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Technological Capabilities Asymmetries in Latin American and the Caribbean

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Abstract

This paper analyzes the convergence process in Latin America and the Caribbean during the 1960-2005 period. The evidence is not favorable to clear convergence or divergence trends, but to a slight process of convergence until the 1970s, and then global divergence. In turn, the results suggest the existence of transitory clubs of convergence during the 1960-1974 and 1990-1994 periods. After that, the lower income economies showed convergence to the relative richer countries, but in a context of increasing dispersion of the per capita income. The development accounting and the decomposition of the total factor productivity (TFP) indicate that those results are mainly explained by relative differences in the technological capabilities, and that the existence of structural differences is a key factor to explain the non-convergence in technological capabilities. The efforts to integrate the economies were not enough to reduce the gap but the divergence in technological capabilities would have been worst without the integration process.

JEL: 047 – F15 - 054
Keywords: Convergence, Total Factor Productivity Decomposition, Technological Capabilities, Economic Integration, Latin American and the Caribbean

1. Introduction

The long run performance of the Latin American and the Caribbean countries, as well as their relative lags in comparison with the most advanced economies, is significant to evaluate the state of regional development. Nonetheless, in a context of increasing integration the reduction in asymmetries -particularly in income- between those economies must be a critical focus of attention.

There is a vast literature on economic convergence for a wide sample of countries, beginning with the Baumol´s seminal paper (Baumol (1986)), and after that with the works of Barro and Sala i Martin (1992), Quah (1996a), Lee et al (1997), De Long (1998), and Quah (1996b, 1997), who focused the theme towards clubs of convergence. On the other hand, there is a line of work that investigate the convergence into the regions or states of a country (Anríquez and Fuentes (2001), Díaz and Meller (2002) and Duncan and Fuentes for the Chilean regions, Cárdenas and Pontón (1995) for Colombians departments, Utrera and Koroch (1998) and Marina (1999) for Argentina, and Azzoni (1996) for Brazilian states. The evidence differs among countries. The studies show divergence for Brazil and convergence for Chile, while the evidence for Argentina is ambiguous. In the branch of research on convergence for countries that integrate an economic region the evidence is heterogeneous. Cuaresma et al (2008) found strong convergence for 15 countries of the European Union, while Madariaga et al (2003) show convergence for the NAFTA countries, but not for the MERCOSUR. Similarly, the results of Dobson y Ramlogan (2002), and Dabús and Zinni (2005) suggest that there is no convergence in Latin America.

In short, there is not evidence of convergence in this region, but indications of divergence. This suggests an interesting hypothesis: it can be more plausible the convergence in blocks of developed economies, so that the issue itself merits a deeper study. Hence, the goal of this paper is to analyze if, under the application of usual and unusual methodologies, the non-convergence dynamics in the region is kept. In turn, we try to determine the existence of convergence clubs, i.e. convergence among economies with structures and similar initial conditions, during the 1960-2005 period. Secondly, we investigate the explanatory factors of such dynamics, by means of the development accounting methodology. This allows us to discern between possible channels through which the economies diverge or converge. In particular, our search is focused on the technological progress as the main factor of the divergence in the region since the middle of the past century. Besides, we decompose the Solow´s residual to approximate the contribution of underlying sources to the multifactor productivity (technological capabilities, as well as technological and structural changes).

The results do not indicate a sustained long run trend to convergence or divergence, but transitory convergence clubs. The dynamics of per capita relative income is explained by relative behaviour of the total factor productivity (TFP), and particularly by the differences in technological capabilities. To shed light about what explain asymmetries in technological capabilities, following to Hall and Jones, we related them with some aspects of the "social infrastructure" (Hall and Jones, 1999).

Our study is devoted to a set of similar emerging economies, but with differences in per capita income levels and growth performance. Some of them have reached a relatively high income level, based mainly on their endowment of natural resources, while others have been in long run stagnation. In turn, the evidence shows that they keep differences in their development level in time, which constitutes a key factor to explain differences in technological capabilities. In this sense, the institutional efforts of economic integration were not enough to reduce the gap. In fact, our evidence shows that neither foreign trade policies nor those measures devoted to reach improvements in institutional quality are significant to explain the dynamics of the economies in the region.

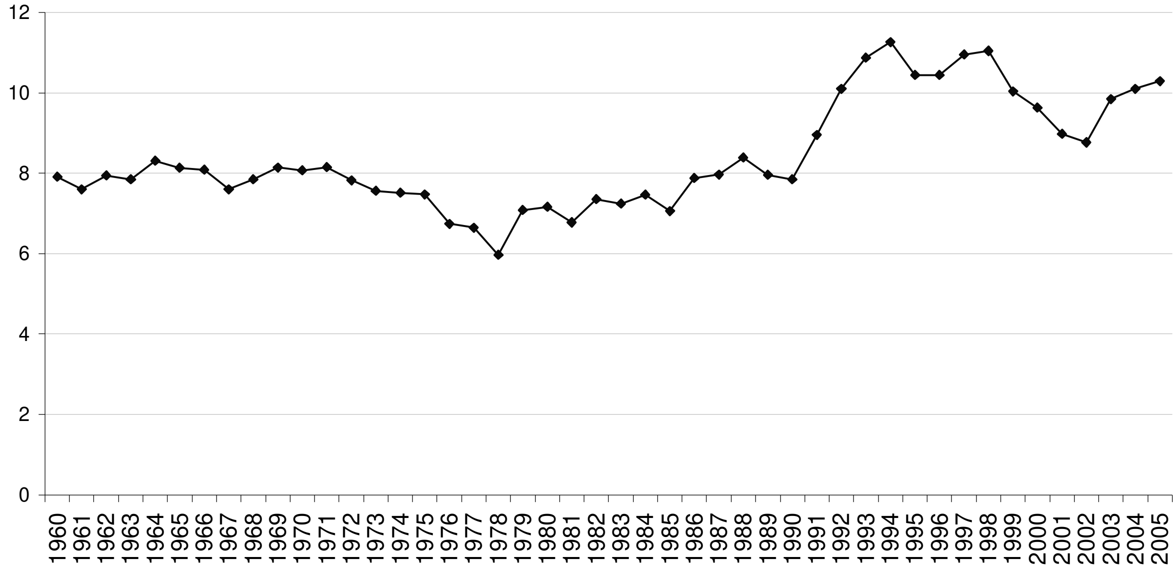
In the next section we present empirical evidence on convergence. Section 3 introduces the baseline model of the development accounting methodology. The results obtained by applying this methodology are shown in section 4. In section 5 we analyze the explanatory factors of technological capabilities. Finally, the conclusions are presented in section 6.

