Convergence in the Eastern Caribbean States

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Abstract

We examine absolute (sigma) and conditional (beta) convergence among selected members of the Eastern Caribbean Central Bank (ECCB). With the countries sharing the same monetary policy, we expect high rates of income convergence. While the ECCB members fail to converge absolutely, two convergence groups appear to form, implying different steady states. Employing panel data methods under different control variables, we find that conditional convergence is occurring for the whole group at a rate at least twice of the large sample of countries found in the literature. We interpret this result as a possible consequence of membership in the ECCB.

KEYWORDS: Beta-Convergence, Eastern Caribbean Countries, Sigma-Convergence.

CONVERGENCE IN THE EASTERN CARIBBEAN STATES

1. Introduction

The literature on growth spans for about half a century and argues that if the assumptions of the Solow (1956) growth model are satisfied poorer countries will grow faster than richer countries, thus inducing a catch-up process. Countless studies have examined this implication empirically, but when large samples of countries are examined there is no evidence supporting a catch-up process. Some authors, such as Romer (1989), have rather found evidence of a growing gap between rich and poor countries. Representative cross-section approaches include Levine and Renelt (1992) and Mankiw et al. (1992). The latter found significant tendency towards convergence in OECD countries at around the 2% rate.

Starting with Barro and Sala-I-Martin (1992) who found convergence among U.S. states since the 1860s, a growing body of work has focused on regional aspects of convergence. One would expect convergence within national boundaries to be faster than across borders. Empirical evidence, however, provides contrasting results, such as Cashin and Sahay (1996) who study 20 Indian states from 1961 to 1991 and found that income convergence of the initially poor states to the initially rich states occurred at a rate of 1.5% per year, below the rate found for industrial or OECD countries. Funke and Strulik (1999) found evidence of convergence among eleven West German regions, but they also find evidence of persistent inequality in the steady state. Controlling for human capital, Funke and Niebuhr (2002) examines 71 West German regions and estimate statistically significant coefficients ranging from -0.011 to -0.014. Carmeci and Mauro

(2002) control for the unemployment rate and labor market features and find high speeds of convergence (per year) varying between 17% and 23% across Italian regions. The process of convergence is not necessarily stable over time, as documented for Mexican regions by Chiquiar (2005) and Rodriguez-Oreggia (2005). They find a convergent behavior of per capita output across Mexican states which broke down after 1985. In particular, Rodriguez-Oreggia (2005) finds that the lack of convergence can be explained by different levels of human capital and oil production.

The literature has been more recently extended to other concepts than income per capita convergence. Lall and Shalizi (2003), for example, examine Brazilian Northeastern municipalities and find that productivity among them is converging at about 3% per year. Christopolous and Tsionas (2004) use a model that allows for the existence of technological gaps, and find convergence in the productivity growth of Greek prefectures, which they explain as an effect of capital deepening. Bunyaratavej and Hahn (2005) propose a model that integrates three convergence variables (real GDP per capita, productivity and employment) through Markov Chain Monte Carlo methods.

In addition to the regional growth literature, studies that control for a number of factors have found evidence of convergence, suggesting that countries with similar characteristics could indeed be candidates for the catch-up process to occur. Baumol (1986) and Quah (1996) call the groups of those countries “convergence clubs”, which are characterized by similar characteristics such as population growth rates, education and technological growth. One such example is provided by the findings of Wang and Ge (2004). They first exclude the presence of absolute

convergence within the Chinese regions, and then show that there are three steady states to which three sets of provinces appear to converge.

This observation leads to the research question of a set of small Caribbean economies sharing closely related economic and population features. An earlier study for the Caribbean region by Atkins and Boyd (1998) has pointed out that the members of the Caribbean Community meet the criteria of similarity that are associated with the characteristics of a convergence club. However, they did not find strong evidence of long-run and persistent convergence; rather their findings of convergence vary in strength and are a consequence of individual circumstance, and not the automatic forces of stabilization. Conversely, a more recent study in Bertram (2004) finds evidence that small island economies tend to converge to their mainland patrons, rather than to each other. The large sample used by Bertram (2004) includes the islands members of the Eastern Caribbean Central Bank (ECCB henceforth), which are identified as having the same mainland patron: the United States.

Institutional factors may contribute to a faster rate of convergence among the cross-section units as well. In 1983 the Eastern Caribbean Countries joined a monetary union which led to the formation of the Eastern Caribbean Central Bank (ECCB). By entering this agreement, the eight members (Antigua and Barbuda, Anguilla, Dominica, Grenada, Montserrat, St. Kitts and Nevis, St. Lucia and St. Vincent and the Grenadines) relinquished their freedom of conducting an independent monetary policy, centralizing this duty to the ECCB. The objective of the ECCB (http://www.eccb-centralbank.org/PublicAwareness/particles_5.asp) is to "issue and manage the Eastern Caribbean currency, to safeguard its international value, to promote

monetary stability and a sound financial structure and to promote the economic development of the participating countries".

