Are Caribbean countries diverging or converging? evidence from spatial econometrics

CRAIGWELL, ROLAND and MAURIN, ALAIN

2011

Are Caribbean Countries Diverging or Converging? Evidence from Spatial Econometrics

ROLAND CRAIGWELL[1]
Department of Economics
University of the West Indies
Cave Hill Campus
St, Michael
BARBADOS
Email: roland.craigwell@cavehill.uwi.edu

and

ALAIN MAURIN
Laboratoire d'Economie Appliquée au Développement (LEAD)
U.F.R, des Sciences Juridiques et Economiques
Campus de Fouillole, BP 270
97157, Pointe-a-Pitre, Cedex
GUADELOUPE
Email: alain.maurin@univ-ag.fr

March 2010

[1] Correspondence Address: Email- roland.craigwell@cavehill.uwi.edu

Are Caribbean Countries Diverging or Converging? Evidence from Spatial Econometrics

ROLAND CRAIGWELL and ALAIN MAURIN

Abstract

After gaining political independence from the European countries and the United States, the Caribbean Basin economies have at the end of the 2000s display considerable differences in income and living standards. In this paper the concepts of convergence are used to examine whether disparities in per capita GDP of selected countries in the Caribbean Community (CARICOM) have tended to diminish or not. It was shown, based on descriptive statistical methods, and spatial statistical and econometric tests of beta-convergence and sigma-convergence that there was an absence of convergence for CARICOM countries since the early 1980s. This is so even in the OECS group which are linked in a quasi monetary union framework.

JEL No:

Keywords:

Contents

Introduction

Caribbean societies consist of a diverse set of cultures which have been derived through history from the merging of Arawak, Amerindian, African, European and Indian civilisations. Several types of languages are spoken in these countries including English, Spanish, French, Dutch and Creole. Caribbean economies also have very different systems of government: independent states (Antigua and Barbuda, The Bahamas, Barbados, Belize, Cuba, Dominica, Grenada, Guyana, Haiti, Jamaica, Dominican Republic, Saint Lucia, Saint-Kitts and Nevis, Saint Vincent and the Grenadines, Trinidad and Tobago); overseas French regions (Guadeloupe, French Guyana and Martinique); a British colony (Montserrat), and; a State of the United States of America (Puerto Rico). In addition, Caribbean countries differ in their size of surface area and population, as well as in the level of economic development which range from those islands that are quite poor (Haiti) to the more developed territories like Barbados.

With the establishment of the Caribbean Community (CARICOM) in 1973 and the signing of several agreements with Europe (Lomé), the United States (CBI) and Canada (CARIBCAN), Caribbean economies have been involved in a process of regional integration seen as a solution to strengthen their industrial base while protecting them from strong international competition. The Caribbean Heads of States have set explicit goals of improving key macroeconomic indicators by developing intraregional and inter-regional trade. With varying degrees of success, they have experimented with devices that seek to harmonize economic policies, to establish a common market and close cooperation in some target sectors such as education, health, research and transport. The unequal development among these countries leads one to ask the following question, “Can one observed a narrowing or convergence of the gaps between real per capita gross domestic product (GDP) among these countries as would be asserted by recent growth theorists?

The convergence hypothesis is a prediction of the standard neoclassical growth models of Solow (1956) and Swan (1956), and more recently, the 'new growth theories' (Romer (1990), Barro and Sala-i-Martin (1995)) and the new economic geography (Krugman (1991)). Conducted on cross-section, time series or panel data, the econometric applications are essentially on tests that seek to detect the absence of absolute or conditional convergence.

Recently, however, the econometric research has shifted to the incorporation of space in the economic growth models. This has meant that instead of assuming independence of the cross section data collected, explicit modelling of the spatial properties of geographic observations is included in the econometric models and tests of autocorrelation and spatial heterogeneity undertaken (see Beaumont et al (2000), Le Gallo (2000, 2001, 2002), Jayet (2001) and Toral (2002)). In light of these recent studies, it is now accepted that spatial properties of geographic observations should be systematically tested and formalized in models that seek to examine the issue of convergence or divergence among countries.

In spite of the high quantity of articles, books and academic works on the empirical analysis of the convergence process, the record for the Caribbean as a whole is lean. Individual Caribbean countries, mainly those contained in the database of Summers and Heston (1998), have been considered in various studies (see, for example, Moreno and Trehan (1997), Durlauf and Quah (1998)). Hence, unlike the research conducted on other geographic areas of developing countries (see, for example, Nagaraj, Varoudakis and Véganzonès (1999) who examined long-run growth performances in the case of Indian states; AKanni-Honvo (2003) and Parikh and Shibata (2004) who considered sets of countries in Asia, Africa and Latin America; Dramani (2007) who focused on the case of French speaking African countries), very little investigation has been done on the specific area of the Caribbean. In fact one can only identify the work of Atkins and Boyd (1998), Birchwood (2005), Moreira and Mendoza (2006) and Giudici and Mollick (2008) whose econometric methodologies assumed independence of the cross section data collected.

This paper is a continuation of these studies with the following differences. One, the period of investigation and the selection of countries are larger. Two, the econometric models and tests incorporate the spatial properties of geographic observations. The content of this paper falls into four sections. The first is a descriptive analysis of the economic situation existing in the Caribbean islands. The second section presents a brief review of the concepts of convergence and points to the need to take into account the spatial effects in a study area such as the Caribbean. The third gives the results of the spatial econometric tests of convergence. The final section concludes.

2. Statistical Analysis: Stylised Facts

Unless stated otherwise, GDP is the indicator used in this paper to represent the economic development of Caribbean countries. Even though it has its limitations in correctly identifying the economic development stance of countries, it has proven to be the most appropriate macroeconomic indicator when making international comparisons, and for this reason it is mostly utilized in this paper.

2.1. Disparities According To GDP Per Capita

Firstly, the levels of GDP per capita in the twenty-two countries shown in Table 1 are very unequal. According to the income ranking of the World Bank (2006), twelve countries (Anguilla, Belize, Cuba, Dominica, Grenada, Guyana, Jamaica, the Dominican Republic, Montserrat, Saint Lucia, Saint Vincent and the Grenadines, Suriname) are in the lower bracket, with a GDP per capita of between INT$3000 and INT$7500, while five countries (Antigua and Barbuda, Barbados, Saint Kitts and Nevis, Netherlands Antilles, Trinidad and Tobago) belong to the upper bracket with GDP per capita ranging from INT$7500 to INT$15000. The intermediate group is flanked, on one extreme, by Haiti, which is one of the poorest countries in the world, where the GDP per capita is less than INT$1500, and on the other, by the richest countries, including The Bahamas, Guadeloupe, Martinique, Aruba, British Virgin Islands and the US Virgin Islands whose GDP per capita is higher than INT$15000.

It should be noted that the above World Bank classification is in line with that of CARICOM's (2005) who found the following four clusters: Relatively High Middle Income - Antigua and Barbuda, The Bahamas, Barbados, Saint-Kitts and Nevis and Trinidad and Tobago; Medium Middle Income - Belize, Grenada, Saint Lucia and St. Vincent and the Grenadines; Low Middle Income - Dominica, Guyana, Jamaica and Suriname; and, Low Income - Haiti.

If the focus is placed on the fourteen CARICOM states huge demographic, geographic and economic disparities are also observed. Guyana alone occupies more than half of the total surface area of all the countries put together. With 2.63% of this surface area, Jamaica has more than 40% of the total population, while the seven countries comprising the Organisation of Eastern Caribbean States (OECS) - Antigua and Barbuda, Dominica, Grenada, Montserrat, Saint Kitts and Nevis, Saint Vincent and the Grenadines and Saint Lucia - count for only 8.28% of the total population, distributed over less than 1% of the total surface area of CARICOM. Also note that the population of Jamaica is larger than that of the combined population of the three largest countries (Guyana, Suriname and Belize).

In terms of a country's economic weight, which can be measured by the percentage of a country's GDP to CARICOM's total GDP, size does not appear to be a significant factor, with the exception of Jamaica. In fact, the countries are ranked in the following order: Trinidad and Tobago, Jamaica, The Bahamas, Barbados, Belize, Guyana, and Montserrat. Size is even less important if the barometer employed is income per capita. The Bahamas, Antigua and Barbuda, Barbados and Montserrat, in that order, perform much better than the largest countries (Suriname, Guyana and Jamaica), which are in the bottom positions.

Table 1: GDP Per Capita and the Unemployment Rate in the Caribbean in 2006

	GDP per capita 2006 (2000 International $)	GDP per capita (US$ 2003)	Unemployment rate
Anguilla	7485*	n.a	8.0*
Antigua and Barbuda	12318	11124	8.1
Aruba	19884	n.a	6.9*
Bahamas	16359	16691	10.2
Barbados	11646*	9651	7.6
British Virgin Islands	35821*	n.a	3.6
Cuba	3000*	n.a	2.5
Dominica	6047	3554	23.1*
Dominican Republic	7618	1825	18.4
Grenade	7378	4103	13.0
Guadeloupe	19500*	n.a	26.9
Haiti	1479	460	55.0
Jamaica	3907	2962	11.7
Martinique	21600 *	n.a	23.5
Montserrat	5250*	n.a	13.0
Netherlands Antilles	10794*	n.a	14.5*
Saint Kitts and Nevis	12521	7641	5.0*
Saint Lucia	6482	4048	21.0
Saint Vincent and the Grenadines	6056	3329	19.8*
Trinidad and Tobago	14708	7836	10.4
Belize	6460	3891	11.6
Guyana	4204	911	11.7
Suriname	7231	2470	15.0
US Virgin Islands	18512*	n.a	6.0

Source: World Bank (2006), CARICOM: http://www,caricomstats,org/ , INSEE (*): 2004
Note: n.a means not available

2.2. Disparities According To the HDI

As mentioned previously, per capita GDP as a measure of wealth and development has its limitations, thus it may be worthwhile studying complementary approaches. One such approach is the Human Development Index (HDI) developed by the United Nations for Development Program (UNDP). This index is based on three dimensions: the average level of wealth (GDP per capita), life expectancy at birth and the level of education.

Table 2 which shows the HDI indicates that the overall performance of the Caribbean have deteriorated since 1990, with an average score up from 56.46 in 1991 to 59.46 in 2000 and 70.08 in 2005. The pattern varies for different countries: Barbados and St. Kitts and Nevis show stable trends, with high scores; Barbados, The Bahamas, St, Kitts and Nevis, Antigua and Barbuda and Trinidad and Tobago have high levels of human development (with values over 0.800); Belize, Dominica, Jamaica and Saint Lucia record performances that are quite volatile from one year to another; and Haiti, Guyana, Jamaica, Belize, Saint Lucia and Saint Vincent and the Grenadines registered relatively weak outturns.

Taken together, these observations on the HDI reveal that there are differences in positions among the countries from year to year implying there may be economic divergence among countries in the Caribbean.

Table 2: Human Development Index Relating to Caribbean Economies

	Ranking 1991 Report	Value 1995 Report	Ranking 1995 Report	Ranking 1998 Report	Ranking 1999 Report	Value 2000 Report	Ranking 2000 Report	Ranking 2005 Report
Antigua and Barbuda (ATG)	46	0.895	29	29	38	0.800	37	60
The Bahamas	28	0.893	32	32	31	0.826	33	50
Barbados	22	0.914	24	24	29	0.871	30	30
Belize (BLZ)	67	0.807	63	63	83		58	91
Dominica (DOM)	53	0.879	41	41	53	0.779	51	70
Grenada (GRD)	64	0.851	51	51	52	0.747	54	66
Guyana (GUY)	89	0.670	100	100	99	0.708	96	107
Jamaica (JAM)	59	0.735	84	84	82	0.742	83	98
St. Kitts and Nevis (KNA)	65	0.854	50	50	51	0.814	47	49
St. Lucia	68	0.839	58	58	81	0.772	88	76
St. Vincent and the Grenadines (VCT)	79	0.845	55	55	75	0.733	79	87
Suriname	55	0.796	65	65	64	n.a	67	n.a
Trinidad and Tobago	39	0.880	40	40	46	0.805	50	57
Mean	56.46	n.a	53.23	53.23	60.31	n.a	59.46	70.08
Haiti (HTI)	n.a	n.a	159	n.a	n.a	n.a	146	153

Source: Caribbean Trade and Investment Report 2000, Human Development Report 2005
Note: n.a means not available

2.3. Evolution of Growth Indicators during 1978-2006

Table 3 and Figures 1 and 2 show per capita GDP in the initial period (1977) and its average growth over the 29 year period spanning 1978 to 2006. Recognising that GDP per capita in Table 3 is in ascending order, note that countries with low GDP per capita have a net average growth rate below those of leading countries in 1977. Notice also that the observed values for the average growth rates of GDP per capita of the OECS are within a relatively narrow range (from 2.42 (DOM) to 4.57 (KNA)). This is not surprising since these islands have been part of a quasi monetary union since 1981 and have engaged in common policies in key areas like monetary policy, the fight against poverty, education reform, and management and protection of the environment (see Jessamy (2003)).

