, the econometrician observes T_N realizations of random fields at a collection of locations $\{s_i\}_{i=1}^{T_N}$ inside Λ_N, one location corresponding to each country. To model these locations as being realizations of a continuous random process that is such that T_N and the number of inter point distances in any interval grows without bound as the volume of Λ_N grows. It can take the limits by letting sample regions Λ_N increase as $N \to \infty$, using the MATLAB algorithm of the GWR model, explained in previous section (for more information see Conley and Ligon (2002)).

Here, $\overline{Z}$ and $\overline{Y}$ are the sample averages of Z and Y and $\{W_N\}$ is a sequence of weighting functions, each normalized so that the weights sum to one[1]. As $N \to \infty$, it is required that W_N to concentrate its mass at zero. Thus, by large samples, the covariance at lag k will be estimated by an average of cross products of only those observations that are very close to k units apart. The $\hat{C}$(k) is used to estimate covariance for positive distances k. The points at distance zero are not used in this calculation in order to allow for country-specific effects. The estimator (1.8) can be regarded as a non-parametric regression of cross products (Z_{s_i} - $\overline{Z}$) and (Y_{s_j} - $\overline{Y}$) on the distances between s_i and s_j.

Thirty-eight regression equations (presented in Appendix A), one equation for every country would be suitable if one were modeling a phenomenon reflecting a "***hollowing out***" of the central city or a decay of influences of spillovers of countries over others (a spatial cluster observed in locations around or in close proximity of an observation).

The main contribution of the **GWR** model is the use of distance-based weighted, W_N to Conley and Ligon (2002) model to produce locally linear regression estimates for every point in space. Each set of parameter estimates is based on a decay function sub-sample of "neighboring observations", which has a great deal of intuitive appeal in spatial econometrics.

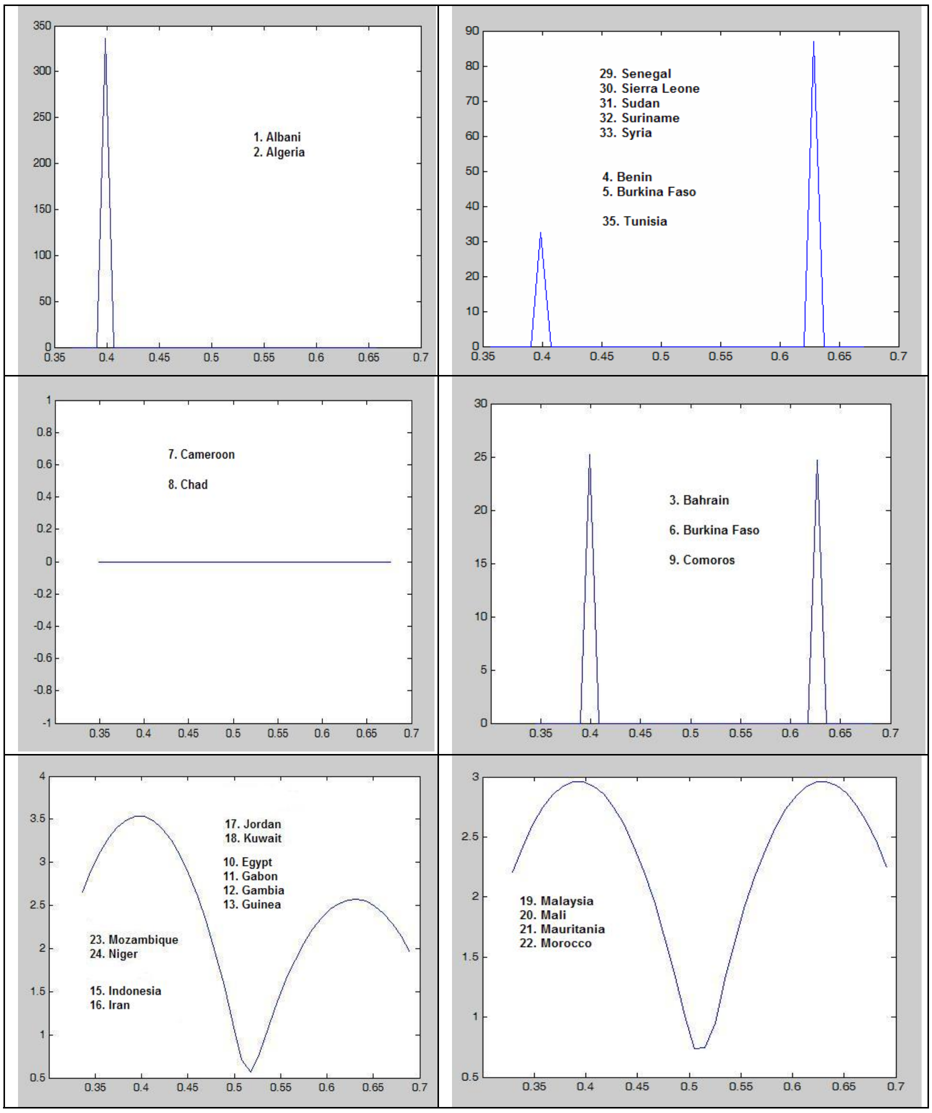
The distance-based weights used by BFC for data at observation i take the form of a vector w_i determined using a vector of distances, d_i between observation i and all other observations in the sample. This distance vector along with a distance decay parameter are used to construct a weighting function that places relatively more weight on neighboring sample observations from the