Despite its two decades of existence, there are no studies that we could find that addressed the issue of convergence among the ECCB members other than Atkins and Boyd (1998). If the ECCB was successful in its stated goals with regard to all the members, then an increasing level of similarity should have arisen, hence strengthening the characteristics of a single convergence club. Note that in this case the change in institutional framework attributed to the common monetary policy from 1983 onwards is *conducive to convergence*. This does not need to be necessarily the case. In fact, Chiquiar (2005) applies conditional convergence methods and concludes that convergence across Mexican states broke down after trade liberalization, even in a conditional sense. In that particular case, NAFTA strengthened the ties between U.S. and Mexico. Therefore, Mexican border states (already subject to higher initial per capita income) tended to perform better than states located further away from the border. The major exogenous change in Mexico therefore *widened its regional differentials*.

Adopting the blend of regional growth studies with the growth econometrics of panel data, the purpose of this paper is twofold. First, it attempts to evaluate whether the ECCB members are converging to one another following the establishment of the ECCB, by examining σ-convergence, which is the strictest measure of convergence. Second, we search factors that might be hampering or promoting convergence, conditioning for other growth factors.

The convergence issue is examined by a variety of methods. Absolute σ-convergence is first tested by evaluating the autoregressive nature of the dispersion across the per capita GDP of

the ECCB members. Examination of σ-convergence indicates that the ECCB group is on the path of a persistent differential in per capita GDP, and the evidence seems to indicate that there are two groups of convergence. The first is composed by Antigua and Barbuda, and St. Kitts and Nevis, which appear to be on the path satisfying the most stringent requirements of convergence. The second group is composed of the remaining countries, which exhibit a persistent, but moderate spread in per capita GDP. The tests of the whole group for the less stringent σ-convergence indicate a much larger rate of convergence than the one found in the literature for the OECD countries.

A variation of the panel data approach developed by Islam (1995) is employed next to identify the variables that need to be controlled in order to obtain convergence. Regardless of the specific econometric model used, a convergence rate of at least 5% is clearly higher than the values reported by Mankiw et al. (1992) who obtain a rate of convergence of about 2% when considering a large sample of countries with heterogeneous characteristics. Our results are also more in line with Islam (1995), who reports implied convergence parameters varying from around 4% (nonoil countries) to between 7% and 9% (OECD countries) depending on the panel data method used. We interpret our results following Mundell (1961) on optimal currency areas and the positive impact of a single currency on trade and income.

The remaining part of the paper is organized as follows. In the next section we provide a brief review on the empirics of convergence. Section 3 describes the data and section 4 describes the methodology. Section 5 discusses the results and section 6 concludes the paper.

2. A Brief Review of the Empirics of Convergence

The idea of convergence is an implication of the Solow (1956) growth model. The model takes the rates of population growth, savings and technological level, *A(t)*, as exogenous. It also assumes diminishing returns to capital, and that output, *Y(t)*, follows a Cobb-Douglas production function with capital, *K(t)*, and labor, *L(t),* as inputs:

$$Y(t) = K(t)^{\alpha}\left(A(t)L(t)\right)^{1-\alpha}, \qquad 0 < \alpha < 1 \tag{1}$$

By assuming that labor and the level of technology grow with an exponential form, at rates *n* and *g* respectively, the model predicts that there is a steady state for income per capita, represented by the function:

$$\ln\left[\frac{Y(t)}{L(t)}\right] = \ln A(0) + gt + \frac{\alpha}{1-\alpha}\ln(s) - \frac{\alpha}{1-\alpha}\ln(n+g+\delta) \tag{2}$$

where: δ is the constant rate of depreciation. This steady state level of per capita GDP is affected positively by the rate of saving and negatively by the population growth rate.

The diminishing returns to capital and labor imply that those countries that are initially more advanced will grow slower than those countries that initially lag behind. This differential in growth rates will generate a growth pattern in which the countries that lag behind will catch up

with those that are richer. At the steady state, the level of per capita income should coincide, provided that the countries have similar savings and population growth rates.

The numerous empirical studies of convergence have found contrasting results. Evidence of convergence is found in the contiguous U.S. states [see Barro and Sala-i-Martin (1992) and Evans and Karras (1996)], but the rate of convergence diminishes if the rate of return to capital is not controlled for. Similarly, Funke and Strulik (1999) have found evidence of convergence among eleven German regions, but they also find evidence of persistent inequality in the steady state.

The U.S. contiguous states and the German regions are characterized by factor mobility, and a common economic and bureaucratic structure that may not be equaled by groups of countries. As a consequence, finding strong evidence of convergence among countries is less likely than among regions. Barro and Sala-I-Martin (1992) find evidence of convergence in a group of countries only after controlling for different steady states. Atkins and Boyd (1998) have studied convergence among CARICOM members and have found existence of different steady states.

Barro and Sala-i-Martin (1992) introduced σ-convergence, a stringent measure of convergence, which is obtained when the dispersion of per capita income across countries or regions declines near zero over time. Should evidence for σ convergence be found, the countries examined are actually converging to the same steady state. An alternative form of convergence that accommodates for differences across countries and regions is denoted β-convergence, and indicates that poorer countries are growing faster than the richer ones. β-convergence does not

imply that the countries will reach the same steady state, as implied by σ convergence. A less restrictive form of β-convergence is its conditional version, which is obtained by augmenting the estimation equation with a number of control variables.