2. Regional convergence or divergence path?

In this section we analyse the hypothesis of regional convergence by applying common statistical tools: the evolution of the maximum gap among the countries, the relationship between the initial and the final per capita GDP for each country, the relationship between initial income and growth rate for the period, and the evolution of the dispersion of per capita income into the sample. Finally, we try to determine the existence of convergence clubs by means of the kernel density graphs.

At a first glance, the difference between extreme values for the countries with lowest and highest per capita income increased from 7.9 to 10.6 times during the 1960-2005 period (see figure 1). As a matter of fact, the evolution of this gap suggests a transitory catching-up at the end of the ´70s, followed by a divergence path at the final of the period.

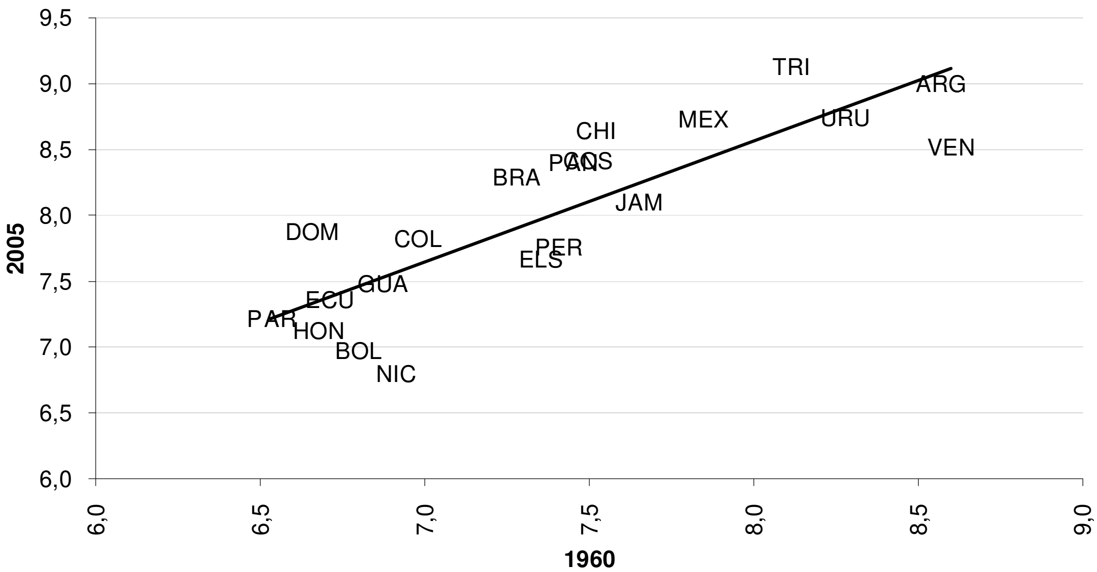
Figure 1
Relative per capita GDP (natural logarithm of per capita GDP, u$s constant 2000)



Source: Our own elaboration based on World Bank data.

Figure 2 shows a positive relation between initial and final per capita values, which indicates that the 1960 GDP is a good predictor of 2005 GDP, as well as additional evidence against the hypothesis of convergence.

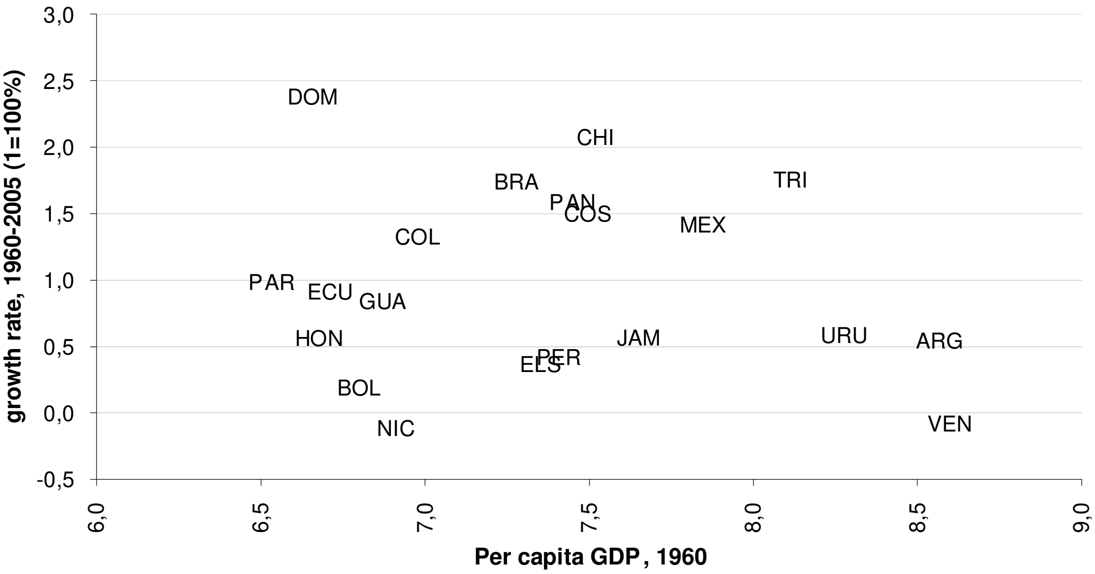
Figure 2
Per capita GDP: 1960 versus 2005 (natural logarithm of per capita GDP, u$s constant 2000)



Source: Our own elaboration based on World Bank data.