The simple correlation coefficient calculated for the two distributions in Table 3 is -0.29. If Haiti is omitted, a value of -0.56 is obtained. Similarly, when the focus is on the eleven CARICOM countries, a figure of -0.39 is derived. These negative values of the correlation coefficient are consistent with the hypothesis of convergence but they do not imply the presence or absence of the phenomenon of convergence.

Figure 2 also seems to roughly indicate a negative relationship between the two variables. However, too many countries lie in the extreme positions of the sample to validate this idea that the poor countries in the early period grew faster than the rich countries.

Table 4 and Figures 3, 4 and 5 unambiguously show that per capita incomes have evolved in very unequal amplitude and periods. Overall, the coefficient of variation indicates a reduction in the dispersion of GDP per head for the period 1977 to 1988 but a slowdown since the early 1990s.

Table 3: Per Capita GDP in 1977 and the Average Growth Rate between 1978 and 2006

Country	VCT	HTI	DMA	BLZ	GRD	JAM	GUY	KNA	DOM	ATG	SUR	VEN	TTO
$GDPpc_{i,1977}$	2393.93	2470.95	2696.74	2741.67	2970.96	3074.61	3490.87	3511.43	3887.59	4128.36	7078.69	7793.49	8240.41
g_i	3.31	-1.67	2.99	3.1	3.26	0.88	0.76	4.57	2.42	3.91	0.26	-0.45	2.18

g_i = mean of the GDP growth rate for the period 1978-2006

Figure 1: Mean of the GDP Per Capita Growth Rate 1978-2006

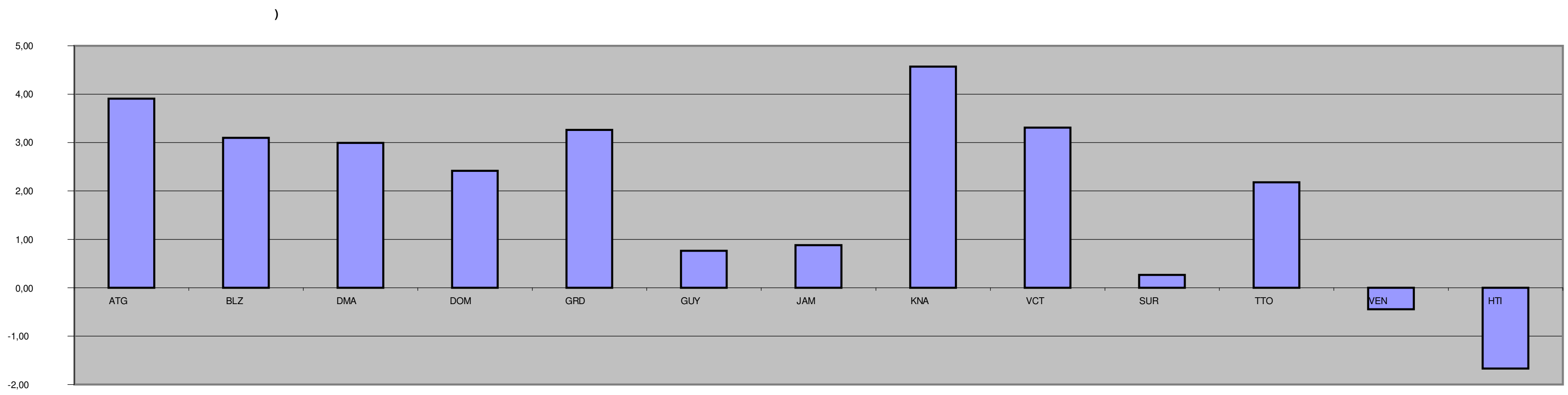


Figure 2: GDP Per Capita Growth Rate Verses Initial GDP

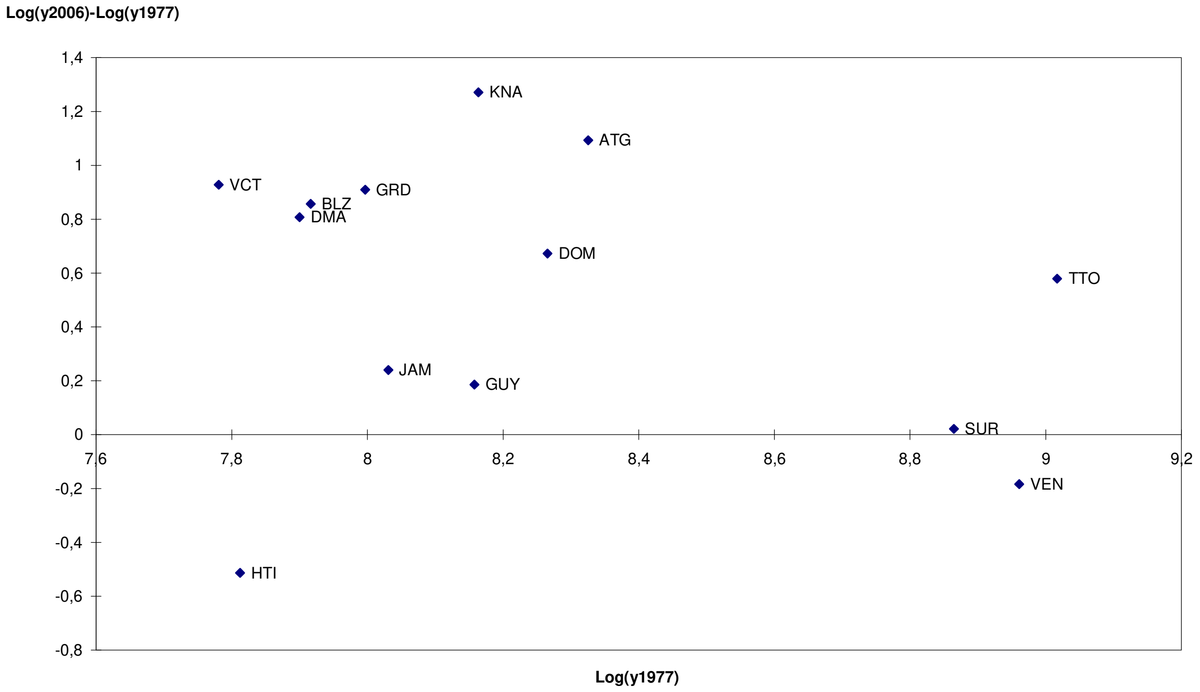


Figure 3: GDP Per Capita (2000 International $)

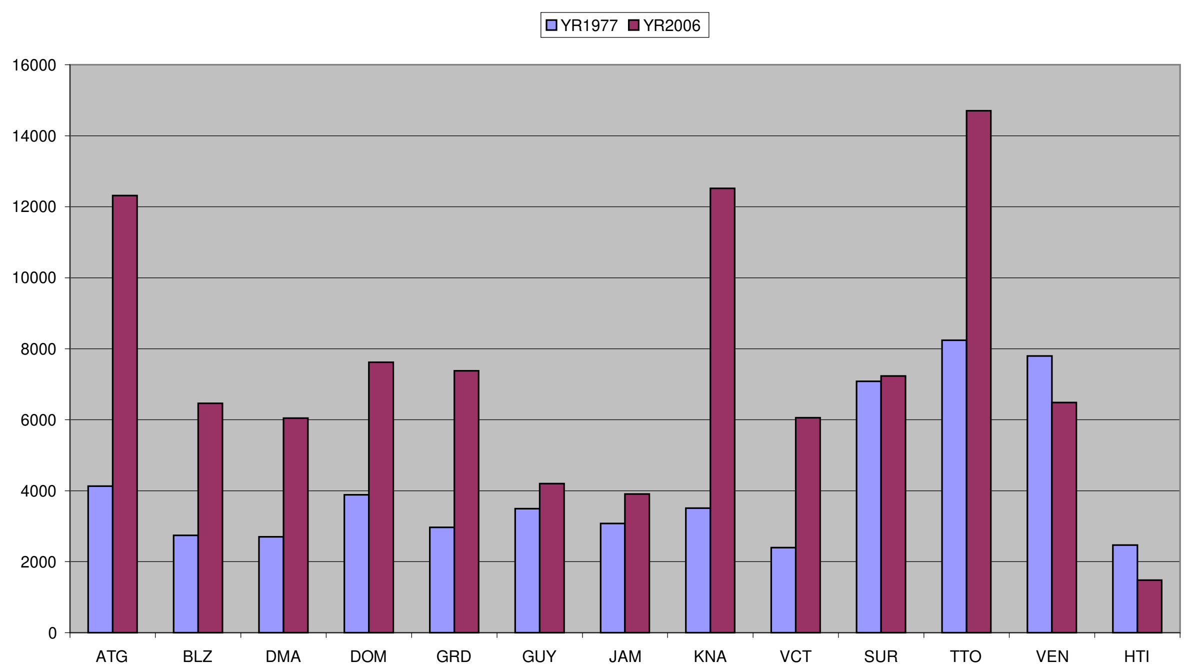


Table 4: GDP Per Capita (2000 International $) and Coefficients of Variation

	1980	1990	2000	2006
Antigua and Barbuda	4920.03	8867.58	10196.02	12318.23
Bahamas	15241.91	16742.29	17054.79	
Belize	3379.58	4228.01	5681.98	6459.95
Dominica	2424.45	4431.46	5622.16	6046.87
Grenada	3346.96	5518.59	7317.46	7378.20
Guyana	3355.49	2482.31	3922.38	4203.59
Haiti	2803.45	2135.62	1618.91	1479.33
Jamaica	2767.73	3215.27	3597.29	3907.42
St, Kitts and Nevis	4389.02	7821.18	11132.20	12520.94
St, Lucia	2953.03	5039.23	5897.00	6482.11
St, Vincent and the Grenadines	2746.16	4526.16	5236.86	6056.13
Suriname	6577.07	5582.46	5529.64	7230.62
Trinidad and Tobago	9918.81	7037.39	9091.61	14708.07
Dominican Republic	4178.10	4295.68	6394.85	7617.82
Standard deviation	3446.91	3533.24	3716.31	3581.22
Mean	4928.70	5851.66	7020.94	7416.10
Coefficient of variation	0.70	0.60	0.53	0.48

Source: World Bank

Figure 4: GDP Per Capita (2000 International $) cannot see horizontal axis clearly