The cross sectional framework of β-convergence involves regressing the difference between logs of per capita income at two distinct points in time over a constant and the log of income at the earlier time:

$$\frac{\ln\left(y_{i,t+T}\right)-\ln\left(y_{i,t}\right)}{T}=A+\beta\ln\left(y_{i,t}\right)+\varepsilon_{i,t} \tag{3}$$

For convergence to exist, the average growth rate between time t and $t+T$, must decline with increasing levels of initial income. Hence, in the above regression β-convergence is associated with $\beta < 0$. Furthermore, the rate of convergence, b, can be computed by solving the equation below for b as in Maurseth (2001):

$$\beta=-\left(\frac{1-e^{-bT}}{T}\right) \tag{4}$$

One shortcoming of the cross-sectional approach is that it ignores the dynamic effects of growth. In particular, we can not employ this method in this context, as the ECCB has only eight

members, of which we only have data for six. Thus, by using only cross-sections, our sample size would be too small to obtain meaningful results.

Atkins and Boyd (1998) use a modified version time series version of equation (3) to which they include a trend variable. Other modifications of the basic equation are obtained by Mankiw et al. (1992) when introducing control variables in cross-sectional model, and by Islam (1995) in order to test for convergence by means of panel data.

The approach followed by Mankiw et al. (1992) is to estimate conditional β-convergence by controlling for a set of control variables (X^j), in line with (2). Their model is estimated over a period of time *T*, leading to a cross- sectional equation of the type:

$$\ln\left(y_{i,t}\right) = a + b\ln\left(y_{i,t-T}\right) + \sum_j c_j X_i^j \ . \qquad (5)$$

σ-convergence is the most restrictive form of convergence: it denotes that the standard deviation of GDP per capita of a group of countries decreases over time if they are converging. For σ-convergence to exist, countries with initial lower per capita GDP must grow faster than those with higher per capita GDP. In other words, for σ-convergence to exist, β-convergence must occur. For a mathematical derivation of the relationship, see Furceri (2005).

Maurseth (2001) derives an expression for σ-convergence by letting *T=1* in equation (3), obtaining a difference equation. Since the error term *u* and per capita GDP are uncorrelated, the sample variance of per capita GDP can be found to be related to its lags by the following:

$$\sigma^2_{y,t} = (1+\beta)^2 \sigma^2_{y,t-1} + \sigma^2_u \quad (6),$$

where: β is the coefficient estimated in equation (3), and σ^2 represents the variances of the error term u and per capita GDP. Furthermore, for σ-convergence to occur, it is necessary that $\beta < 0$, indicating that β-convergence must hold.

Criticisms on the measures of convergence are widespread. Mankiw et al. (1992) argue that both measures, β and σ, are incomplete as they ignore the interactions between countries, such as technological spillover effects. They therefore introduce a number of control variables in their regression. The ECCB in part sidesteps some of these criticisms, in virtue of their similarities in terms of size, dependence on foreign energy sources, geographical characteristics and proximity. For completeness we test for convergence under a variety of methods.

3. The Data

The data are obtained from the Penn World Tables (PWT 6.1) database by Summers and Heston (1991). This dataset does not include any information about Anguilla and Montserrat, which are therefore excluded from this study. For the remaining six countries, the yearly series of GDP is obtained form the *Real GDP per capita (constant Prices: chain series)*. The consumption (KC), government (KG) and investment (KI) share of GDP and population data are also from the Penn World Tables and span a period from 1977 to 2000 in yearly data. The Current Saving variable obtained form the database is defined as "the percentage share of current savings to GDP and is

derived by subtracting CC [consumption share of GDP] and CG [government share of GDP] from 100."[1] After obtaining the national income account figures, we calculate the openness measure (OPEN) as usual as the sum of exports and imports divided by GDP. This variable will, together with the income-based variables, be used as an alternative control variable. The per capita GDP set spans a period from 1977 to 2000 for five countries, except St. Lucia, which starts in 1980. The series has missing data for Dominica from 1997 to 1999, with its missing values replaced by linear interpolation.

It is important to note that data limitations arise for the Caribbean countries. For example, calculations of TFP for the region can only be made under the standard specification of the production function through capital and labor. Augmented forms allowing for human capital as in Mankiw et al. (1992) or for different technology measures (such as R&D expenditures, number of Ph.D.s in the country, number of patents, or R&D shares of GDP) are all not feasible. The study by Inter-American Development Bank (2006) is a case in point. For all the Caribbean countries discussed in this study there are missing values for series on technology that potentially could allow for different assumptions of technology growth. As Inter-American Development Bank (2006) makes clear, technology related data are unavailable for all the countries examined herein.

[1] The savings rate is thus computed directly in the Penn World Tables by (Y – CC – CG)/Y, where: CC = consumption share of GDP and CG = government share of GDP. Calculated in this manner, the savings rate is not equal to the investment rate. Allowing for differences, it captures situations in which countries are lending (S>I) or borrowing from abroad (S<I). Four of the countries of our data set had similar gaps between the savings rate and the investment share, with Antigua and Barbuda and St. Lucia displaying lower values of the gaps.