On the other hand, figure 3 shows the relation between the per capita income and the growth rate for the total period. The evidence is mixed. There are cases of high (low) initial levels with low (high) growth rates, meanwhile some countries presents with both low initial levels and growth rate, such as Bolivia, Nicaragua, Honduras and Paraguay, and cases with high values in both cases, such as Chile, Mexico and Trinidad and Tobago. Even though this relation is not clear, once again there is not evidence of β-convergence.

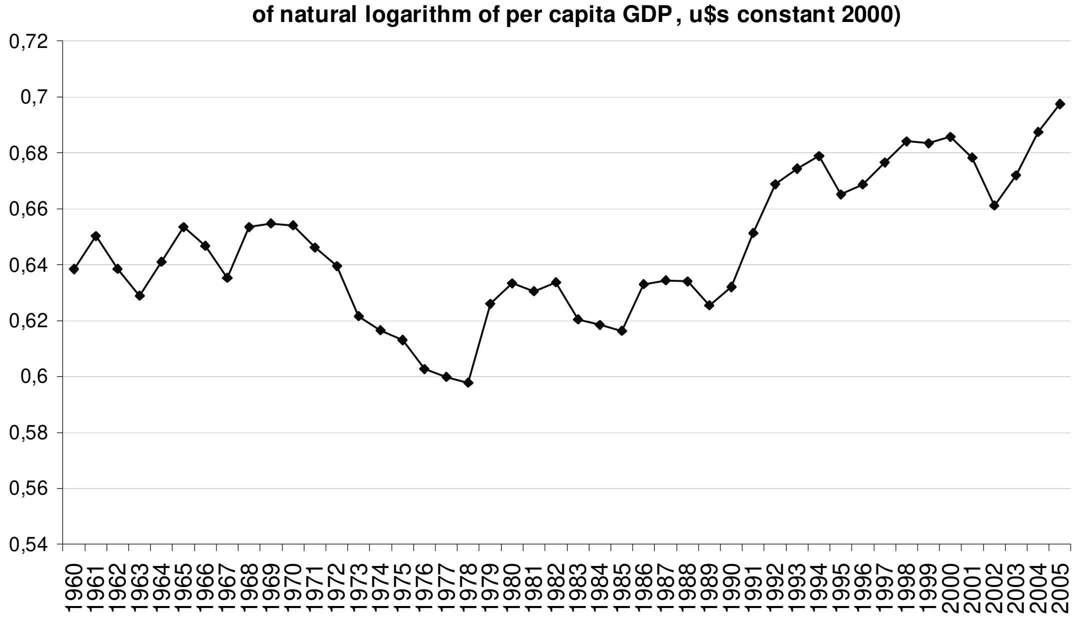
Figure 3
Growth rate versus initial per capita GDP (natural logarithm of per capita GDP, u$s constant 2000)



Source: Our own elaboration based on World Bank data.

Figure 4 shows the evolution of the per capita GDP standard deviation. This measurement is a proxy of σ-convergence, and indicates a decreasing divergence during the ´70s, but a clear reversion and then higher divergence thereafter.

Figure 4
Evolution of the dispersion of the per capita GDP (Cross-section standard deviatior of natural logarithm of per capita GDP, u$s constant 2000)



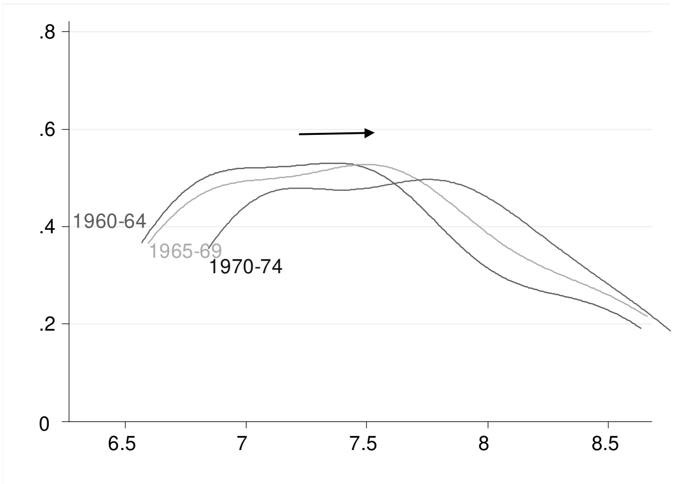
Source: Our own elaboration based on World Bank data.

In short, a first empirical approach is not favourable neither convergence nor to a sustained trend of divergence in Latin America, but a transitory process of convergence followed by global divergence from the end of the ´70s. Nevertheless, the kernel density graphs results, presented in figures 5(a), 5(b) and 5(c), suggest evidence of clubs of convergence. This is a non-parametric estimation of the random variable probabilistic function that, in this application, assumed a Gaussian kernel function.

They show the formation of a transitory club during the 1960-1974 period, which is reverted between the end of the ´70s. The reversion can be explained by the oil crisis and the subsequent debt crisis, which pushed the region into a convergence process toward lower income equilibrium. However, the recovering was associated to a new clubs formation process, mainly during the beginning of the 90´s. Hence, some of the lower income economies were converging to the higher income equilibrium, but into an environment of increasing dispersion of per capita income into the whole sample.