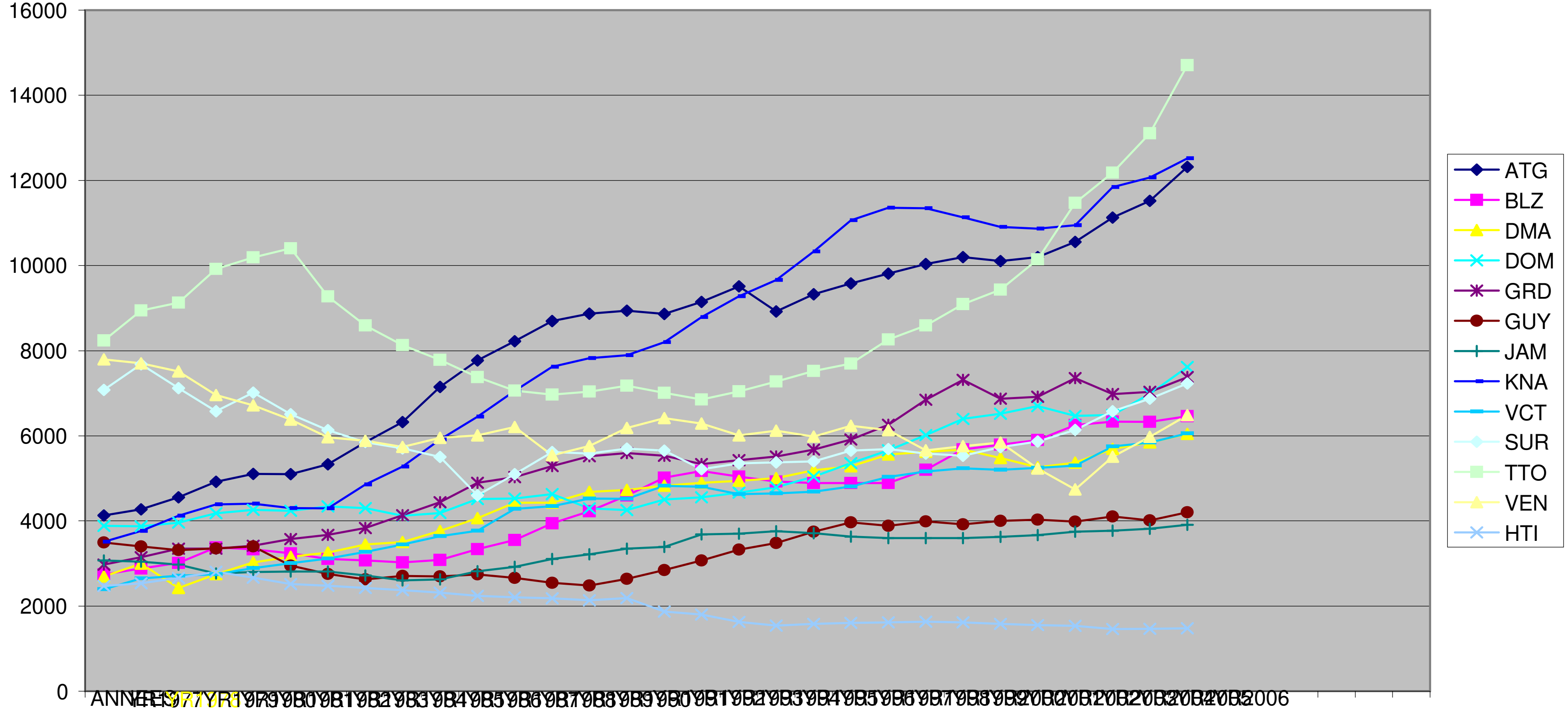
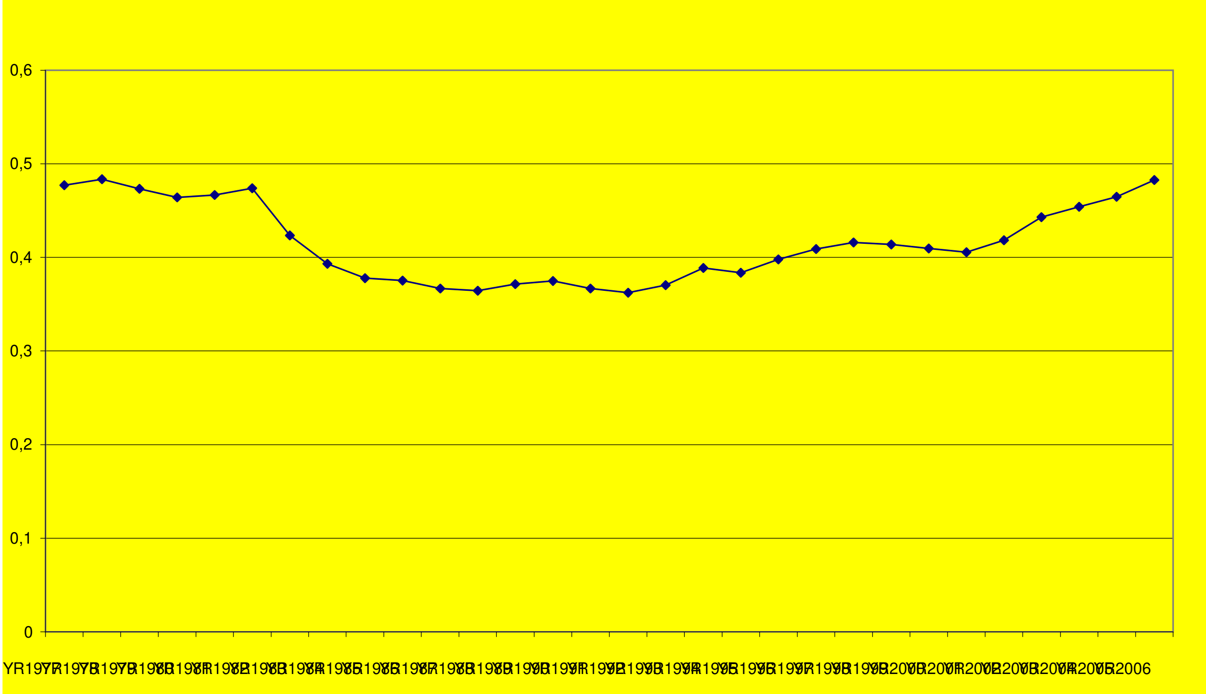


Figure 5: Coefficient of Variation of GDP Per Capita cannot see horizontal axis clearly



2.4. Spatiotemporal Structure of GDP per Capita during 1978-2006

To describe the process of convergence that accounts for spatial patterns among countries involves the simultaneous study of the inter-annual and intra-annual variability of GDP per capita. These two dimensions can be placed in a row-column table, with each row, i, corresponding to one year (i = 1977,.....,2006) and each column, j, to the geographical entity (j = 1, ,,,, P) , P being the total number of countries. Over time, if the countries converge towards the same level of income per capita, then the row vectors of GDP per capita should reflect these changes. So that when the less developed countries move from the initial state of 1977 to the current state of 2006 this represents a situation where the per capita income of the less developed economies are getting close to the per capita income of the most developed economies.

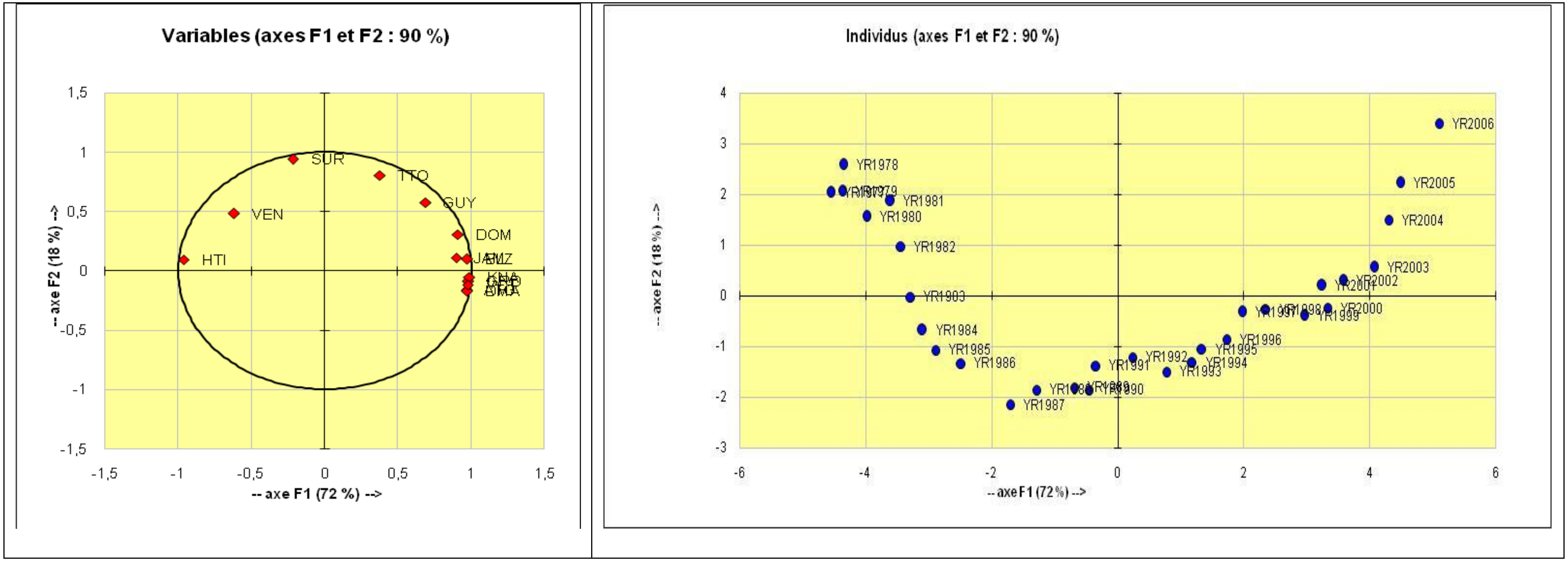
To apply this process to the growth dynamics of Caribbean countries the techniques of multivariate statistics are used. In particular, Principal Component Analysis (PCA) which involves a mathematical procedure that transforms a number of possibly correlated variables into a smaller number of uncorrelated variables called principal components is employed. The first principal component accounts for as much of the variability in the data as possible, and each succeeding component represents as much of the remaining variability as possible.

The results of the PCA show that the first two principal components account for nearly 90% of the total variance of the correlated variables, of which 71.86% belongs to the first principal component (Tables 5 and 6) . The circle of correlations (the first graph in Figure 6) provides a clear picture of the countries and their relationships during the period 1977-2006. The second graph in Figure 6 helps to determine visually the temporal structure of the average level of GDP per capita by highlighting trends and breaks. Table 7 displays the contributions of the individual variables in each country and the contribution of each country in each year. From this information it is seen that the F1 axis represents the relationship between countries and their counterpart with a higher GDP per head. The F1 axis separates the periods into the following four groups: 1977 to 1982, 1983 to 1986, 1987 to 2001 and finally, 2002 to 2006. Thus, it shows more contrast between the extreme years of the period 1977 to 2006. Likewise, according to the first principal component, the year 1987 or the years between 1987 and 1990 seems quite similar.

Unlike the F1 axis, the F2 axis only represents 17.7% of the total initial information and does not provide as clear a picture of the positions of the countries and the years. Additionally, the order structure over the years is very different to that of the F1 axis; the extreme years are quite similar and opposite to the break period 1987-1990.

Figure 6

Graphs of the circle of correlations and the screening of individuals in the principal plane Need to check translation and change French to English in graphs



3. Theoretical and Methodological Foundations

3.1. Theoretical Framework of Convergence

The concepts of convergence proposed for analyzing and measuring the process of convergence of different economies to the same level of development, or the phenomenon of catch-up in living standards among countries, are based on the neoclassical growth model.

The Solow-Swann model of exogenous growth was the first formal framework for the comparative study of the evolution of per capita growth rate for regions or countries. Mathematically, it can be written as

$$\frac{1}{T-t}\ln\left(\frac{y_{i,T}}{y_{i,t}}\right)=\alpha-\left(\frac{1-e^{-\beta T}}{T-t}\right)\ln\left(\frac{\hat{y}*}{y_{i,t}}\right) \quad (1)$$

where T is the length of the period, y_t and y_T is per capita GDP of the first (t) and last years (T), respectively, α and β are parameter coefficients to be estimated and ln is natural logarithms.

It states that the rate of per capita growth for a country will be much higher than it is from its path of long-term equilibrium. As highlighted by Bensidoun and Boone (1998, p.97), this result does not "consider that the absolute convergence of per capita income between countries was an implication of the Solow model. Rather, it calls for understanding convergence as the convergence of each economy to its own equilibrium path." This concept of convergence has been called "conditional convergence" to distinguish it from absolute convergence.