Data availability therefore limits the possibility of letting technological growth differ across countries in a systematic way to be captured by the data. The assumption of a similar growth rate of technology is, however, in line with empirical evidence on total factor productivity of the Caribbean countries examined herein. World Bank (2005) estimates document that our six countries experienced very similar total factor productivities in the period 1981-2000, with an average of 2.70% and a range from 2.31% to 3.11%. This similarity for the ECCB countries is even more striking when compared with the remaining Caribbean countries, which averaged TFP growth rate of 0.597% in the same period.[2] We therefore do not see the assumption of a constant rate of technology growth to represent a serious problem for our sample of six countries.

Figure 1 plots the GDP of the countries used in this study. The plot indicates that in the late 1970's Antigua and Barbuda had the highest per capita GDP. The remaining countries had similar, but lower than Antigua and Barbuda's per capita GDP levels. After almost two decades, we can clearly see that Antigua and Barbuda maintained a higher growth rate than the other countries, with the exception of St. Kitts and Nevis that appeared to have grown in a parallel fashion. However, the remaining countries have followed similar but reduced growth rates, which lead to a growing gap between them and the leading two. Is this an indication of

[2] The average TFP calculations (in percentage growth) for the 1981-2000 period (very similar to our own from 1977 to 2000 or from 1980 to 2000 depending on the country) in the World Bank (2005) report are as follows. First, for the ECCB members: Antigua and Barbuda 3.11, Dominica 2.80, Grenada 3.07, St. Kitts 2.45, St. Lucia 2.31, and St. Vincent 2.44. This makes ECCB members to have mean TFP of 2.70 and standard deviation of 0.346. Second, for the non ECCB members: Barbados 0.68, Belize 1.53. Dominican Republic 1.70, Guyana 0.63, Jamaica -0.49, Trinidad and Tobago -0.47. This yields for the non-ECCB a mean TFP of 0.597 and standard deviation of 0.940. The regional median was 2.04, the TFPs had a mean of 2.70 and a standard deviation of 0.346.

divergence, or just a sign that within the members of the ECCB two distinct clubs formed? If that is the case, is there evidence of convergence within each club? These questions motivate the empirical part of the paper.

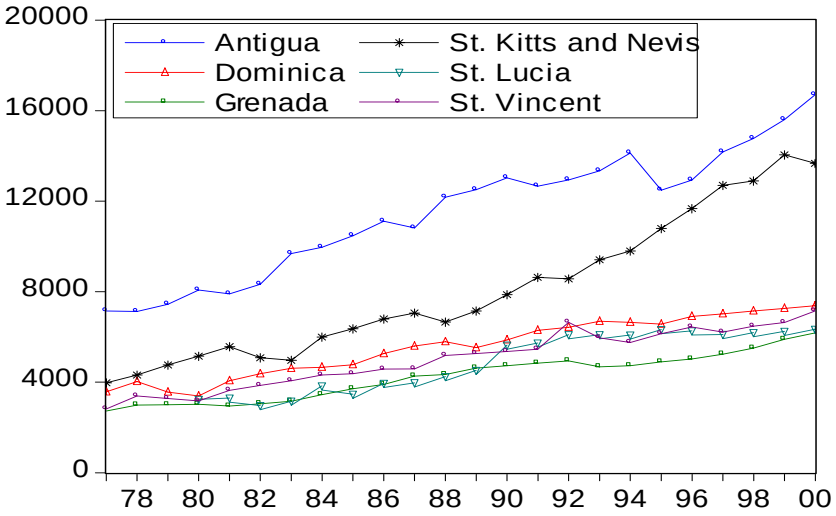

Figure 1. Plot of per capita GDP at constant prices for selected ECCB members.

4. Methodology

In order to assess the degree of σ-convergence occurring in the ECCB, we examine the time trend of the coefficient of variation. The coefficient of variation is defined as the ratio of the standard deviation and the average of per capita income at every point in time. The advantage of using such measure is that it is dimensionless, and it is easy to interpret. In fact, should the countries be converging to a common level of per capita income, the coefficient of variation will approach zero. Should the coefficient of variation have a steady state different than zero, then there will be a persistent income gap among the countries.

As far as conditional β-convergence is concerned, we use four models to estimate the rate of convergence for the ECCB countries. First we employ a slightly modified version of the model used by Islam (1995), which includes per capita GDP (*y*), population growth rate (*n)*, savings rate (*s*), technology growth rate (*g*), and the rate of depreciation (δ):

$$y_{i,t} = \gamma y_{i,t-\tau} + \beta_1 \ln(s) + \beta_2 \ln(n+g+\delta) + \eta_t + \mu_i + \nu_{i,t} \quad (7)$$

In the above specification, Islam (1995) follows Mankiw et al. (1992) and assumes that the rate of technology growth (*g*) and depreciation (δ) total 0.05. In this study, however, they are assumed to be zero, as variations in these will be reflected in the constant term and will not affect the coefficient of convergence. Also, while Islam (1995) takes a value of τ equal to five years, we take it to be each of one, two, three and four years. Doing so, we check for different time windows. Following Islam (1995), we average the control variables over the τ years.

Once equation (7) is estimated, the speed of convergence can be computed by recognizing that:

$$\gamma = e^{-\lambda\tau} \quad (8)$$

where λ is the rate of convergence maintained over the time span τ.