1- A normal density kernel can be used for this application:

$$W_N(|\text{k} - \text{d}(s_i, s_j)|) = (1/\sqrt{2\pi})\, e^{\frac{-(|\text{k - d}(\text{s}_\text{i}, \text{s}_\text{j})|)^2}{2}}$$

Noting that the weighting system of Conley and Ligon (2002) is different from the the weighting system that is used in this project [no absoute valuse is used for k - d(s_i , s_j) with N=38]. Three different distance- weighting functions with different decay parameter (or bandwidth) as a number of nearest neighbors for every country in are being used. Therefore, the negative covariance is being computed.

spatial data sample (see the following diagram 1.4 for nearby effects of the OIC's).:



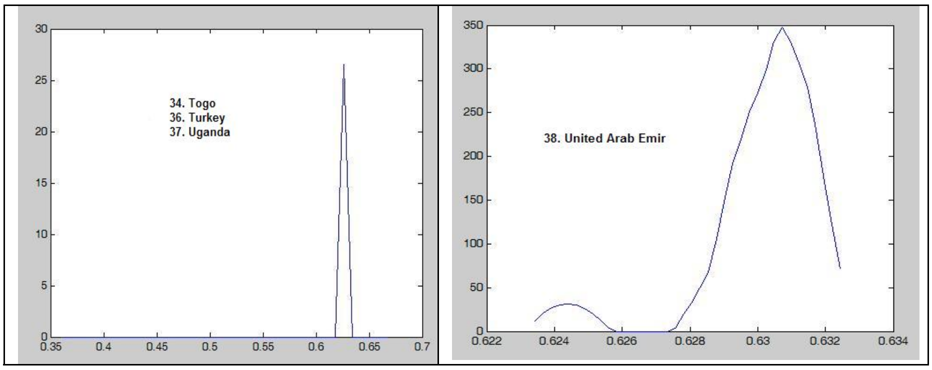


Diagram4: shows distance-weight functions with different decay parameter (or bandwidth) as a number of nearest neighbors to observation i (every country in the OIC member states), using Gaussian Kernel density functions.

Manipulation of the MATLAB coding[1], shows $\hat{y}_v$ = yhatv = xs*b is equivalent to Z_{s_i}. The summation of the calculated weighting function gives matrix W_N, [$\sum_{i=1}^{T_N} \sum_{j \neq i} W_N$ (k–d(s_i, s_j))]. The following Rows 1 through 20 and Columns 1 through 8, of the matrix W_N, the matrix of variance-covariance that is illustrated a part only as an example):

Albania	Algeria	Bahrain	Banglad	Benin	Burkina F	Cameron	Chad
1.0000	0.9659	0.5765	0	0	0	0	0.0388
0.9872	1.0000	0	0	0.0514	0.7885	0	0.2879
0.3499	0	1.0000	0.9599	0	0	0	0
Bangladesh 0	0	0.1270	1.0000	0	0	0	0
Benin 0	0.2163	0	0	1.0000	0.9999	0.9993	0.9882
0.1815	0.7188	0	0	0.9997	1.0000	0.9828	0.9579
0.0020	0	0	0	0.9990	0.9865	1.0000	0.9989

1- When the vector of distance is being sorted to find maximum distance associated with the grid of the q values, a weight matrix is searched, then the entire grid of q values are being generated and the regressions are carried out for every value of q in the grid. After collecting a matrix of scores, the minimum is found and the associated q value that is produced the minimum score is returned by the function.