The endogenous growth models have also led to clear advances in the study of the sources of growth and the search for the phenomena of catching up and convergence of groups of economies (Amable, 2002). It is with these endogenous growth models that Barro and Sala-i-Martin (1991) have refined the concepts of convergence. They define absolute beta-convergence as the per capita GDP of poor countries (or regions) growing faster than those of rich countries (or regions), when the initial conditions involve countries with similar economic structures (natural resources, technologies, etc.,). On the contrary, when the initial conditions of countries are different, the convergence process is called beta-conditional convergence. In practice, empirical tests of the beta-convergence hypothesis are made from the traditional growth regression:

$$\frac{1}{T}\log(\frac{y_{i,T}}{y_{i,0}})=\alpha+\beta\log(y_{i,0})+\varepsilon_{i,T} \quad (2)$$

where $y_{i,T}$ and $y_{i,0}$ denote GDP per capita of the country or region i=1,…, N, at the initial year 0 and the final year T, respectively and $\varepsilon_i \sim i.i.d\left(0,\sigma_\varepsilon^2\right)$. In the regression model (2), a negative and statistically significant value of the β coefficient validates the hypothesis of β-absolute convergence, confirming that the poorest regions or countries have higher growth rates. From this estimated value of β, the speed of convergence, defined as $\theta=-\ln\left(1+T\beta\right)/T$, can also be calculated.

By introducing X_i, a vector of explanatory variables that maintain the state of the economy i to its constant level and therefore is representative of preferences and technology (degree of openness, investment effort, savings rate, stock of physical capital, fertility, etc.,) from one country to another, the hypothesis of conditional beta-convergence is tested using the following estimated model:

$$\frac{1}{T}\log(\frac{y_{i,T}}{y_{i,0}}) = \alpha + \beta \log(y_{i,0}) + \Pi X_i + \varepsilon_{i,T} \quad (3)$$

More simply, the measure of the convergence phenomenon consists of examining whether the dispersion of income per head is reduced. According to Barro and Sala-i-Martin (1991), sigma-convergence occurs when a strengthening of per capita income relative to the average level of all countries (or regions) is observed from one period to another. By designating the standard deviation of per capita GDP of the N countries at the time t by σ_t, the condition of sigma-convergence between the period t and t + h is:

$$\sigma_{t+h} < \sigma_t \quad (4)$$

with $\sigma_t^2 = \frac{1}{n}\sum_{i=1}^{n}\left[\ln\left(Y_{i,t}\right) - \mu\right]^2$ and $\mu = \frac{1}{n}\sum_{i=1}^{n}\ln\left(Y_{i,t}\right)$

By calculating the variance using Equation (1), it is easy to show that the link between the beta and sigma convergence is as follows:

$$\sigma_t^2 \cong \left(1-\beta\right)^2 \sigma_{t-1}^2 + \sigma_\varepsilon^2 \quad (5)$$

The evolution of σ_t is stationary if and only if $0 < \beta < 1$. This implies that beta-convergence is a necessary but not sufficient condition for sigma-convergence.

With the start and end dates of the period as the only time references, the convergence criteria mentioned above do not provide any information of the trajectories of GDP per capita of the countries. From a methodological point of view Quah (1993) has criticized the regression approach and stressed that the evaluation of the hypothesis of convergence should systematically exploit the temporal information included in the variance of the cross-section.

Since the early 1990s, the least that can said is that the specification of the theoretical models of endogenous growth have increased by applying a variety of factors such as the accumulation of knowledge, human capital accumulation, investment in education and training, innovations such as new property or new qualities of existing goods (Amable, 2002).

3.2. Modelling Spatial Effects

There has been a new dynamism in the study of convergence since the seminal work of Anselin (1988). Noting the difficulties in testing this hypothesis on a global or regional scale, some authors have explicitly considered the role of spatial effects. They started from the simple observation that the geographical distribution of the phenomena of growth among countries or within regions of a country does not depend on luck but is related to the dissemination of technologies and factor mobility and other factors often found in the endogenous growth literature.

Montouri and Rey (1999), Beaumont et al, (2000), Le Gallo (2000) and Toral (2002) were the among the first to study the phenomena of economic convergence by considering the influence countries have among other regions or neighbouring countries as well as adopting the methodological framework of spatial econometrics.

The main foundation underlying the specification of spatial models is the construction of a weighted matrix that accounts for the topology of the spatial system considered, that is, to position the observations relative to each other according to their sizes and structures. To measure these characteristics of the structure and intensity of the spatial effects, many studies employ a simple symmetric binary contiguity matrix W such that $wij = 1$ if the regions i and j share a border and $wij = 0$ otherwise. By definition, this matrix does not introduce space interactions between the areas of a continental zone or between countries. More general weighted matrices derived from various functional forms like the inverse exponential function or a function of the inverse of the distance must be derived to capture the degree of interaction between two areas *i* and *j*. Formally, one can define the matrix W in these two cases respectively as follows: $w_{ij} = e^{-\delta d_{ij}}$ or, $w_{ij} = \begin{cases} 1/d_{ij}^{\gamma} & \text{if } d_{ij} < \bar{d} \\ 0 & \text{else} \end{cases}$

d_{ij} being the distance between the region *i* and *j* and δ and γ are parameters, fixed a priori.

The configuration of the matrix W is also important as it may enable one to define the concept of the spatial lag which plays a major role in the specification of spatial econometric models. For location i and the study variable y, the spatial lag is given by the product Wy with the element $(Wy)_i = \sum_{j=1}^{N} w_{ij} y_j$ which is, a weighted average (by weight space) of the observations associated with neighbouring locations j. Other generalizations of the matrix W disregard physical distance completely in favour of particular representations of the spatial dependence.

This choice of the matrix W is a crucial step because, as pointed out by Anselin (1988), the results of tests for spatial dependence can vary with the regional unit of analysis and the spatial weights chosen. It is also critical to note that the matrix W must be selected to ensure its exogeneity in the model specification. Anselin and Bera (1998) and Keller (2002) have indeed shown that the distances must be exogenous in order to avoid the empirical model becoming highly nonlinear.

Once this choice of W is made, then the estimate of convergence is based on the different classes of spatial models, which can take various forms. Anselin (1988, 2001) has compiled a fairly comprehensive overview of these models. The most widely used of these specifications is utilised here, that is, those based on extending the beta convergence equation with a spatial autoregressive error space. For instance, consider the following spatial autoregressive process of order 1:

$$\frac{1}{T}\log\left(\frac{y_{i,T}}{y_{i,0}}\right)=\beta_0+\beta_1\log\left(y_{i,0}\right)+\Pi X_i+\varepsilon_{i,T} \qquad (6a)$$

$$\varepsilon_i = \lambda W\varepsilon_i + \eta \qquad (6b)$$

where $\eta \sim N(0,\sigma^2 I)$ and λ is a parameter that represents the intensity of the spatial autocorrelation between the residuals of the regression. More generally, the spatial autoregressive model (SAR) includes mechanisms of spatial dependence both in the equation of convergence and in the error structure. In matrix notation, this generalization of the model (6) is given by:

$$y_G=\beta_0+\beta_1 y_0+\rho W y_G+\varepsilon \qquad (7a)$$

$$\varepsilon=\lambda W\varepsilon+\eta \qquad (7b)$$

In (7a) Wy_G denotes the lagged endogenous variable for the weight matrix W. It reflects the idea that the observation for country i is explained by the values given to the countries in its neighbourhood $\left(Wy_T\right)_i$. Incorporating this autoregressive structure reveals that spatial correlation is more complex than temporal correlation. Indeed, it is not only unidirectional as in a time series model but rather multidirectional since it is also based on the dimensions associated with each geographical unit. The coefficient of spatial autocorrelation must be considered, and where it is significantly different from zero, a positive (negative) reveals a positive spatial autocorrelation (negative) in the convergence process.

4. Econometric Analysis of Convergence in the Caribbean

4.1. Classical Tests

To begin the econometric tests of the convergence hypothesis for the Caribbean the growth regression in Equation (2) is estimated. Naturally, with the small sample of cross section data of a dozen countries covering thirty years, the low number of degrees of freedom is an obstacle to obtaining consistent estimates of β.

To remove this constraint, a panel approach developed by Coulombe and Lee (1995) is adopted. They suggested simply incorporating additional data reflecting the movement of relative growth during the period under study. To do this, the entire period is divided into m sub-periods of length L. Econometric tests are conducted on sets of *mn* observations with the following modified equation:

$$\frac{1}{L}\ln\left(\frac{y_{i,t+L}/\overline{y}_{i,t+L}}{y_{i,t}/\overline{y}_t}\right)=\alpha-\beta\ln\left(\frac{y_{i,t}}{\overline{y}_t}\right)+\mu_{i,t} \qquad (8)$$

The left term of the equality is the relative growth rate of GDP per capita in the i-th country during the period between the dates t and t+L, $y_{i,t}$ corresponds to GDP per capita of country i at time t and $\overline{y}_t$ is the average GDP per capita of countries in the sample at time t. To apply this approach, five sub-periods of 6 years each are selected: 1977-1983, 1983-1889, 1989-1995, 1995-2001 and 2001-2006. Haiti is omitted because of its abnormal behaviour vis-à-vis other states in the Caribbean.

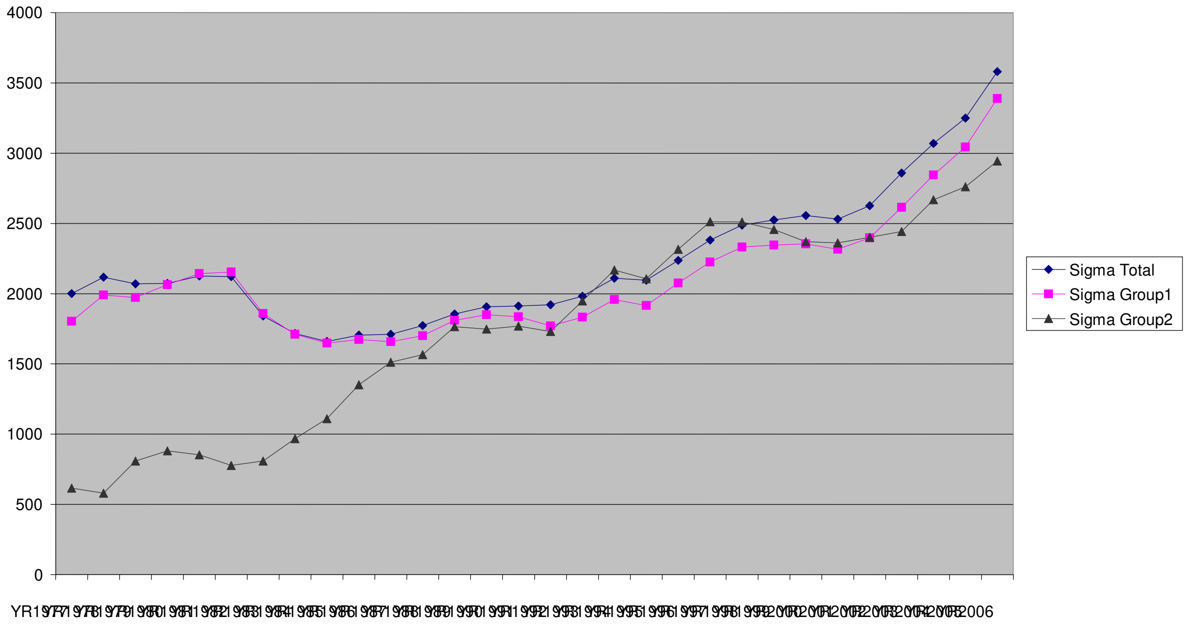
Table 8 presents the results from the different panel models over the various sub-periods. Specifically, estimates for the least squares model, fixed effects model, random effects model and the model in first differences over periods of 12 to 30 years were calculated. Apart from the least squares model the R^2 for the other three models gives a fairly good fit and the estimated coefficients are significant. Overall, it appears that the relationship between average growth and initial level of GDP per capita is positive. Thus, GDP per capita seems to be diverging in the set of Caribbean countries used here.