The above model is modified by subtracting $y_{i,t-\tau}$ from both sides to yield:

$$y_{i,t} - y_{i,t-\tau} = (\gamma - 1) y_{i,t-\tau} + \beta_1 \ln(s) + \beta_2 \ln(n + g + \delta) + \eta_t + \mu_i + \nu_{i,t} \quad (9)$$

By estimating the model in first-differences we reduce the possibility of unit root related problems. The model is further modified to include alternative control variables. We provide a rationale for their choice as follows based on the income equation:

$$Y = C + I + G + NX \quad (10)$$

where the variables on the right hand side represent consumption, investments, government spending and net exports. Differentiating with respect to time yields:

$$\frac{\partial Y}{\partial t} = \frac{\partial C}{\partial t} + \frac{\partial I}{\partial t} + \frac{\partial G}{\partial t} + \frac{\partial NX}{\partial t} \quad (11)$$

By approximating income with its Taylor series expansion at time *t-1*, yields:

$$Y(t) \approx Y(t-1) + \left.\frac{\partial Y}{\partial t}\right|_{t-1} \quad (12)$$

Substituting for the rate of growth of income, we obtain:

$$Y(t) \approx Y(t-1) + \left.\frac{\partial C}{\partial t}\right|_{t-1} + \left.\frac{\partial I}{\partial t}\right|_{t-1} + \left.\frac{\partial G}{\partial t}\right|_{t-1} + \left.\frac{\partial NX}{\partial t}\right|_{t-1} \tag{13}$$

Equation (13) can be restated in discrete time, and on a per capita basis and included in the Islam (1995) equation, to yield the following model:

$$y_{j,t} = \gamma y_{j,t-\tau} + \beta_1 \bar{c}_{j,\tau} + \beta_2 \bar{g}_{j,\tau} + \beta_3 \bar{i}_{j,\tau} + \beta_4 \bar{o}_{j,\tau} + \eta_t + \mu_i + \nu_{i,t} \tag{14}$$

This substitution of control variables is possible, as Islam (1995) estimates γ to be near unity for all the samples of countries (for non oil producing countries his estimate is 0.976). Hence, by letting γ = 1, equations (7) and (14) show an identity among the two sets of control variables. For this alternative model, the computation of the speed of convergence is the same as Islam's model, as shown in (8). The treatment of the control variables is also the same as in Islam's model, as they are averaged over the τ years under consideration. We estimate the model above in levels and in first-differences, as in (7) and (9), respectively.

The countries in consideration, however, do not offer much freedom with respect to the choice of the methodology to use. This is because the data on GDP span only twenty years and the cross-section is limited to six countries. To avoid small sample related problems, we employ the panel data approach put forward by Islam (1995), who grouped countries in five year spans

and regressed the per capita GDP at the end of the five years on the GDP of the first year, and some control variables.

We propose a number of modifications to ensure the robustness of our findings. First, we estimate the model in Islam (1995) by using time spans from one through four years. The choice of five-year periods was motivated by Islam as being free of the effects of business cycles. However, it is hard to find any evidence on the length of the business cycles in the ECCB members, and by increasing the time span we reduce the sample size excessively. Second, we modify Islam's model by subtracting income from both sides, as shown in (9). This should decrease the likelihood that the dependent variable has a unit root. Third, estimation of the panel is done as in Islam (1995), by using fixed effects, and by three estimation methods: least squares; least squares with EGLS applied to a cross section; and EGLS applied to the time series. Of the three models, the one with less serial correlation in the residuals was selected. Fourth, additional control variables were selected as described in equation (14). We run the model in (14) and also by subtracting the lagged per capita income from both sides, similar to (9).

5. Results

5.1. σ-convergence

For each cross section, we compute the average per capita GDP, its standard deviation and the coefficient of variation (CV)[3]. The resulting time series of the CV is plotted in Figure 2. We can see from the graph that the group of all ECCB members seems to have a persistent coefficient of

[3] The estimates of the coefficient of variations, their autoregressive specification and the solution of the difference equations are available from the authors upon request.

variation between 0.4 and 0.5. If we isolate the two fast growing members, Antigua and Barbuda and St. Kitts and Nevis, the coefficient of variation is declining, possibly suggesting absolute convergence. The four lagging economies, however, seem to hover around the value of 0.1, which indicates a consistent, albeit small, spread in per capita GDP.