0.7084	0.5250	0.2591	0	0.9902	0.9806	0.9994	1.0000
0	0	0.2356	0.6080	0	0	0	0
0.9921	0.3602	0.9833	0.5873	0	0	0.0072	0.6305
0	0	0	0	0.9991	0.9829	1.0000	0.9903
0	0.1939	0	0	0.8744	0.9895	0.3147	0
0	0.1235	0	0	0.9181	0.9932	0.4657	0
0	0	0	0	0	0	0	0
0	0	0	0.9843	0	0	0	0
Iran 0.5391	0	0.9998	0.9540	0	0	0	0
Jordn 0.9807	0	0.9956	0.7313	0	0	0	0.1183
Kwt 0.6444	0	1.0000	0.9388	0	0	0	0
0	0	0	0.9983	0	0	0	0

Extracting matrix W_N from GWR model (noting that W_N is different from the distance matrix W_{ij} in SAR) then, the product of this matrix by the vector of $(Y_{s_j} - \bar{Y})$ yields the extend of covariance $\hat{C}$(k). As explained in GWR model, the **GWR** model estimates one regression equation for every country i (or obs= i, i=1,2,...,38) in the sample space on all other countries. Where, the connection of the covariances of the nearby clusters can make different contour lines, as distinct points ($s_i \in \Lambda$) and the way the different random fields, say Z_{s_i} and Z_{s_j} for the different countries can be mapped in space.

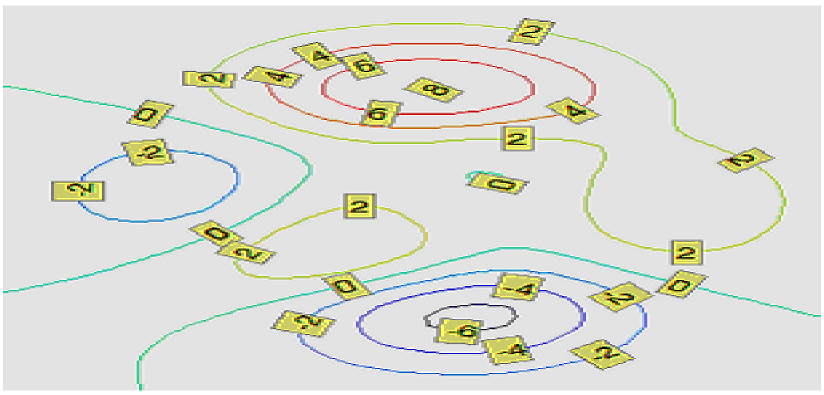


Diagram5: shows an illustration of the contour lines for the covariances.

The mapping of the isoquant values of the covariance is similar to the following diagram (1.5), enabling us to roughly approximate some of the missing observations (the 19 OIC states) in data set. Sorting out of the vector $\hat{C}$(k) as a scenario#3, gives the following ranking for the OIC member states. This result is the most suitable measurement to establish a common market. It should be mentioned that, using a geographically weighted regression or a geostatistical approach to the problem means specification of a smooth distance decay function and a parameter space that ensures a definite weighted variance-covariance matrix for every observation. In other words, the structure of this variance-covariance matrix is such that every location is correlated with every other location in the system, but closer locations weight more so. Close countries are allowed to have highly correlated variables while variables from countries far away from each other are uncorrelated, or less correlated. Spillovers within this framework are measured by looking at the relationship between a country's growth rate and the characteristics of its neighbors in this space. In particular, it is presented a measure of a country's neighbors' characteristics to predict its economic growth rate, once its own characteristics have been controlled for.