Table 8: Results of the Beta Coefficients in Absolute Convergence Panel Models, Caribbean Countries, 1977-2006

	Beta	t-Student	R^2	Number of observations
Cross-sectional	-0,599	-2,19	0,77	12
Panel 1977-2006 (29 years)				
Least-Squares	0,016	1,56	0,04	60
Fixed Effect	0,0064	0,24	0,29	60
Random Effect	0,015	1,30		60
First differenced	0,100	3,95	0,25	60
Panel 1977-1989 (12 years)				
Least-Squares	0,0146	0,66	0,03	24
Fixed Effect	0,081	3,06	0,91	24
Random Effect	0,058	2,74		24
First differenced	0,081	3,06	0,46	24
Panel 1989-2006 (17 years)				
Least-Squares	0,0166	2,05	0,115	36
Fixed Effect	0,138	4,75	0,62	36
Random Effect	0,0943	4,08		36
First differenced	0,151	4,42	0,46	36
Panel 1995-2006 (11 years)				
Least-Squares	0,027	3,42	0,36	24
Fixed Effect	0,104	2,34	0,79	24
Random Effect	0,046	2,11		24
First differenced	0,104	2,32	0,32	24

Following the definitions of convergence discussed in Section 3, this section continues with an analysis of sigma-convergence, dealing first with the evolution of the standard deviation. Figure 7 summarizes the changes in the sigma-convergence process for three groups of Caribbean countries: all thirteen countries, eleven countries where Haiti and Venezuela are omitted and the five countries of the OECS (Antigua and Barbuda, Dominica, Grenada, St, Kitts and Nevis, St, Vincent and the Grenadines). At first glance, the figure shows a generally upward trend over the period, reflecting the existence of an increase in the dispersion of GDP per capita over the long term and a lack of convergence in the sense of Barro and Sala-i-Martin. However, a closer look at the figure suggests that the curves reveal alternating periods of convergence and divergence. Between 1977 and 1982 there is a small movement of divergence between groups 1 and 2 but episodes of convergence within the OECS grouping.

Figure 7: Sigma convergence - Standard Deviation of the Log of GDP Per Capita
Horizontal axis not clear



The second period, from 1982 to 1995, which is relatively long, highlights the most significant decreases in the standard deviation for groups 1 and 2, implying a powerful trend towards convergence between these two groups. However, during this same period, there is a different profile for the OECS countries. Indeed, the dispersion of GDP per capita increased steadily from 1982 to 1989 and remained stable between 1989 and 1992, rising again over the period 1992 to 1995. In essence, it appears that between 1982 and 1995, there is convergence within CARICOM and the broader group of Caribbean countries but alternating patterns among the countries of the OECS.

Over the period 1995-2000, for the three groups of countries, the curve is like a reversed U shape, indicating an episode of increased standard deviation of GDP per capita (1995 to 1998) and then an episode of decrease (1998 to 2001)\. Finally, from 2002, the standard deviation has a new profile with the highest ascending slope over the study period. However, the dispersion of GDP per capita of the countries of the OECS is again much lower than that observed in the two other groups.

These results are comparable to those highlighted by Giudici and Mollick (2008) who studied the convergence process in the Member States of the OECS for the period 1977-2000 by applying the panel econometric methods of Islam (1995). They have shown that "if the whole set of countries is considered, there is a permanent gap in income among the members, which corresponds to a spread of about 44% of the average income. If the richer countries of Antigua and Barbuda and St. Kitts and Nevis are omitted, the remaining islands maintain a steady spread of only 12%. At the same time, the richer islands are converging to each other at a very fast rate. This indicates that the islands are growing as *two distinct convergence clubs*,"

4. 2. Spatial Analysis

Instead of viewing each country as an isolated entity, it seems useful in the analysis of the convergence process to examine the role of spatial dependence. In fact, it is hard not to consider certain aspects of interdependence among countries in the Caribbean. One such area is the phenomena of migration. Several authors have stressed that the movement of intra-regional population are multifaceted and reflect essentially the hierarchy of living standards across countries (see Table 1 and Borda et al. (2008)). On the same line of thought, Guzman et al. (2006) noted that "intra-regional movements are especially to countries where labour markets and education offer the most opportunities and where, in general, the level of social protection is higher." These countries consisting principally of Barbados, The Bahamas, Guadeloupe, French Guiana, Martinique, Trinidad and Tobago and Puerto Rico are termed "receivers". Conversely, the countries with intra-regional movement away from them are called 'issuers' and are usually affected by the most difficult economic or political situations. Examples of these include Haiti, Cuba, Dominica, Grenada and St, Vincent and the Grenadines.

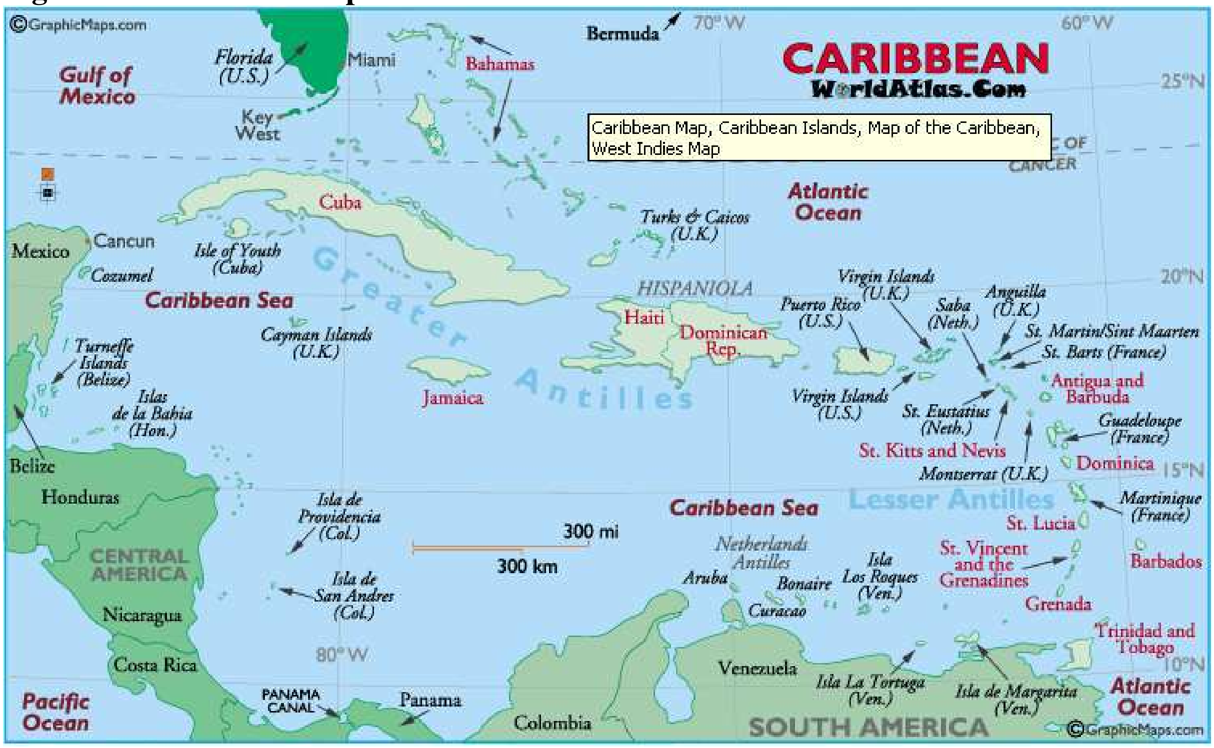
The intensity and pattern of dependencies among the Caribbean countries can also be seen in the trade that they conduct. Several proxies exist for trade including imports as a measure of regional integration and exports and imports of intermediate goods indicative of national economic strategies such as the transfer of technology or modernization of the productive market size (see Rodrik, 1999; Fontagné and Guerin, 1997). Recently Virol (2006) adds the phenomena of agglomeration, concentration and dispersion to better reflect space or geography among countries. Applied to the case of Europe, he found it necessary to take into account factors such as population and communications infrastructures to enable a better appreciation of the interactions between the geographic units considered.

The forty years of the CARICOM existence and the long tradition of cooperation in foreign policy, health and education which unites the member countries should also help to justify the existence of significant spatial interactions among Caribbean states. For instance, on the issue of education, the University of the West Indies has three campuses located in Barbados, Jamaica and Trinidad and Tobago and subsidiary institutions present in other islands, which certainly contributes to the convergence of Caribbean economies. Also, one cannot deny that the process of integration in the Caribbean has helped to strengthen the bargaining power of member countries vis-à-vis other third world countries, it is equally undeniable that the Caribbean economic performance remains relatively weak.

In reality, it seems that the dynamic spatial relationships among Caribbean countries are quite weak. For instance, the share of intra-CARICOM trade, for most members' states, is still low, representing less than 10%. Regional cooperation in its present context still faces too many obstacles, both economic and political. Development strategies of Caribbean countries remain more competitive than complementary. The size of the market offers reduced opportunities, which allows us to understand the paradox noted by Duhamel and Calero (2003) concerning the CARICOM: "One feature of this grouping is that it is among the largest in terms of membership but also among the smallest in geographic and economic terms. "

As part of a study on the convergence of economies in the Caribbean, all of these points call for a measure of the degree of dependence of GDP per capita that relates to the geographic location of the countries. The four groups of countries identified in Section 2.1 above stretches from the Caribbean island of Cuba which is in the vicinity of Florida and the Gulf of Mexico to Trinidad and Tobago (see maps below). Do these groupings of countries have similar characteristics? Or are they a random distribution of countries with different GDP per capita? These issues raise the problem of positive spatial autocorrelation if countries with similar GDP per capita (low or high) also have a strong geographical proximity and negative spatial autocorrelation if they are combinations of countries with GDP per head very different to its geography.

Figure 8 : Caribbean Map



4.2.1. The Spatial Weights Matrices

The diversity of factors mentioned above to describe the processes that connect the countries of the Caribbean lead naturally to the use of several spatial weighting matrices. Recently, Fernández (2009) presents the weighting schemes utilised by most in the developed world. However, because of the differences characterizing the geography of the Caribbean and developed countries, it is clear that the several types of matrices frequently adopted in studies on Europe or the United States are not suitable for measuring distances among Caribbean countries. The specification of the matrix W which is a controversial step in the work of spatial econometrics is even more difficult in the case of the Caribbean. Two definitions of the matrix W are proposed. The first is based on the spherical distance between the centroids of Caribbean countries, with the element w_{ij} then calculated from geographical coordinates (latitude and longitude) of the principal city of each country and applying the formula for great circle distance. The second is based on the concept of distance introduced by Head and Mayer (2002) and expressed by the following formula:

$$d_{ij} = \left(\sum_{k \in i} (pop_k / pop_i) \sum_{l \in j} (pop_l / pop_j) d_{kl}^{\theta} \right)^{1/\theta}$$

with: i and j are the two countries concerned; pop_k is the population of the metropolitan k belonging to country i; and θ is a parameter for measuring the sensitivity of trade flows with respect to bilateral distance d_{kl}. This definition is thus based on the idea of taking into account the geographical distribution of populations within countries as well as the intensity of trade they maintain.