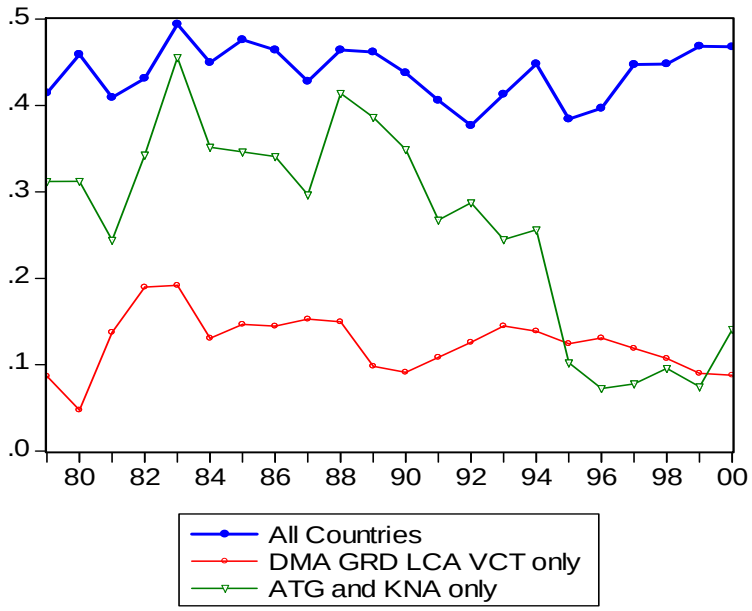

Figure 2. Plot of the coefficients of variation of per capita GDP for different sets of ECCB members: all members; the two richest members (Antigua and Barbuda, and St. Kitts and Nevis); and the remaining four members (Dominica, Grenada, St. Lucia, and St. Vincent).

In order to obtain a quantitative measure of the behavior of the coefficient of variation, we first tested the series for unit root, and then estimated it as an autoregressive process by minimizing the Akaike Information Criterion and by testing the residuals of the estimate for normality and serial correlation. We use the estimated coefficients to solve the difference equation. The initial values used for the solution are the first and the last point where the

residuals are zero. The solved equation allows us to determine the behavior of the coefficient of variation in the long run, to assess whether there is a steady state, as in Holden and Pearson (1993). We computed the solutions for three specifications of the CVs: the entire set of countries, the leading group (Dominica, Grenada, St. Lucia and St. Vincent), and the trailing group (Antigua and Barbuda and St. Kitts and Nevis).

The whole set of countries will maintain a coefficient of variation of 0.44, meaning that the standard deviation of the per capita GDPs will remain about 44% of the average GDP at any point in time. The plot of GDP in Figure 1 indicates that a group of islands (Dominica, St. Lucia, Granada, and St. Vincent) grew at a very similar speed, reaching a common growth path. At the same time, St. Kitts and Nevis has grown at a much faster rate, almost catching up with Antigua and Barbuda. This pair has clearly maintained its position of richer countries and appears to be responsible for the failure of the whole set to converge to a single per capita income.

The four lagging countries will reach an estimated steady state CV of 0.127, meaning that the standard deviation of the GDPs will be only 12.7% of the average GDP of this group. We can interpret this small value as evidence of σ-convergence in this subset of islands. Comparing to other regional convergence studies, this figure is small. In India, for instance, its long-run value of the dispersion of per capita incomes (0.32) is over twice the level of those for regional economies in Australia, Japan, and the U.S. as noted by Cashin and Sahay (1996).

The same is not true when the fast growing Antigua and Barbuda and St. Kitts and Nevis are examined and coefficient of variation between these two countries is zero. This implies that the two islands will achieve an identical GDP path.

Overall, σ-convergence fails among the ECCB members. Despite their size similarities and geographical locations, the evidence supports two convergence clubs within the ECCB: one composed of Antigua and St. Kitts and Nevis (steady state of CV of zero); the other composed of Dominica, St. Lucia, Grenada and St. Vincent (steady state of 0.127).

5.2. β-convergence

Since σ-convergence is the strictest measure, we proceed with β-convergence. Using a dependent variable in levels or in first-differences has an impact only on the significance of the coefficient of the lagged per capita income, which is the coefficient of interest for the computation of the rate of convergence. The coefficients and the t-statistics of the control variables and the estimated rate of convergence are identical in both estimation methods. However, the adjusted R^2 declines when the first-difference is used, and this might have eliminated the possibility of a spurious regression, as found before for the region by Atkins and Boyd (1998). In this paper we focus on the estimates in first-differences and the estimates in levels are available upon request.

Next, the estimation by using population growth rate (POPGR) and savings rate (SAV) indicates that population growth rate is not significant, except for a negative value (-6.377) of τ of two years (Table 1, column 3B). Savings rate, on the other hand is consistently positive for τ of one and three years, but is not significant for τ of two and four years. We infer that changes of the saving rate have a positive and immediate impact on GDP, although the magnitude of its effects varies for other lag lengths.

For τ of one year initial income has a coefficient near -0.04 in all specifications. This supports the idea of conditional convergence across the Caribbean countries. As τ increases from one to four years (Tables 1 and 2), the value of the initial income per capita coefficient decreases. In all cases, the negative term is supportive of the conditional convergence hypothesis, although the first set of results (under $\tau = 1$) seems more reasonable.

We also estimate two variants of Islam (1995), by omitting savings (columns 2A and 2B) or population growth (columns 3A and 3B). We observe that population growth rate fails to be significant even when savings rate is removed, with the exception for the case of $\tau = 2$. Savings alone is significant for τ of one and three years as before. When significant, both variables appear with their signs as predicted by the theoretical model: population growth rate has a negative coefficient, hampering growth of per capita GDP, while savings rate is positive, promoting the growth of per capita GDP.

The estimation of the model by controlling for the changes of consumption (KC_CHG), investment (KI_CHG), and the government spending (KG_CHG) provides interesting results. First, using change in openness (OPEN_CHG) as a control variable appears to be not appropriate, as it fails to be significant in all models. This can be seen in columns 4A and 4B of Tables 1 and 2 and could be explained by the fact that this proxy is incapable of distinguishing an increase in imports from an increase in exports, as the two variables are added together, while in the income equation (10) the first is negative and the latter is positive.