Figure 5
Kernel density graphs of per capita GDP (natural logarithm of per capita GDP, u$s constant 2000)

(a)



(b)

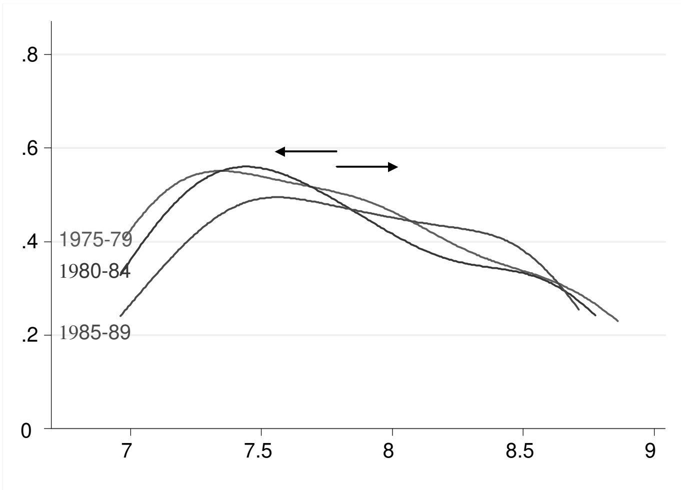
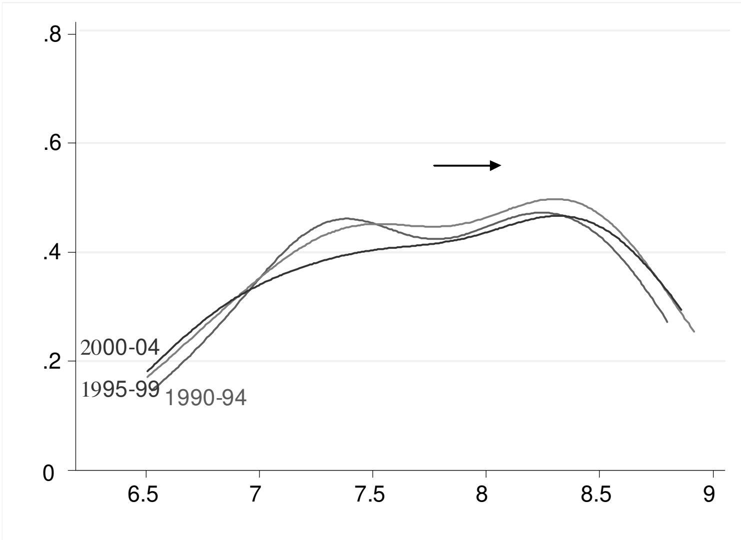


Figure 5
(*Continuation*)

(c)



Source: Own elaboration based on World Bank data

These results are compatible with the evidence presented previously. In fact, figures 5(b) and 5(c) indicates an increasing gap of the relative income between poorer and richer countries. In turn, the differences among economies observed in the growth versus initial per capita product can be associated with the oscillating behaviour shown in Figure 5. And the fact that the clubs are not consolidated would indicate that such oscillations can be explained by shocks that became widespread in the region.

3. Development accounting: an approximation to regional income asymmetries

This section presents a baseline model of development accounting. This considers a Cobb-Douglas function that contain three productive factors and a multifactor productivity or TFP variable, which represents the residual of the production function. We assume that all the economies of the sample can be explained by the same model. Hence, the residual contains all the possible structural differences.

The product Y is represented in the following expression [1]:

$$Y_i = K_i^{\alpha} H_i^{\beta} \left(A_i L_i\right)^{1-\alpha-\beta} \qquad (1)$$

[1] Equation (1) can be reach from a three sectors model, one of them produces final goods and the others composed by j firms that produce physical and human capital, respectively. A benchmark in this approach is the Romer´s model. In turn, this expression of the production function is used by Mankiw et al. (1992), and Klenow and Rodriguez-Claire (1997).

where *i* indicate the country, while *α* and *β* are the shares of physical and human capital, K and H, in the product, respectively, with $(\alpha+\beta<1)$. The human capital stock is the product of the human capital average level, h, and the workers, L $(H_i = h_i \times L_i)$. In turn, A represents the multifactor productivity.

To determine if differences in income are due to production factors or multifactor productivity, we obtain an expression that relates them with the per capita income. Denoting P_i as the population of the country *i*, equation (2) contains per capita income and its components:

$$\text{(2)} \qquad \frac{Y_i}{P_i} = \frac{L_i}{P_i}\left(\frac{K_i}{Y_i}\right)^{\frac{\alpha}{1-\alpha-\beta}}\left(\frac{H_i}{Y_i}\right)^{\frac{\beta}{1-\alpha-\beta}}\mathrm{A}_i \,.$$

where L/P is the labour participation rate and capture the effect of the labour on per capita income. K/Y and H/Y indicate the intensity of physical and human capital in the product, and A is the multifactor productivity. This last depends on two factors. The first is called "technological capabilities", and represents a complex set of human abilities, technological knowledge and organizational structure, which are required to operate efficiently the technology as well as to reach a process of technological change (Llal, 1992). The second factor captures the jumps in the production possibility frontier. i.e. changes in technology due to learning processes provoked by endogenous factors or incorporated from the rest of the world (by means of imports of goods or technology, foreign investment, immigration, etc.). These changes need to be relevant, so that they can modify strongly the "real costs of production" (Harberger, 1998).

From equation (2) we carry out a typical exercise of development accounting. This consists in taking the ratio between per capita income of two economies, and to repeat the procedure with its respective components:

$$\text{(3)} \qquad \varphi_{ij}^{Y/P} \equiv \frac{Y_i}{P_i}\bigg/\frac{Y_j}{P_j} = \varphi_{ij}^{L/P}\varphi_{ij}^{K/Y}\varphi_{ij}^{H/Y}\varphi_{ij}^{A}$$

$$\varphi_{ij}^{L/P} \equiv \left(\frac{L_i}{P_i}\bigg/\frac{L_j}{P_j}\right); \qquad \varphi_{ij}^{K/Y} \equiv \left(\frac{K_i}{Y_i}\bigg/\frac{K_j}{Y_j}\right)^{\frac{\alpha}{1-\alpha-\beta}};$$

$$\varphi_{ij}^{H/Y} \equiv \left(\frac{H_i}{Y_i}\bigg/\frac{H_j}{Y_j}\right)^{\frac{\beta}{1-\alpha-\beta}}; \qquad \varphi_{ij}^{A} \equiv \left(\mathrm{A}_i/\mathrm{A}_j\right) = \frac{\varphi_{ij}^{Y/P}}{\varphi_{ij}^{L/P}\varphi_{ij}^{K/Y}\varphi_{ij}^{H/Y}}$$

where *i* and *j* represents both economies, and $\varphi_{ij}^{\bullet}$ is the ratio of the component g of per capita income. More different values from the unity indicate higher differences of those components. Thus, these ratios show what factors are relevant to explain convergence or divergence paths. Frequently, these are computed in average terms for a certain period, and the persistence of the same value for several periods allows us to verify long run trends. In turn, once the more important components are identified, we can determine what factors explain the behaviour of such components.