4.2.2. Global Spatial Autocorrelation

Moran's I (1950) is the first and most widely available tests to detect the presence of spatial autocorrelation. Its original definition is based on the ratio between the covariance of spatial units and the total variance:

$$I_t = \frac{N}{S_0} \times \frac{\sum_{i=1}^{N} \sum_{j=1}^{N} w_{ij} (y_{it} - \bar{y}_t)(y_{jt} - \bar{y}_t)}{\sum_{i=1}^{N} (y_{it} - \bar{y}_t)^2}$$

with N being the number of spatial units, y_{it} is GDP per head of unit i at time t, $\bar{y}_t$ the average of y_{it} and $S_0 = \sum_{i=1}^{N} \sum_{j=1}^{N} w_{ij}$ is a standardization factor. Thus, by definition, the I statistic is similar to the coefficient of regression of $W\tilde{y}$ on $\tilde{y}$, $\tilde{y}$ is the variable centered on $y - \bar{y}$. It is asymptotically distributed as a normal distribution with mathematical expectation $E\{I\}=-1/(N-1)$. Equality between I and $E\{I\}=-1/(N-1)$ suggests a lack of spatial autocorrelation. A value significantly above $-1/(N-1)$ reveals a positive spatial autocorrelation, and in the opposite case, it would be a negative autocorrelation indicating here that there is no grouping of countries with similar GDP per capita but, a tendency for rich countries to be surrounded by poorer countries and vice versa.

The calculated values of Moran's I statistic reported in Table 9 are all below its expected value $E\{I\}=-1/(N-1)$ = -0.0625. Thus, for the two extreme years of the observation period, the empirical results of the Moran statistics are consistent with the presumption of a negative spatial autocorrelation. Overall, the dominant trend is that each country has a per capita income that is different from those observed in neighbouring countries.

Table 9. Moran's I statistic for variables 1977, 2006 and 1977 to 2006 by weight matrices

Variable GDP per capita, 1977		
Matrix	I	Variance
W1	-0.089373022	0.008153832
Variable GDP per capita, 2006		
Matrix	I	Variance
W1	-0.107690437	0.008208137
Variable GDP per capita, 1977 to 2006		
Matrix	I	Variance
W1	missing	missing

4.2.3. Local Spatial Autocorrelation

The lessons arising from the Moran's I statistic have a global scope, and do not allow us to understand the structure of local interactions among the geographical entities concerned. To analyze the configuration of these local interactions identifying the units that contribute most to the overall spatial autocorrelation or, in the absence of autocorrelation, those that are atypical locations or pockets of non - local-stationarity must be done. The diagram of Moran is the standard tool for the analysis of local spatial autocorrelation. It proposes to show the scatter of geographical entities in the plane formed by the intersection of income per capita $\tilde{y}$ (horizontal axis) and the variable $W\tilde{y}$ that represents the average per capita income neighbours (vertical axis). The plan then consists of four quadrants associated with the four possibilities of local spatial association between an entity and its neighbours: HH is a unit that displays high GDP per capita and is surrounded by units characterized by high GDP per head; LL is a unit characterized by a low GDP per capita but its environs comprise of units with low GDP per capita; in the third quadrant (HL), a unit has a high per capita income but is surrounded by units with low income per capita; and, in the fourth quadrant (LH), a unit with a low income per head has units with high per capita incomes around it. In terms of interpretation, the HH and LL quadrants associated with clusters of similar values represent a situation of positive autocorrelation. Conversely, the LH and HL quadrants which comprise dissimilar values show a negative autocorrelation.

The diagrams on three data sets of GDP per capita are constructed to take into account the dynamics of each country and their neighbours: those concerning countries in the initial date (1977), the final date (2006) and those giving the average growth rate over the 'whole period 1977-2006. Figures 8 through 10 show the results of the three weighted matrices. When these graphs are examined and compared a number of observations can be seen:

- At the initial period, the distribution of countries in the four areas of the diagram is as follows: 2 (11.7%) and 5 (29.4%) in quadrant HH and BB, respectively, while 4 (23.6%) and 6 (35.3%) were in quadrants HB and BH. Also, the majority of Caribbean countries exhibited an unusual combination of income per capita; only a percentage (41.2%) of countries characterized by a geographical relation of similar values of their GDP per capita can be seen.
- The configuration of the final year shows a distribution with little differences from the year of 1977: 2 (11.7%) and 5 (29.4%) countries are classified in quadrant HH and BB respectively and, 5 are associated with HB and 4 in quadrant BH.
- In both 1977 and 2006, it should be noted that there is a group of countries from Haiti, Cuba, Dominican Republic, Puerto Rico and Jamaica that corresponds to countries with low GDP per head and surrounded by other countries with low GDP per head. This group of 5 countries form a spatial concentration that persists over time.
- In the beginning and end of the study period, the overall pattern of spatial association is that of a negative autocorrelation. Around this global trend, it is noteworthy that there is a marked deviation made by three countries: St. Lucia, Dominica and Martinique. Also, it appears that St. Lucia and Dominica are countries with low GDP per head whose environs are composed of countries with higher GDP per capita. Barbados, Martinique, and the Bahamas are found to be associated with the HB type, that is to say, high-income countries are surrounded by countries with low per capita income.
- It is important to note that the map of the Caribbean (see Figure 8) confirms the consistency between the positions of countries and geographical classification given by the diagram of Moran.

Cartographic representations of GDP per capita of the initial and final periods (Figure 9) provide the real image of these indices of Moran. Clearly, they show little change between

1977 and 2006 in the spatial pattern of standard of living of the countries, whether considered separately or by neighbouring subgroups. As illustrated in the colour game legend on both maps, there are stable "images of clusters of neighbours". Thus, within the arc of the Lesser Antilles, Martinique and Barbados a combination of HB type exists, but the neighbours, St. Lucia, Dominica, Grenada, and Saint Vincent and the Grenadines have not benefited from the diffusion process of growth.

The stability of spatial patterns of association highlighted with the diagrams of Moran in the years 1977 and 2006 reflects a strong presumption of the persistence of spatial disparities in development levels within the Caribbean basin, from the Greater Antilles to Lesser Antilles. To go further in exploring the local schema of the statistical pattern of local spatial association, it is interesting to examine the dynamics of spatial association by considering the same information as those used for Figure 2. Also, the diagram of Moran for growth rate of GDP per capita over the period 1977-2006 can be compared to the diagram of Moran's GDP per capita in 1977.

The main findings arising from the above can now be stated:

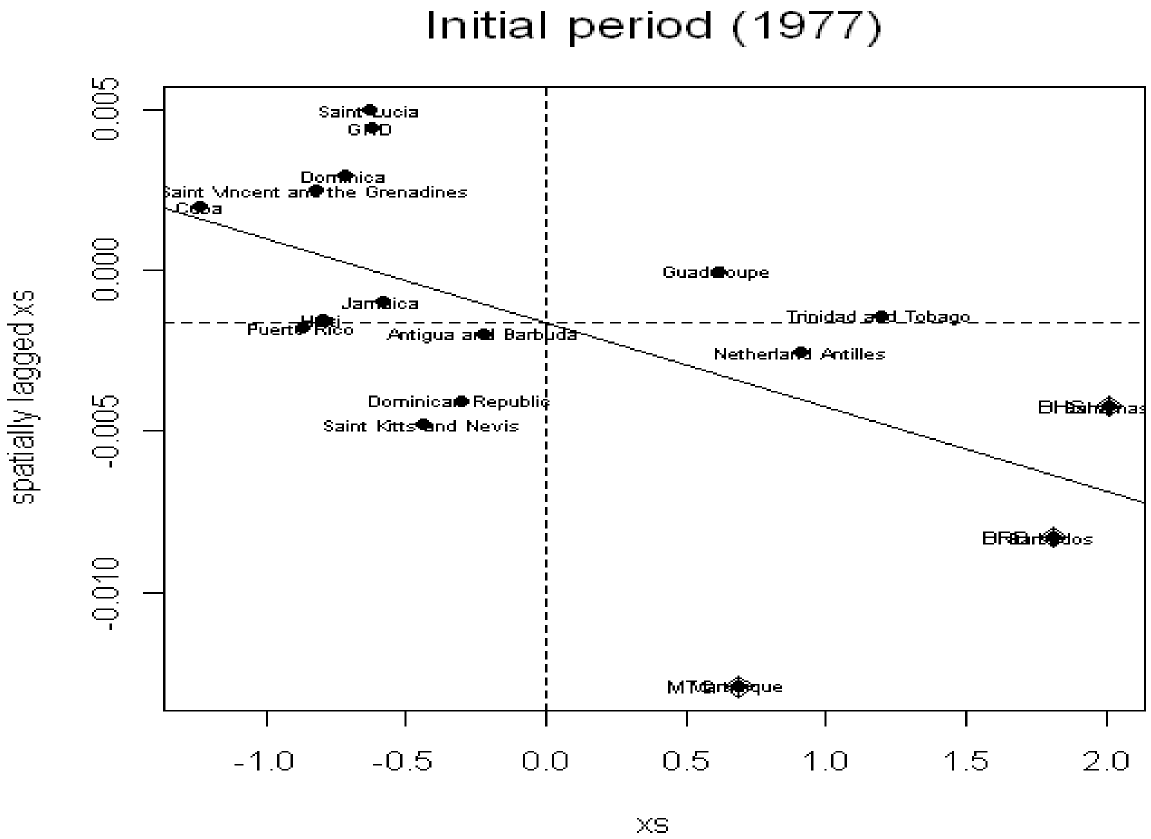
- Haiti and the Dominican Republic that were located in quadrant BB of Moran 1977 diagram also remain positioned in the same quadrant when considering their average growth rate over the period 1977-2006. This result shows once more the poor performance of these two countries;
- The Bahamas, which belonged to the HL group in 1977 was in the BB group when its average growth rate is considered over the same period, these positions are consistent with a phenomenon of the growth slowdown of the Bahamas;

- Barbados and Trinidad and Tobago, which were attached to the HL and HH quadrants diagram of Moran in the early period, respectively, belong to type the LH grouping when considering their growth. These two countries should also be interpreted as countries that experienced lower growth;

- Martinique who was in the HL group during the initial part, is however in the HH quadrant diagram of the growth rate. Guadeloupe situated in the HH quadrant of the diagram of the initial period is found in the HL quadrant of the diagram of the growth rate; it appears that in the French islands, strong growth is unrelated to the performance of their immediate neighbours but is rather dependent on external factors like the importance of public transfers allocated by France and the European Commission in the training of their income populations;

- St. Lucia, Dominica, Antigua and Barbuda, Saint Vincent and the Grenadines, Grenada, Saint Kitts and Nevis are located in the quadrant HH diagram of growth as they formed groups of space or type LL and LH in 1977, this result provides further illustration of the phenomenon of convergence of the OECS countries mentioned above.