Changes in consumption share of GDP (KC_CHG) are only significant for τ of one year. This could indicate that the effects of increases in consumption are immediately transmitted to

per capita GDP, and these effects are diminished if the period is extended. It is puzzling, however to see that the impact of this variable is negative. One likely channel could be if consumption were mostly based on imported goods, thus decreasing per capita GDP.

The rate of change of government share of GDP (KG_CHG) is significant only for τ of three years. When significant, this variable indicates that the differences in growth rates of the islands are explained by their different shares of government spending. Those with higher government spending achieve higher per capita GDP within three years. This is consistent with the stylized fact of reasonable lags in fiscal policy.

The rate of change of investment share of GDP (KI_CHG), on the other hand, is significant for values of τ less than four years, and its significance declines when openness is introduced. This variable has a negative impact on GDP, the opposite one would expect from the income equation.

Since our objective is to estimate the rate of convergence, the control variables are only of secondary importance in this context. There is in fact a problem with the interpretation of the control variables since it is not clear whether the control variables are proxying for differences in country steady-state income levels or for differences in country long-run growth rates: "the control variables could be picking up effects on the log-level of the country's steady-state income path rather than on the slope of that path." Klenow and Rodríguez-Clare (1997, p. 600).

Overall, all models estimate very similar values of the rate of convergence λ. However, the magnitude of the implied λ is sensitive to the selection of the values of τ. We find that the estimate of the rate of convergence is positively correlated with τ. Given that we are bounded by

the size of our sample, we cannot increase τ above four. However it would be interesting to investigate if this correlation continues indefinitely with τ. In any case, Islam's model seems to be less sensitive to increases in τ for values up to three years. But when τ is four years, there are no differences between controlling for population and savings or controlling by consumption, investment and government spending.

By using Islam's (1995) model, the estimate of λ is near 5% for τ of up to three years, jumping to 14% when we extend τ to four years. On the other hand, the model derived from the income equation estimates the rate of convergence in a similar range: from 4% when τ is one, to 14.44% when τ is four years. The similarity of the two models is noteworthy, but we recall that for intermediate values of τ, the model derived from the income equation appears to increase the estimate of λ, and the model with population and savings is more stable with λ-estimates around 5%. While further research is needed, this indicates the robustness of the two methods.

Regardless of the model used, a convergence rate of 5% is higher than the values reported by Mankiw et al. (1992), who obtain a rate of convergence of about 2% when considering a large sample of countries with heterogeneous characteristics. Islam (1995) shifts from cross-section to panel data methods and reports implied λ varying from around 4% (non-oil countries) to between 7% and 9% (OECD countries) depending on the econometric method. We thus confirm the higher rate of convergence as in Islam (1995). In the literature following Mundell (1961) on optimal currency areas, there are numerous references to the positive impact of a single currency on trade and thus on income. We interpret our results as supportive that the ECCB has had a positive impact on the rate of income convergence.

6. Concluding Remarks

The introduction of a common currency and monetary policies among the members of the ECCB should lead the different islands towards a unique level of GDP. However, the literature indicates that convergence fails to appear in its strictest from even at the regional level. In this paper, motivated by the lack of studies of convergence among the ECCB members, we investigated convergence in the strictest from (σ-convergence) and in its most relaxed version (β-convergence). The results show that, if we consider the whole set of countries, there is a permanent gap in income among the members, which corresponds to a spread of about 44% of the average income. If we isolate the richer Antigua and Barbuda and St. Kitts and Nevis, the remaining islands appear to maintain a steady state 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*.

We also measure β-convergence by using two models with different controls for: population growth rate and savings rate as in Solow (1956); and consumption, government spending, investment and openness as derived in this paper. In both cases we estimate the rate of convergence to be significantly higher (at least twice as much) than what is commonly found for heterogeneous set of countries. For only one time period, we obtain statistically significant coefficients supportive of the idea of conditional convergence across the Caribbean countries at around the 4% rate. Employing the panel data methods by Islam (1995), we hereby confirm the higher rate of convergence, a result subject to different sets of macroeconomic control variables.

While σ-convergence indicates the possibility of the formation of two clubs, the evidence on conditional β-convergence highlights a large rate of convergence. This is a possible signal that all the members of the ECCB are reaping the benefits of a single currency, but not all are benefiting at the same rate. In contrast to Chiquiar (2005) who found widening of regional economic disparities among Mexican states after opening up to trade, the common monetary policy from 1983 onwards has *stimulated convergence among the Caribbean countries* along the lines of Mundell (1961). Clearly, Antigua and Barbuda and St. Kitts and Nevis have been able to maintain the largest rates of growth of all, and the others are slowly crawling behind. As remarked by Islam (1995), the finding of a higher rate of conditional convergence actually calls for *more* policy activism since our framework extends beyond the typical savings and labor force growth set up.