On the other hand, relative multifactor productivity is an indicator of the technological performance between two economies, as follows:

$$(4) \qquad \mathrm{A}_{it} \equiv \mathrm{X}_{it}\mathrm{E}_{i}\mathrm{T}_{t}$$

where *it* represents an economy *i* in the period *t*, so that X_{it} shows specific effects in *i* and *t*, and it refers to technological capabilities. E_i captures the effects that are specific in *i* and invariant in *t* (for example, the effect of the productive structure on multifactor productivity). In turn, T_t is related to the effects that are invariant in *i* and specific to *t* (for example, a widespread technological shock). Given a technological shock, this component captures the average effect on the economies, while X_{it} captures the differences between them.

Therefore, from (2) and (4) we can estimate X_{it}, E_i and T_t, as follows:

$$(5) \qquad \hat{\mathrm{X}}_{it} = \frac{\hat{\mathrm{A}}_{it}}{\hat{\mathrm{E}}_{i}\hat{\mathrm{T}}_{t}}$$

$$(6) \qquad \hat{\mathrm{E}}_{i\psi} = \frac{\left(\overline{Y/P}\right)_{i\psi}}{\left(\overline{K/Y}\right)_{i\psi}^{\frac{\alpha}{1-\alpha-\beta}}\left(\overline{H/Y}\right)_{i\psi}^{\frac{\beta}{1-\alpha-\beta}}\left(\overline{L/P}\right)_{i\psi}}$$

$$(7) \qquad \hat{\mathrm{T}}_{t} = \frac{\left(\overline{Y/P}\right)_{t}}{\left(\overline{K/Y}\right)_{t}^{\frac{\alpha}{1-\alpha-\beta}}\left(\overline{H/Y}\right)_{t}^{\frac{\beta}{1-\alpha-\beta}}\left(\overline{L/P}\right)_{t}}$$

Then,

$$(8) \qquad \varphi_{i,j,t}^{\mathrm{X}} \equiv \frac{\hat{X}_{it}}{\hat{X}_{jt}}; \qquad \varphi_{i,j,t}^{\mathrm{E}} \equiv \frac{\hat{\mathrm{E}}_{i}}{\hat{\mathrm{E}}_{j}}$$

where ψ represents a sub-period of time, $\wedge$ is referred to estimated values of the variables, and $\overline{\ }$ the average value. The behaviour of the ratio $\varphi_{i,j,t}^{\mathrm{X}}$ expresses the relative evolution of the technological capabilities between *i* and *j* economies. Similarly, the behaviour of the ratio $\varphi_{i,j,t}^{\mathrm{E}}$ reflects the relative performance of the domestic process in technological production. Finally, $\varphi_{i,j,t}^{\mathrm{T}}$ is equal to the unity for all time *t*.

4. Development accounting: estimation method and empirical results

The estimations of coefficients φ are carried out in two steps. In first place, we calibrate the parameters of equation (2). Secondly, the relative components are estimated from (3), (5) and (8).

We realized three calibrations. The first is the main case, while the others are introduce to determine sensibility of the results to the parameters. Table 1 shows the values for each case, as well as the literature associated to these values.

Table 1
Parameters used in the calibration

Cases	α	β	Sources
Main	0.31	0.28	Mankiw et al. (1992), Klenow and Rodríguez-Clare (1997), McGrattan and Schmitz (1999), Hopenhayn and Neumeyer (2004)
Alternative 1	0.31	0.04	(1-α- β) from Bernanke y Gürkaynak (2001): average share of wage in income for economies of both samples = 0.648; α is taken from Mankiw et al. (1992) and β by difference.
Alternative 2	1/3	1/3	Mankiw et al. (1992), McGrattan and Schmitz (1999)

The panel of data corresponds to the 1960-2005 period, and contains the information of 20 American economies: 10 of South America, 7 of North and Central America, and 3 of the Caribbean. Following the World Bank classification, 12 economies are of low medium income and 8 of high medium income.

Table 2 presents the descriptive statistics of the relevant variables for the first and the last year of the sample.

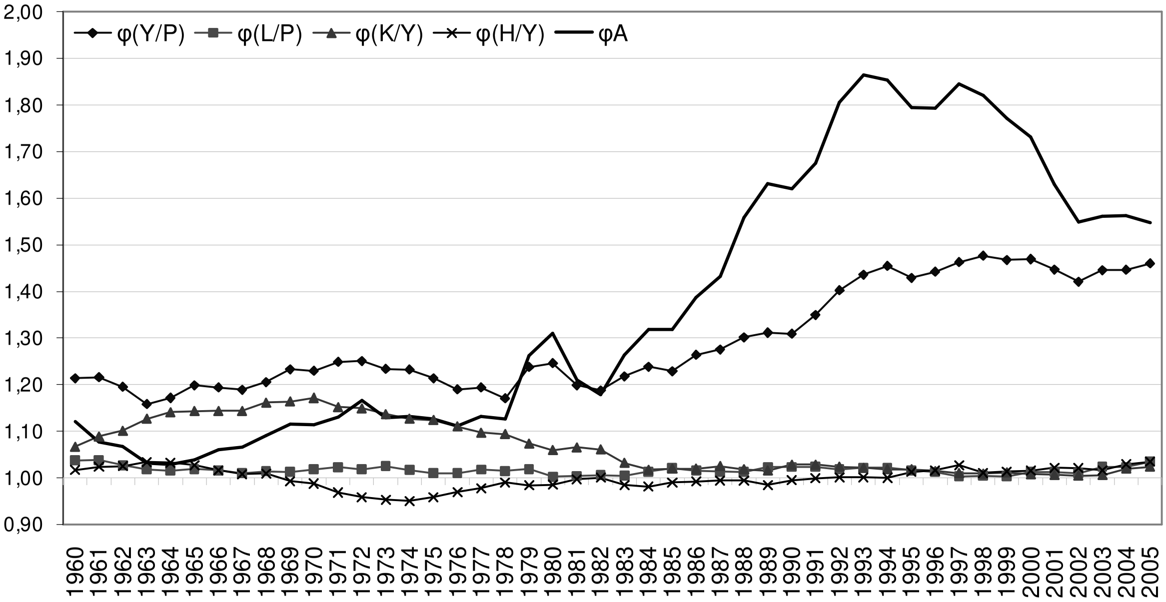
Table 2
Descriptive statistics*. Latin America and the Caribbean (20 economies**)