Figures 8a,8b and 8c : Moran diagram for the weight matrix W1 Where is 8c



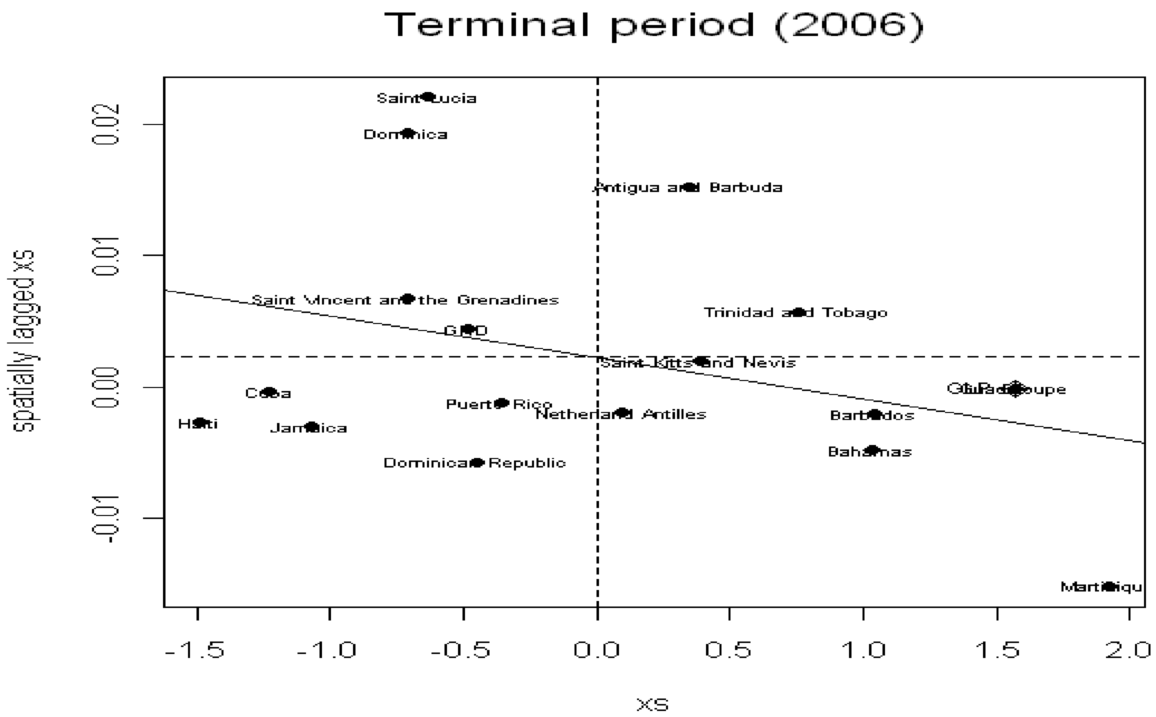
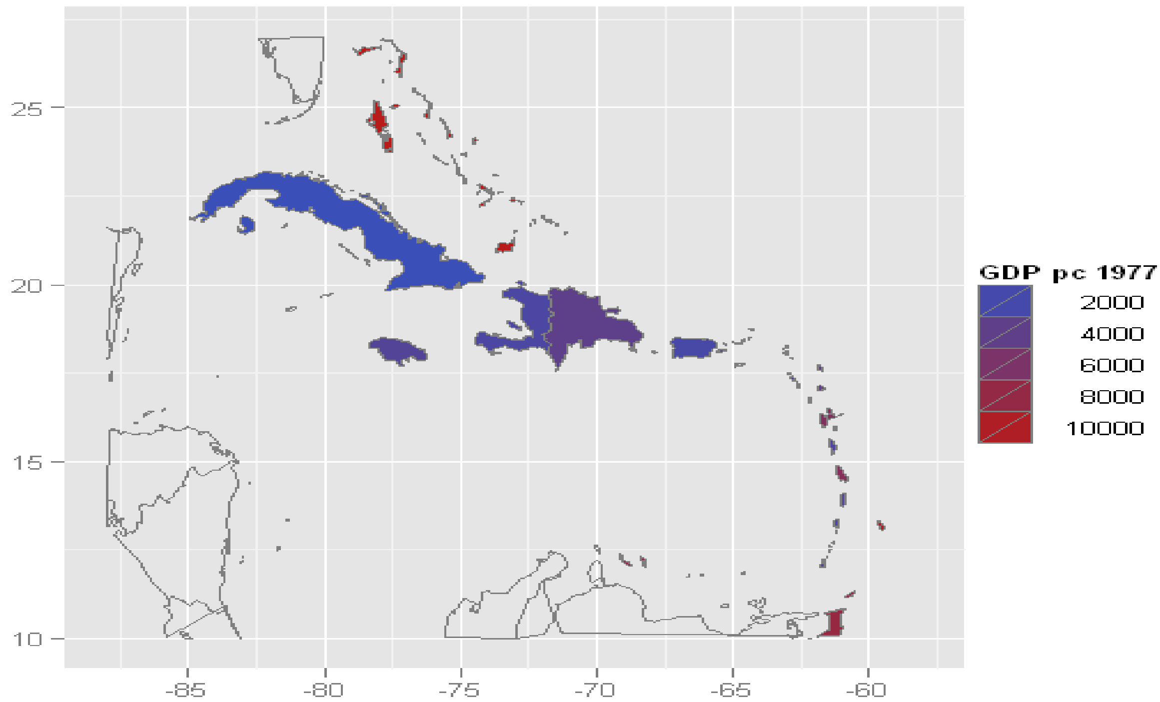


Figure 9. Maps of the per-capita GDP in 1977 and in 2006

Map of the per-capita GDP in 1977



Map of the per-capita GDP in 2006

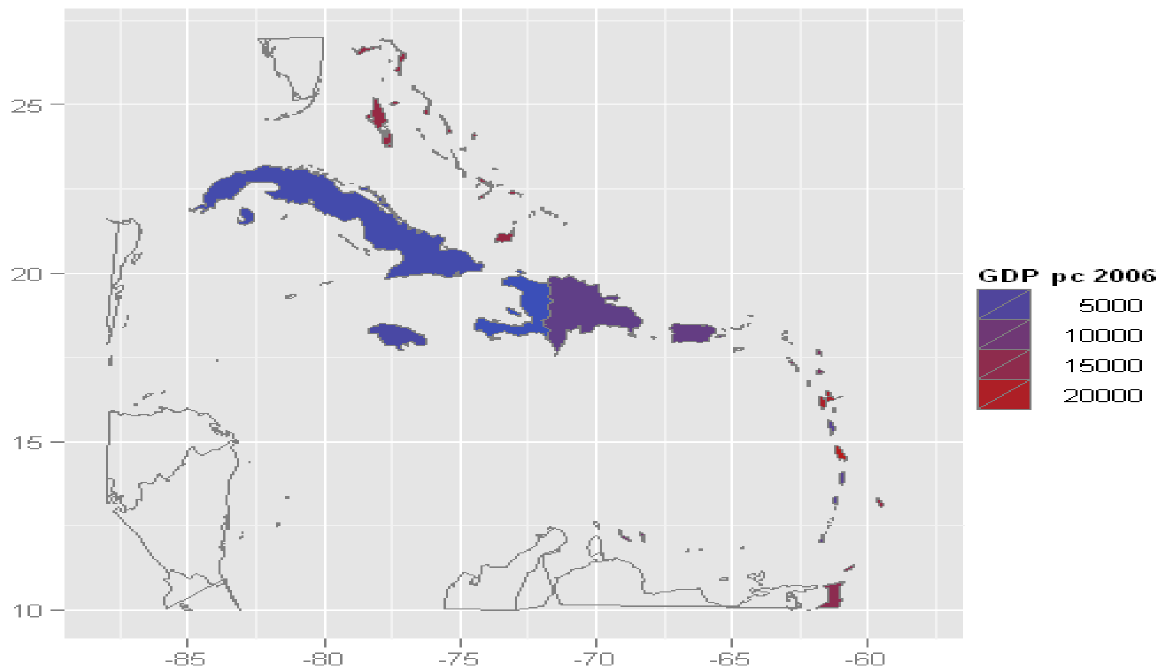
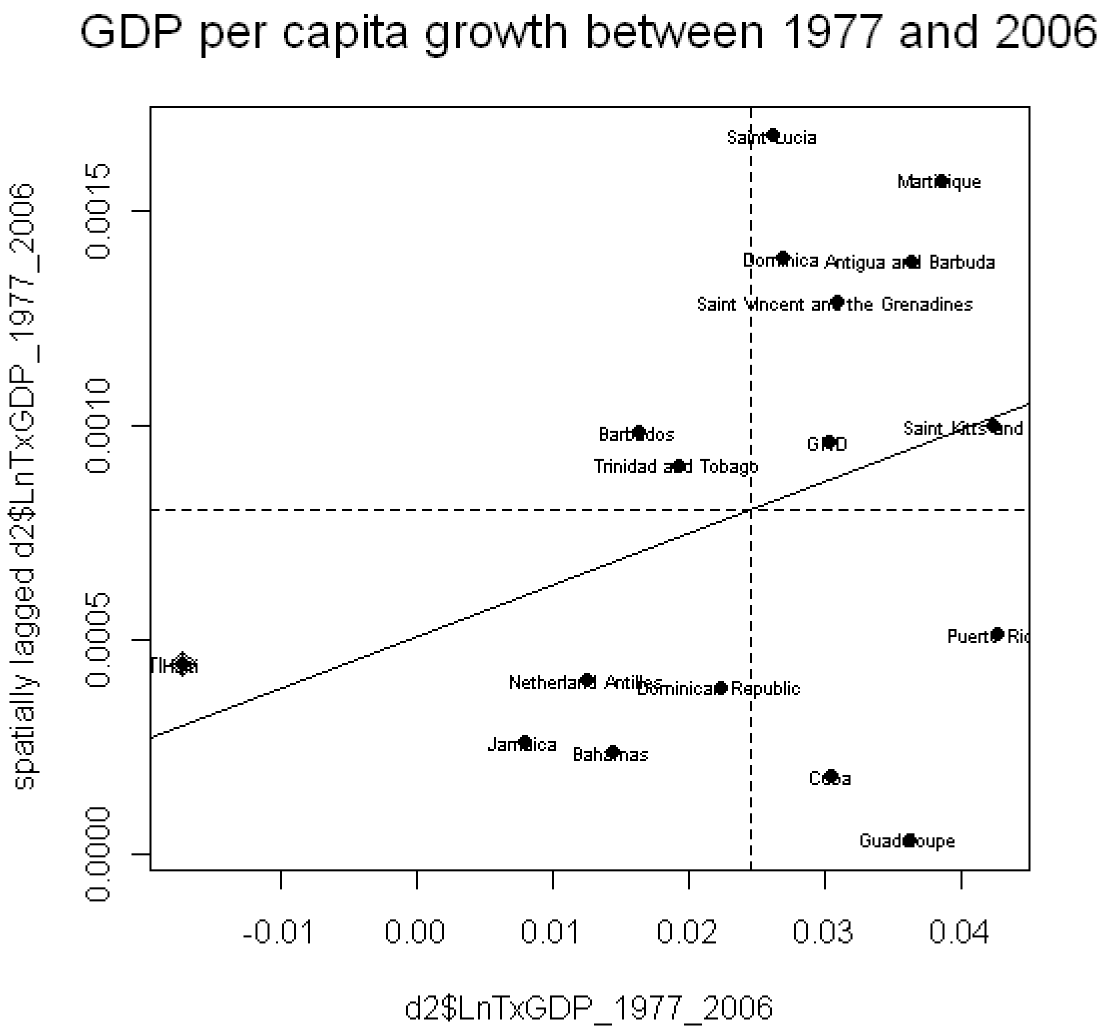


Figure 10. Moran Scatter Plot for the W1 Weight Matrix



Conclusion

The focus of this article is to analyse and verify empirically whether the process of convergence of per capita GDP exists among countries in the Caribbean. It was shown, based on descriptive statistical methods, and statistical and econometric tests of beta-convergence and sigma-convergence that there was an absence of convergence for CARICOM countries since the early 1980s. This is so even in the OECS group which are linked in a quasi monetary union framework.

Theoretical debates and the European Union's example have often emphasized the benefits of economic integration, whose principal aims are the elimination of custom barriers, the coordination of economic policies and the organisation of trade and financial systems. The above results suggest that there is a need for regional development policies to facilitate the integration of Member States as the integration process in the Caribbean appears to be largely incomplete. No longer can the region continue to let time slip by without correcting this lack of a common global strategy, especially since the economic and political contexts are changing with the Caribbean now facing several new challenges including the new rules of international trade, the preferential agreements once granted by the EU to ACP countries in the Caribbean are being gradually suppressed. Secondly, the extension of the European Union to include the countries of Western Europe marks the start of a period which will prove to be particularly difficult for the Caribbean countries that are signatories of LOME conventions, In fact, the arrival of these new members is synonymous with new requests for aid and investment, thus reducing the share allotted to Caribbean countries.

Despite these difficulties, a possible solution for the future development of the Caribbean's small, insular countries is the completion of the integration project, which can be achieved through a regional approach in key structural domains. This approach must cover at least the following objectives: the reduction and harmonization of tariffs; the restructuring of financial sectors; the harmonization of investment incentives and fiscal systems; the coordination of agricultural policies; the adoption of common strategies for commercial trade. All of these objectives must be met if these countries are to arrive at ways and means of continuing the integration process and getting involved in international trade, in the best possible conditions. In the long run, these countries could equip themselves with, on a regional level, the infrastructure and institutional means which would permit them to attain a level of technical competence and economic power, which they could never aspire to reach by acting alone.