TABLE 1 - ESTIMATION OF β CONVERGENCE WITH τ EQUAL TO ONE AND TWO YEARS

	Dependent variable : ln y(t) - ln y(t-τ), τ = 1					Dependent variable : ln y(t) - ln y(t-τ), τ = 2				
	[1A]	**[2A]**	**[3A]**	**[4A]**	**[5A]**	**[1B]**	**[2B]**	**[3B]**	**[4B]**	**[5B]**
RGDPLN(-1)	-0.043	-0.039	-0.038	-0.040	-0.038	-0.109	-0.150	-0.108	-0.122	-0.120
	(-1.968)	(-1.829)	(-1.993)	(-2.880)	(-2.794)	(-2.019)	(-3.629)	(-1.986)	(-4.521)	(-4.499)
POPGR	0.930		0.411			-4.175		-6.377		
	(0.793)		(0.438)			(-1.562)		(-2.591)		
CSAV_CHG	0.320	0.333				0.377	-0.001			
	(5.773)	(6.142)				(1.729)	(-0.802)			
KC_CHG				-0.467	-0.474				-0.443	-0.411
				(-4.579)	(-4.628)				(-1.602)	(-1.521)
KG_CHG				-0.163	-0.139				0.0217	-0.136
				(-1.098)	(-0.970)				(0.036)	(-0.246)
KI_CHG				-0.897	-1.016				-2.224	-1.906
				(-4.667)	(-6.797)				(-3.557)	(-4.034)
OPENK_CHG				-0.090					0.1975	
				(-1.031)					(0.779)	
Adj. R^2	0.3479	0.3728	0.0093	0.5216	0.5271	0.4294	0.3135	0.4363	0.5898	0.6093
DW stat.	2.227	2.214	2.201	2.080	2.120	1.910	2.176	2.122	2.011	2.022
N	96*	96*	131	131	131	42*	60*	42*	62	62
METHOD	EGLS - P	EGLS - P	EGLS - XS	EGLS - XS	EGLS - XS	EGLS - P	EGLS - P	EGLS - P	EGLS - XS	EGLS - XS
IMPLIED λ	0.0443	0.0399	0.0390	0.0403	0.0387	0.0578	0.0812	0.0571	0.0652	0.0642

Notes: The bottom row reports the estimate of the convergence rate (λ) with income lag of one year based on equation (8): $\lambda = -(1/\tau)\ln(\gamma - 1)$. The Table reports the results when the dependent variable is the difference of the logs of per capita GDP at times *t* and *t-τ*. For the left half of the table *τ* is one year, and for the right half *τ* is two years. The values in parenthesis are the t-statistics. N is the number of observations in the panel. The estimation method are: least squares (LS), period EGLS (EGLS-P) or cross sectional EGLS (EGLS-XS). The symbol * represents estimation done with a balanced sample.

TABLE 2 - ESTIMATION OF β CONVERGENCE WITH τ EQUAL TO THREE AND FOUR YEARS

	Dependent variable : ln y(t) - ln y(t-τ), τ = 3					Dependent variable : ln y(t) - ln y(t-τ), τ = 4				
	[1A]	**[2A]**	**[3A]**	**[4A]**	**[5A]**	**[1B]**	**[2B]**	**[3B]**	**[4B]**	**[5B]**
RGDPLN(-1)	-0.155	-0.172	-0.218	-0.268	-0.275	-0.430	-0.351	-0.339	-0.439	-0.437
	(-2.240)	(-2.668)	(-3.463)	(-5.891)	(-6.073)	(-4.858)	(-3.562)	(-4.002)	(-4.612)	(-5.374)
POPGR	-3.980		-4.657			4.974		6.275		
	(-0.798)		(-0.900)			(0.630)		(0.664)		
CSAV_CHG	0.762	0.756				-0.367	-0.500			
	(1.902)	(1.955)				(-0.495)	(-0.540)			
KC_CHG				-1.114	-0.790				0.094	-0.148
				(-1.658)	(-1.296)				(0.049)	(-0.092)
KG_CHG				2.964	2.346				1.263	1.470
				(-2.330)	(2.031)				(0.524)	(0.658)
KI_CHG				-4.018	-3.236				-1.640	-2.366
				(-3.335)	(-3.279)				(-0.593)	(-1.578)
OPENK_CHG				0.504					-0.440	
				(1.104)					(-0.318)	
Adj. R^2	0.2497	0.2709	0.1884	0.8694	0.8673	0.5800	0.2918	0.2799	0.4344	0.4962
DW stat.	2.053	2.109	2.097	2.066	2.081	2.050	2.023	2.088	2.139	2.124
N	40	42	40	40	40	24*	29	29	24*	24*
METHOD	LS	LS	LS	EGLS - XS	EGLS - XS	EGLS - P	LS	LS	EGLS - P	EGLS - P
IMPLIED λ	0.0561	0.0630	0.0821	0.1038	0.1071	0.1406	0.1078	0.1036	0.1444	0.1437

Notes: The bottom row reports the estimate of the convergence rate (λ) with income lag of one year based on equation (8): $\lambda = -(1/\tau)\ln(\gamma - 1)$. The Table reports the results when the dependent variable is the difference of the logs of per capita GDP at times *t* and *t-τ*. For the left half of the table *τ* is one year, and for the right half *τ* is two years. The values in parenthesis are the t-statistics. N is the number of

observations in the panel. The estimation method are: least squares (LS), period EGLS (EGLS-P) or cross sectional EGLS (EGLS-XS). The symbol * represents estimation done with a balanced sample.

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