Variable	1960				2005			
	Average	St. Dev.	Min	Max	Average	St. Dev.	Min	Max
Y/P	1981,0	1435,1	685,7	5425,4	3704,8	2413,0	893,4	9195,0
L/P	0.3	0,0	0,2	0,4	0,4	0,0	0,3	0,4
K/Y	1,3	0,3	0,9	2,4	1,8	0,4	0,9	2,6
H/Y	0,6	0,2	0,3	1,0	1,2	0,3	0,8	1,8
Y (000000)	21987	36088	1263,3	108322	114175	209868	4600,3	739613

* Average value, Standard Deviation, Minimum and Maximum.
** Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Trinidad and Tobago, Uruguay, Venezuela.
Source: Own elaboration based on sources reported in the Appendix.

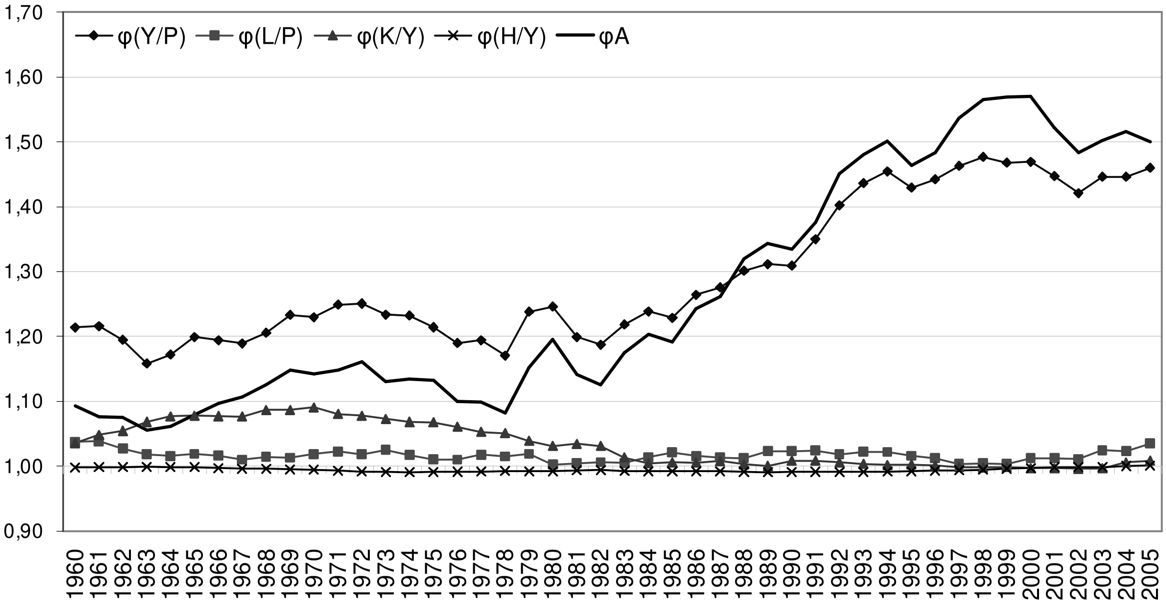
The ratios φ were estimated pair-wise, so that the exercise includes 190 *ij* individuals. Figures 6, 7 and 8 show the evolution of the average relative per capita income and φ, for each calibration.

Figure 6
Average φ`s. Main calibration (0,31; 0,28)



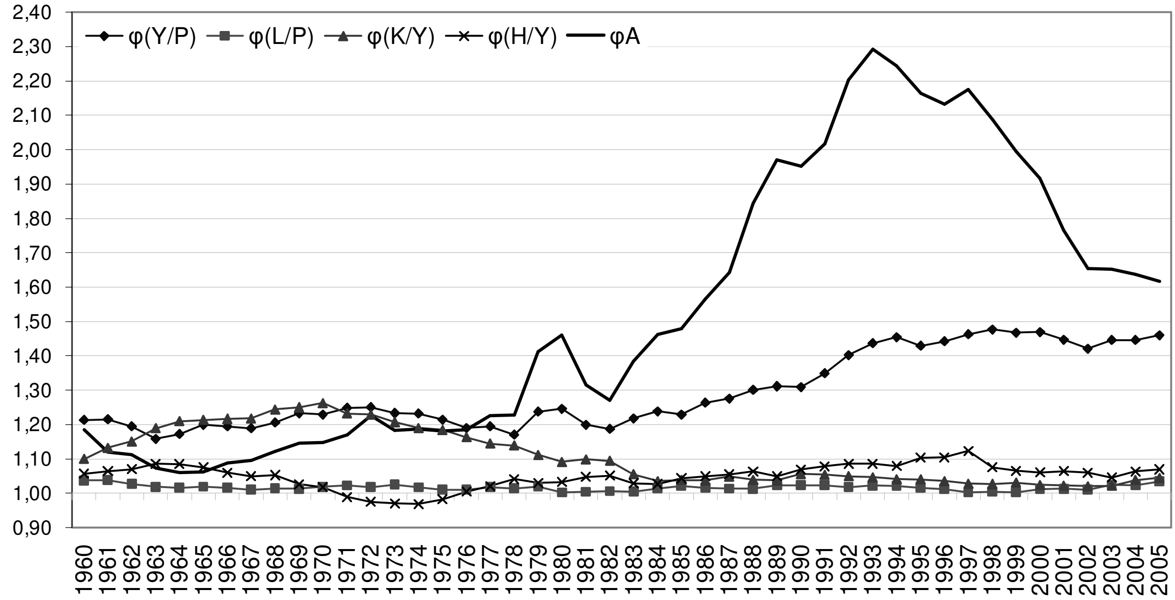
Source: Our own elaboration.