Scenario#3: third (the final) ranking of the OIC member states

The final ranking of the OIC countries based on – GWR model. (Real numbers of distances, d_{ij} or d(s_i, s_j) is the only "economic distance" for establishing a common market in a region or among the OIC member states.)

Rank	Country	$\hat{C}$ (k)
1	Malaysia	10.1236
2	Bangladesh	10.0109
3	Indonesia	8.7891
4	Saudi Arabia	7.5412
5	Bahrain	7.0369
6	Kuwait	6.8071
7	United Arab Emir	6.4437
8	Iran, Islamic Rep.	6.2972
9	Comoros	5.8606
10	Jordan	5.5897
11	Syrian Arab Rep.	5.2937

12	Oman	5.2097
13	Egypt, Arab Rep.	4.6624
14	Sudan	4.4045
15	Pakistan	4.0202
16	Mozambique	3.2444
17	Turkey	1.3447
18	Uganda	0.8376
19	Tunisia	0.8001
20	Albania	0.7691
21	Guyana	-0.0814
22	Suriname	-0.0814
23	Algeria	-1.1712
24	Morocco	-5.1274
25	Chad	-7.5698
26	Cameroon	-9.1902
27	Gabon	-9.8706
28	Niger	-10.0993
29	Senegal	-10.1117
30	Mauritania	-10.2454
31	Gambia, The	-10.4923
32	Nigeria	-10.5504
33	Benin	-10.6677
34	Burkina Faso	-10.8243
35	Guinea-Bissau	-10.8684
36	Togo	-10.9867
37	Sierra Leone	-11.36
38	Mali	-11.435

This ranking is the most complete and comprehensive version of the spatial econometric model of this research project[1].

1- Note that, two different distance weight measures: one by the CEPII[1] based on bilateral distances among the capitals of every country and their corresponding latitudes, longitudes for the OIC member countries to calculate the distance between countries i and j and the other as real distances are tested. Both of them give the same results. In addition, different weights of economic distances such as transportation or tariff costs can be applied, as well.

7- Summary and the findings

The scenario#3 is the most complete and the most suitable measure for ranking the OIC member states to determine the degree of development for establishing a common market. Because distance factor (and transportation costs) limits the extent of the countries' accessibility to a market, a measure of variance-covariance to determine the degree to which countries can share a common market, are applied.

Note that, the difference between the two systems of ranking of SAR and GWR models with the Conley and Ligon (2002) model is to relate and compare their specifications. The SAR model considers only real or relative distances, where the GWR model considers the distance- based decay functions to maximize for the "*nearest neighbors*" effects (in spite of all other similarities between the specified principles). The third scenario is a combination of GWR model with the Conley and Ligon model uses distance-based decay functions of the GWR model along with the spillovers of the Coley and Ligon model. In SAR or GWR models the estimated pattern y_t and $\hat{y}$ does not show any changes of direction in variance-covariance pattern (e.g., look at the ranking of United Arab Emirate), whereas in Conley and Ligon model, the variance-covariance pattern of growth rates shows significant changes, because of spillover effects among countries (e.g., look at the ranking of United Arab Emirate).

As Scenario#3 shows, since the high positive variance-covariance of the several top countries, are very close together. Thus, cutting or assuming a borderline between them is critical. In addition, selecting one or more leading “core” as a strategic location should not be based only an economical consideration but also some other geopolitical issues. Therefore, considering the degree of development (as weights of variance-covariance), and accessibilities to a market in a region, the following prioritization are suggested for the OIC state members:

Cores (one or more location):

1. Malaysia or Bangladesh (one of them, as a first choice)
2. Saudi Arabia or Kuwait (one of them, as a second choice)
3. Bahrain, United Arab Emirate or Iran (one of them, as a third choice), and

4. Comoros, Jordan or Syrian Arab Rep [(one of them), is just a *economical solution based on numbers and figures*, some other criteria should be considered as well.

Semi Peripherals:

All countries with positive covariance (not selected as a core) are semi peripheral countries that may benefit if integrate and trade with the cores such as:
Indonesia, Bangladesh, United Arab Emirate, Iran, Bavarian, Oman, Egypt Arab Rep., Sudan, Pakistan, Turkey, Uganda, Tunisia, Albania, or,....