Finally, the origin and answer to this question of why the absence or lack of convergence among the economies of the Caribbean should be developed and discussed by all of those who are interested in the economic development of the region. The origin of the disparities in development within the Caribbean basin have regularly been the subject of macroeconomic studies, conducted both by national and international institutions. The persistence of disparities can be explained by the unequal endowment in natural resources: For instance, Trinidad and Tobago has oil and most of the other islands are dependent on tourism but at the same time, they have performed very uneven in this sector. The particular policy choice adopted by these countries has also impacted on the maintenance of these disparities. Lack of mobility of capital and labour as well as the unequal distribution of skilled workers are two more explanations for the differences among GDP per capita in the Caribbean.

Finding answers to these problems which are often at the centre of the economic literature and current events are real challenges for governments in the Caribbean. In a 2005 report, the World Bank presented a broad argument for strengthening the integration process in

CARICOM as a strategy for promoting economic convergence. The report suggests "a pro-active approach for the region to take on the challenges of a small group of states facing severe resource constraints, eroding trade preferences, declining productivity, and increasing risk of macroeconomic instability. First, it argues that greater integration within the CARICOM region on several fronts will be a critical input into improving competitiveness. Easing up further on labour mobility within the region would improve skill and wage arbitration; joint investment promotion would make the region more attractive for investment, tax harmonization would help reduce harmful tax competition, more cooperation in provision of services and regulation could help to reduce the high costs of government."

References

AKanni-Honvo. A. (2003). Intégration régionale. Effets frontières et convergence ou Divergence des économies en développement. Revue Région et Développement. No 17.

Amable. B. (2002). Un survol des theories de la croissance endogène. Document de travail. Université de Paris X.

Anselin. L. (1988). Spatial Econometrics: Methods and Models. Dorddrecht. Kluwer Academic Publishers.

Anselin. L. (2001). Spatial Externalities. Spatial Multipliers and Spatial Econometrics. Discussion paper of Regional Economics Applications Laboratory. REAL. 01-T-11. August.

Anselin. L. and Bera. A. K. (1998). Spatial Dependence in Linear Regression Models with an Introduction to Spatial Econometrics. in: Giles. D. and Ullah. A. (Eds.). Handbook of Applied Economic Statistics. Marcel Dekker. New York. pp. 237-289.

Anselin. L. and Bera. A. K. (1998). Spatial Dependence in Linear Regression Models with an Introduction to Spatial Econometrics. in: Giles. D. and Ullah. A. (Eds.). Handbook of Applied Economic Statistics. Marcel Dekker. New York. pp. 237-289.

Atkins. F. and Boyd. D. (1998). "Convergence and the Caribbean". *International Review of Applied Economics*. 12. pp. 381-396.

Barro. R. J. and X. Sala-i-Martin (1991). Convergence across States and Regions. *Brookings Papers on Economic Activity*. vol. 1. 1991. pp. 107-158.

Barro. R. J. and X. Sala-i-Martin (1992). Convergence. *Journal of Political Economy*. vol. 100. 1992. p. 223-251.

Bensidoun I. and. Boone L. (1998). L'économie mondiale 1999. Éditions La Découverte. collection Repères. Paris. 1998.

Birchwood A. (2005). Economic convergence in the Caribbean Community. XXXVII Annual Monetary Studies Conference. The Bahamas. November 1-4. 2005.

Borda P.. Manioc O. et Maurin A. (2008). "L'immigration intra-caribéenne : des faits aux enjeux économiques". Revue Hommes & Migrations. juillet-août. N° 1274. pp. 10-20.

Caribbean Community (Caricom) Secretariat, (2005)." **Caribbean Trade And Investment Report 2005 : Corporate Integration And Cross-Border Development.**

Dramani L. (2007). Convergence and economic Integration in Africa: case of CFA countries. Working Paper. University of Cheikh Anta Diop of Dakar. 2007.

Duhamel A.. Calero J-P. (2003). Le marché commun de la Communauté du bassin des Caraïbes. Les Notes d'information de l'Observatoire des Amériques.

Durlauf S.N.and Quah D. (1998). The New Empirics of Economic Growth. Centre for Economic Performance Discussion Paper No. 384.

Fernández G.. Calderón A. (2009). Spatial Regression Analysis vs. Kriging Methods for Spatial Estimation. Int Adv Econ Res (2009) vol. 15. pp.44–58.

Fontagné L. et Guérin. J.L. [1997]. L'ouverture. catalyseur de la croissance. *Economie Internationale*. n° 71. troisième trimestre.

Giudici E. and Mollick A.V. (2008). Convergence in the Eastern Caribbean States. Annals of Regional Science. Vol. 42. No 4. 893-909.

Guzman J.M. et al. (2006). "La démographie de l'Amérique latine et de la Caraïbe depuis 1950". Population-F. Vol. 61. No 5-6. pp. 623-734.

Head and Mayer, 2002, "Illusory Border Effects", CEPII Working Paper No. 2002-01

Islam. N. (1995). Growth Empirics: A Panel Data Approach. in: Quarterly Journal of Economics. 110. 1127-1170.

Keller W. (2002). Geographic Localization of International Technology Diffusion. American Economic Review. 92. p. 120-142.

Krugman. P. (1991) Geography and Trade. MIT Press. Cambridge.

Jessamy V. (2003). Progression of vulnerability of OECS states : a historical analysis of roots causes. Working Paper. Centre for Social and Economic Research on the Global Environnement. School of the Environmental of East Anglia.

Moreno R. and Trehan B. (1997). Location and the Growth of Nations. Federal Reserve Bank of San Francisco.

Moreira M.M. and Mendoza E. (2006). Regional integration. What is in it for CARICOM?. Inter-American Development Bank. September 2006.

Nagaraj R.. Varoudakis A.. Véganzonès M.-A. (1999). Infrastructure et performances de croissance à long terme: le cas des Etats de l'Inde. Annales d'Economie et de Statistique. No 53. 93-127.

Parikh A. and Shibata M. (2004). Does trade liberalization accelerate convergence in per capita incomes in developing countries?. Journal of Asian Economics 15 (2004) 33–48.

Rodrik D. [1999]. The New Global Economy and Developing Countries: Making Openness Work. Washington DC. Overseas Development Council

Romer. P.M. (1990). Endogenous Technological Change. Journal of Political Economy 98. S71-S102.Romer. P. M.. Increasing Returns and Long-run Growth +. *Journal of Political Economy*. vol. 94. 1986. p. 1002-1037.

Swan. T. W. (1956). Economic Growth and Capital Accumulation. in: *Economic Record* 32. 334-361.

Virol S. (2006). Distance temps. discontinuité des interactions spatiales et concentration globale de l'espace Européen. Revue d'Économie Régionale & Urbaine. N° 1 - pp. 7-26.

World Bank. (2005) "A Time to Choose – Caribbean Development in the 21st Century". *World Bank Report No. 31725-LAC*. available online at http://www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/2005/05/04/000012009_20050504154937/Rendered/INDEX/317250LAC.txt .

.

Appendix 1: Definition and data sources

Data on GDP per capita were calculated using purchasing power parity (PPP), national GDP (constant 2000 international $) and population for the fifteen countries in the sample. It is important to note that the GDP series utilised is expressed in international dollars, which is based on the concept of PPP. More precisely, the international dollar, also called Geary-Khamis dollar, is a monetary unit with the same purchasing power characteristic as the U.S. dollar in the United States. So it is a currency that allows comparison of gross national income per capita for several countries.

Appendix 3 : Results of the Principal Components Analysis

Table 5: Correlation Matrix

	ATG	BLZ	DMA	DOM	GRD	GUY	JAM	KNA	VCT	SUR	TTO	VEN	HTI
ATG	1	**0.93**	**0.98**	**0.83**	**0.97**	**0.52**	**0.84**	**0.97**	**0.99**	-0,34	0,26	**-0,65**	**-0,93**
BLZ	**0.93**	1	**0.92**	**0.89**	**0.94**	**0.70**	**0.92**	**0.95**	**0.95**	-0,10	**0,44**	**-0,54**	**-0,92**
DMA	**0.98**	**0.92**	1	**0.82**	**0.97**	**0.56**	**0.87**	**0.98**	**0.98**	-0,36	0,21	**-0,63**	**-0,96**
DOM	**0.83**	**0.89**	**0.82**	1	**0.89**	**0.79**	**0.76**	**0.87**	**0.85**	0,06	**0,67**	**-0,51**	**-0,81**
GRD	**0.97**	**0.94**	**0.97**	**0.89**	1	**0.60**	**0.83**	**0.97**	**0.98**	-0,29	0,32	**-0,68**	**-0,92**
GUY	**0.52**	**0.70**	**0.56**	**0.79**	**0.60**	1	**0.73**	**0.68**	**0.54**	0,33	**0,61**	-0,09	**-0,66**
JAM	**0.84**	**0.92**	**0.87**	**0.76**	**0.83**	**0.73**	1	**0.90**	**0.86**	-0,07	0,28	-0,33	**-0,92**
KNA	**0.97**	**0.95**	**0.98**	**0.87**	**0.97**	**0.68**	**0.90**	1	**0.97**	-0,27	0,29	**-0,59**	**-0,97**
VCT	**0.99**	**0.95**	**0.98**	**0.85**	**0.98**	**0.54**	**0.86**	**0.97**	1	-0,30	0,29	**-0,64**	**-0,94**
SUR	-0.34	-0.10	-0.36	0.06	-0.29	0.33	-0.07	-0.27	-0.30	1	**0,66**	**0,57**	0,30
TTO	0.26	**0.44**	0.21	**0.67**	0.32	**0.61**	0.28	0.29	0.29	**0,66**	1	-0,06	-0,22
VEN	**-0.65**	**-0.54**	**-0.63**	**-0.51**	**-0.68**	-0.09	-0.33	**-0.59**	**-0.64**	**0,57**	-0,06	1	**0,57**
HTI	**-0.93**	**-0.92**	**-0.96**	**-0.81**	**-0.92**	**-0.66**	**-0.92**	**-0.97**	**-0.94**	0,30	-0,22	**0,57**	1

Table 6: Principal Components

	F1	**F2**
Eigen Value	9.34	2.29
% variance	71.86	17.65
% cumulative	71.86	89.51

Table 7 : Results of Contributions

Contributions of the countries (appear here as variables (%))

	F1	F2	F3
ATG	10.07	1.10	0.06
BLZ	10.14	0.41	0.11
DMA	10.12	1.26	0.46
DOM	8.88	4.08	5.01
GRD	10.29	0.36	0.73
GUY	5.09	14.41	5.55
JAM	8.67	0.54	17.36
KNA	10.46	0.13	0.95
VCT	10.22	0.63	0.05
SUR	0.50	38.46	0.01
TTO	1.52	28.14	24.58
VEN	4.10	10.08	41.48
HTI	9.94	0.39	3.65

Contributions of the dates (%)

	F1	F2	F3
YR1977	7.40	6.03	10.77
YR1978	6.78	9.71	6.40
YR1979	6.81	6.16	2.54
YR1980	5.66	3.53	0.26
YR1981	4.66	5.09	0.90
YR1982	4.23	1.38	3.96
YR1983	3.86	0.00	5.87
YR1984	3.43	0.66	5.94
YR1985	2.99	1.65	6.53
YR1986	2.21	2.57	3.37
YR1987	1.04	6.71	1.24
YR1988	0.59	4.99	0.10
YR1989	0.17	4.74	1.90
YR1990	0.08	4.99	0.32
YR1991	0.04	2.74	0.39
YR1992	0.02	2.12	2.87
YR1993	0.21	3.25	6.08
YR1994	0.50	2.51	4.75
YR1995	0.63	1.60	6.66
YR1996	1.06	1.08	4.75
YR1997	1.39	0.15	6.28
YR1998	1.97	0.11	2.85
YR1999	3.12	0.22	0.15
YR2000	3.95	0.08	0.00
YR2001	3.75	0.06	0.04
YR2002	4.55	0.13	2.07
YR2003	5.89	0.46	8.78
YR2004	6.60	3.27	2.03
YR2005	7.16	7.19	1.34
YR2006	9.25	16.81	0.84