Figure 7
Average φ`s. Alternative 1 (0,31; 0,04)



Source: Our own elaboration.

Figure 8
Average φ`s. Alternative 2 (1/3; 1/3)

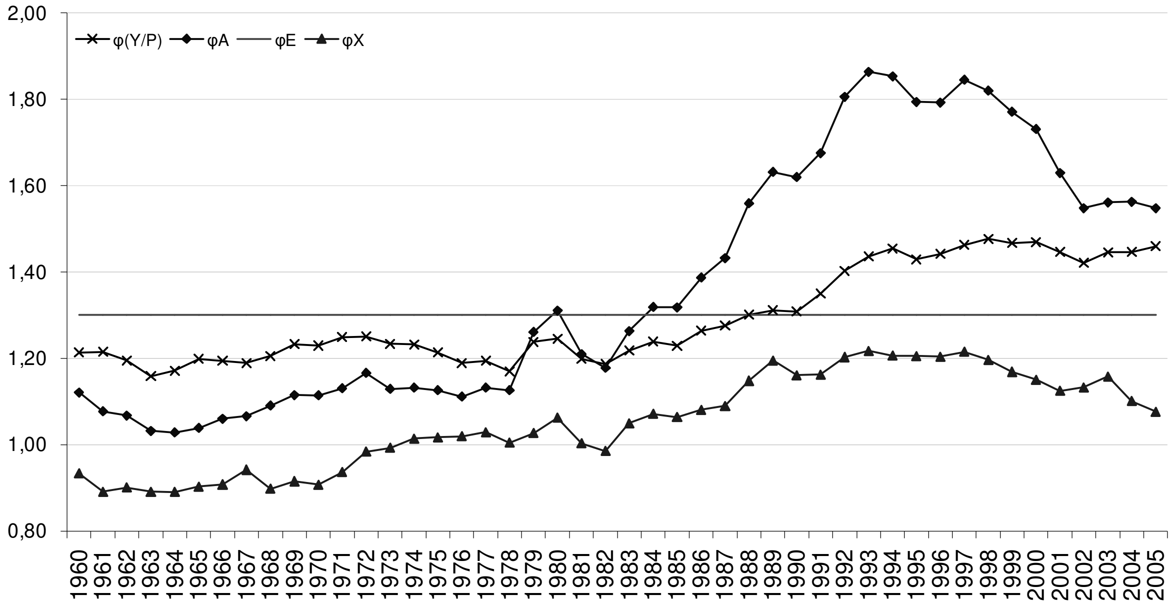


Source: Our own elaboration

The results show that physical capital is important to explain the relative economic performance in the region, with changing intensity at different values of parameters. On the contrary, labour force and human capital were not relevant; in fact, their ratios were around the unity in all cases. Nevertheless, the multifactor productivity seems to be the key variable to determine the path of relative per capita GDP. The evolution of φ^A was oscillating until the ´70s, but presents a clear process of technological divergence from the oil crisis, and particularly from the beginning of the ´80s. In short, these results suggest that the formation of transitory clubs verified during the 1960-74 and 1990-94 periods were mainly driven by physical capital and multifactor productivity intensities. In turn, they indicate a fluctuating evolution of per capita GDP in Latin American economies, which were between a low and a high equilibrium. The convergence process around the former was clearly associated to physical capital intensity. However, since the middle of the ´70s the multifactor productivity is the main explanatory factor of relative per capita GDP, both in convergence and in divergence periods. In turn, the divergence process of per capita income seems to be stopped in the ´90s due to an abrupt convergence in such productivity.

Figure 9 shows the paths of averages in *i* of the multifactor productivity and its components. The average level of φ^E suggests structural differences among the economies, in special in their possibilities to absorb and generate technology. Besides, the evolution of φ^X indicates stability in X differences until the beginning of the ´70s, after which they have increased to reach their maximum in the ´90s. Then there was convergence in technological capabilities, which explain the reduction of both φ^A and the relative per capita income.

Figure 9
Average φ´s of per capita GDP, A and its components. Main calibration



Source: Our own elaboration.

In sum, the evidence show convergence and subsequent divergence processes in technological capabilities. In the next section we search the determinants of φ^{X}. This should allow us to understand the deep determinants of these processes in the Latin American and Caribbean economies.

5. Determinants of technological capabilities

The explanatory factors of relative economic performance are not captured directly by the typical exercise of development accounting. Rodrik (2003), Acemoglu (2007) and Hsieh and Klenow (2009) emphasized the role of geography, integration to international markets, the quality of institutions and public policy. Acemoglu (2007) argued that cultural differences implies unlike individual preferences and beliefs, which in turn leads to different institutional arrangements. Geographies features, such as climate and natural resources, are rescued by Acemoglu (2007) and Rodrik (2003) as a key factor of the institutional framework. These authors state that geography influences social behaviours, physical possibilities and economic integration.

In short, this set of variables determines the "social infrastructure" defined by Hall and Jones (1999) as the set of laws, institutions and public policies that provide the setting for the economic decisions. If such infrastructure favours policies that divert resources to unproductive activities, it reduces the physical and human capital accumulation, as well as technological transfer of abilities. Hence, different social infrastructure can account for differences in relative per capita income.

In the next section we try to verify if this argument is useful to explain the relative performance in Latin American and Caribbean economies. Instead of considering the relative per capita income, we analyze its principal component: the ratio between technological capabilities.

5.1 Data and estimation method

We carry out a set of cross-section and time-series regressions for a panel of 190 individuals and 26 years in the full sample. Three sources of differences in technological capabilities are identified: (i) structural differences in the developing process of these capabilities (ii) geographical differences that determine dissimilar degrees of economic integration, and (iii) differences in quality of political and economic institutions. All the variables are, mainly, ratios that were normalized so that 0 represents equality, and they can take only positive values. Thus, higher values imply higher differences between two economies. The estimation methodology and the sources of the variables are presented in the appendix.