Peripherals:

All other countries with negative covariance can be selected as peripherals.

References

1- Anselin Lus (1988), *Spatial Econometrics*: Methods and Models, Kluwer Academic Publisher.
2- Anselin Luc, (2003), *Spatial Externalities: spatial multipliers and spatial econometrics*, International Regional Science Review, 26; Revised, August 22, 2002 (http://sal.agecon.uiuc.edu/~anselin).
3- Barro, R. (1991), “Economic growth in a cross section of countries”, *Quarterly Journal of Economics*, Vol. 106, May, pp. 407-43.
4- Barro, R. and Sala-i-Martin, X. (1992a), “Convergence”, *Journal of Political Economy*, Vol. 100, April, pp. 223-51.
5- Barro, R. and Sala-i-Martin, X., (2004), *Economic Growth*, 2nd edition, The MIT Press.
6- Ben-David, Dan (1996), "Trade and Convergence among Countries," *Journal of International Economics*, *40*, 279-298.
7- Baumont Catherine, C. Ertur and J. Le Gallo, (2001), “A Spatial Econometric Analysis of Geographic Spillovers and Growth for European Regions, 1980-1995, Working paper, LATEC UMR-CNRS 5118, University of Burgundy.
8- Chua, Hak Bin.(1993), "On Spillover and Convergence," Ph.D. dissertation, Harvard University.

9- Coe, David T. and E. Helpman, (1995), "International R&D Spillovers," *European Economic Review*, *39*, 859-887.
10- Conley T.G. and E. Ligon, (2002), *"Economic Distance and Cross-Country Spillovers"*, Journal of Economic Growth, 7, 157-187.
11- Frankel, Jeffrey A. and David Romer (1999)*, "Does Trade Cause Growth?" American Economic Review* 89(3), 379-399.
12- Frankel, Jeffrey, Ernesto Stein, and Shang-Jin Wei, (1995), "Trading Blocs and the Americas: The Natural, the Unnatural, and the Super-Natural," *Journal of Development Economics*, Vol. 47 (June), pp. 61–96.
13- Guilaume Gaulier, Thierry Mayer and Soledad Zianago, (2004), Note on CEPII's distances measures
14- Goodfriend, M. and Mcdermott, J., (1994), "A Theory of Convergence, Divergence and Overtaking", Mimeo.
15- Haas, Ernst B., (1961), "International Integration: The European and the Universal Process", *International Organization,* 15: 366.
16- Krugman, Paul R. and Maurice Obstfeld, (2003), *International Economics, Theory and Policy*, sixth edition, Reading, Mass.: Addison-Wesley.
17- LeSage James p. (1999), *The Theory and Practice of Spatial Econometrics*, Department of Economics, University of Todelo (http://www.econ.utoledo.edu)
18- McMillen, D.P. (1996), "One hundred fifty years of land values in Chicago: a nonparameteric approach," Journal of Urban Economics, Vol. 40, pp. 100-124.
19- McMillen, Daniel P. and John F. McDonald, (1997), "A Nonparametric Analysis of Employment Density in a Polycentric City," Journal of Regional Science, Vol. 37, pp. 591-612.
20- Mankiw, N.G., Romer, D. and Weil, N.D. (1992), "A contribute to the empirics of economic growth", *Quarterly Journal of Economics*, Vol. 107, May, pp. 407-37.
21- Moreno, R., and B. Trehan, (1997), "Location and the Growth of Nations," *Journal of Economic Growth*, 2: 399-418.
22- Romer, P. (1990), "Endogenous Technological Change", *Journal of Political Economy*, Vol. 98, October 1990, pp. S71-S102.

23- Sala-i-Martin, X. (1994), “Cross Sectional Regression and the Empirics of Economic Growth”, *European Economic Review*, Vol. 38, pp. 739-47.
24- Solow, R. (1956), “A contribution to the theory of economic growth”, *Quarterly Journal of Economics,* Vol. 70, pp. 65-94.
25- Swan, T. (1956), “Economic growth and capital accumulation”, *Economic Record*, Vol. 32, November, pp. 334-61.
26- World Bank. 2000, World Development Report, Washington D.C, and Technical Note 1: Calculating the Human Development Indices, 2004**:** http://hdr.undp.org/statistics/faq.cfm#1, and World Bank: *World Development Indicator* (*WDI*), CD-ROM, 2003.

Appendix A

```
Geometrically weighted regression estimates
Dependent Variable = GDP/cap(A % growth)
R-squared          =    0.8116
Rbar-squared       =    0.7822
Bandwidth          =    4.4721
# iterations       =    26
Decay type         =    gaussian
Nobs, Nvars        =    38,   6
*************************************************************************
Obs =     1, x-coordinate= 19.8167, y-coordinate= 41.3333, sige=  0.2239
Variable                    Coefficient      t-statistic    t-probability
const#-7                    28.800561         6.131450        0.000000
1.HDI-Index                 31.531277         9.628595        0.000000
4.GNI/cap, PPP(cur intl$)   -8.043297       -10.149880        0.000000
5.Manufact VA(A %Growth)     1.848935         2.240408        0.030990
9.Market Potential          -3.990701        -3.198678        0.002784
11.D_Cred prov by Bank      -1.457781        -2.468829        0.018166

Obs =     2, x-coordinate=  3.0000, y-coordinate= 36.8333, sige=  0.2240
Variable                     Coefficient      t-statistic    t-probability
```

const#-7	28.802958	6.125196	0.000000
1.HDI-Index	31.527514	9.621469	0.000000
4.GNI/cap, PPP(cur intl$)	-8.040938	-10.139218	0.000000
5.Manufact VA(A %Growth)	1.854127	2.245388	0.030641
9.Market Potential	-3.994070	-3.198572	0.002784
11.D_Cred prov by Bank	-1.458734	-2.471417	0.018054

Obs = 3, x-coordinate= 50.6333, y-coordinate= 26.2000, sige= 0.2242

Variable	Coefficient	t-statistic	t-probability
const#-7	28.793956	6.137047	0.000000
1.HDI-Index	31.534437	9.634186	0.000000
4.GNI/cap, PPP(cur intl$)	-8.043167	-10.155114	0.000000
5.Manufact VA(A %Growth)	1.849445	2.242010	0.030877
9.Market Potential	-3.989595	-3.199908	0.002774
11.D_Cred prov by Bank	-1.458030	-2.464900	0.018338

Obs = 4, x-coordinate= 90.3667, y-coordinate= 23.7000, sige= 0.2235

Variable	Coefficient	t-statistic	t-probability
const#-7	28.791097	6.144883	0.000000
1.HDI-Index	31.535086	9.640811	0.000000
4.GNI/cap, PPP(cur intl$)	-8.043637	-10.162493	0.000000
5.Manufact VA(A %Growth)	1.847421	2.240728	0.030967
9.Market Potential	-3.988506	-3.202848	0.002752
11.D_Cred prov by Bank	-1.456681	-2.462431	0.018447

--------------------- to be continued to observation

Obs = 37, x-coordinate= 32.5833, y-coordinate= 0.3333, sige= 0.2240

Variable	Coefficient	t-statistic	t-probability
const#-7	28.785722	6.125681	0.000000
1.HDI-Index	31.527211	9.623679	0.000000
4.GNI/cap, PPP(cur intl$)	-8.041171	-10.142785	0.000000
5.Manufact VA(A %Growth)	1.853931	2.246137	0.030588
9.Market Potential	-3.988895	-3.194065	0.002819
11.D_Cred prov by Bank	-1.459793	-2.465407	0.018316

Obs = 38, x-coordinate= 54.4167, y-coordinate= 24.4667, sige= 0.2242

Variable	Coefficient	t-statistic	t-probability
const#-7	28.793081	6.138032	0.000000
1.HDI-Index	31.534471	9.635078	0.000000
4.GNI/cap, PPP(cur intl$)	-8.043218	-10.156106	0.000000
5.Manufact VA(A %Growth)	1.849216	2.241908	0.030884
9.Market Potential	-3.989319	-3.200148	0.002772
11.D_Cred prov by Bank	-1.457896	-2.464423	0.018359