In general, more developed economies should be in better conditions to incorporate technological innovations. Thus, we include variables associated to the level of development:

[a] The relative income level (Scala2) is given by the GDP ratio, and it is taken as principal variable of this subset. In turn, there could be mutual dependence between this and the explained variable, so that we include the following control variable.
[b] The ratio φ^E, by definition, is the best variable to capture structural differences. Nonetheless, this does not present time variability, and then it was not include in panel data, but in pool data regressions.

In both cases the expected sign is positive.

To capture the effects on the geographical differences we used three variables usually included in the gravity models of bilateral trade:

[a] The geodetic distance (in km) between economies.
[b] A dichotomous variable, named Border, with value 1 if the economies are adjacent, and 0 otherwise.
[c] A categorical variable, called Area, with 4 options: 0 if the economies belong to the same geographic area, 1 if the combinations are South America-Central America or Central-North or North-Caribbean; 2 if the combination is South-North or Central-Caribe; and 3 for South-Caribbean.

In most cases we expect greater different technological capabilities for more distant economies. In these cases there should be a less flow of products and factors, as well as higher cultural differences, which affect in transfer of knowledge and institutional design. Thus, [a] and [c] should be positive, and [b] negative. Once again, these variables do not have time variability, so that they were not included in panel data, but in pool regressions.

Finally, the differences in public policies and quality of economic and political institutions were approximated by the following variables:

[a] Partner is a dichotomy variable, which takes value 1 when the economies share political or economic agreements, which promote a more favourable environment to trade as well as to acquire technological capabilities, and 0 otherwise. Thus, its sign should be negative: when such agreement is applied there should be lesser differences between economies.
[b] Openness is a rate that captures differences in trade policies. The raw variable used in the calculus indicates the excess of trade in relation to the *expected* values for a similar economy (see the appendix for additional explanation). In turn, if the economy is closer to the world implies that it must reach higher productivity levels to compete for exports in foreign markets, and, at the same time, it can catch technological

advances. Then, more differences in openness imply more differences in technological capabilities, so that the expected sign is positive.

[c] Government is a ratio that denotes differences in the role of the State on economic activity. The raw variable is the percentage of national expenditure on GDP. The expected sign is negative because the incentives to innovation should be lesser in economies with higher state participation. Thus, higher differences in that variable among economies should imply lower differences in technological capabilities.

[d] Inflation captures differences in economic stability. Instability should diminish knowledge accumulation and then technological capabilities. Hence, the expected sign is negative.

[e] Conflict measures differences in political stability, and similarly to inflation its sign should be negative.

[f] Regime is referred to political organization differences. The raw variable present four categories: civil government, civil militar, militar and others (for example foreign dependence). The environment for technological capabilities development is more favourable (adverse) in the former (last) categories. Therefore, the expected sign is negative: at greater difference in Regime, lower differences in technological capabilities.

[g] Polity3 is a measure of the differences in political institutions quality. The raw variable, Polity2, takes value 10 for more democratic organizations, and -10 for more autocratic organizations. This was transformed so that it is always positive. Then, the expected sign is positive: stronger democracy should show better incentives to accumulation of technological capabilities.

[h] Pluralism and [i] Democracy are similar to Polity3. The first is an indicator of political plurality and the other refers to electoral competence and participation. Thus, the expected sign is positive.

Finally, variables [f] to [i] are substitute because they capture similar aspects: the quality of government institutions.

5.2 Empirical results

The estimation was carried out by applying two-way fixed effects (TWE) with panel-corrected standard-errors (PCSE). Table 3 shows the first series of estimation, where we take the complete model and consider the variables of government institutions quality alternatively.

Scala2 and Partner are always significant and with the expected sign. Inflation, Government and Openness remain non significant in all cases, so that they do not contribute to explain productivity differences among countries. In turn, these results are robust to changes in the proxy variables of institutional quality.

Finally, Regimen is significant and presents the expected sign. On the other hand, Democracy and Polity3 are not significant, and Conflict is significant only when Democracy is included.

Table 4 presents the results of the regressions with clearly significant variables. We use four alternative models to test the sensibility to the estimation method: (i) by pool OLS, (ii) by fixed effects, FE, (iii) by two-way fixed effects, TWE; (iv) by random effects, RE; and (v) by TWE with PCSE.

Except the last model, there is coincidence with respect to significance and signs of the explanatory variables. The TWE-PCSE column shows that Scala2 lost significance, but the p-value takes a reasonable value. The constant term lost completely its significance and the usual tests raised notably their values. Thus, the selected variables –Scala2, Partner and

Regimen- are strong determinants of the differences in technological capabilities, and this result is robust across methodology.

Table 3
Explanation of the differences in technological capabilities

	Modelo 1	Modelo 2	Modelo 3	Modelo 4
Scala2	1.924241 (0.007)	1.917712 (0.009)	1.915448 (0.007)	2.683144 (0.000)
Partner	-.0447303 (0.002)	-.0461963 (0.004)	-.0453887 (0.001)	-.0467217 (0.000)
Openness	5.37e-06 (0.959)	9.25e-06 (0.929)	6.31e-06 (0.952)	4.49e-06 (0.883)
Government	-.0823377 (0.187)	-.0830307 (0.186)	-.0788726 (0.205)	-.0500908 (0.158)
Inflation	.0000214 (0.565)	.0000169 (0.737)	.0000184 (0.618)	.0000218 (0.527)
Conflict	-.0000419 (0.720)	-.0000536 (0.660)	-.0000419 (0.717)	-.0001737 (0.000)
Regimen	-.015874 (0.067)			
Polity3		-.000017 (0.985)		
Pluralism			-.0023172 (0.141)	
Democracy				-.0006149 (0.136)
Constant	-.0527454 (0.679)	-.0472792 (0.718)	.00014. (0.999)	-.1730223 (.0287058)
Observations	7357	7376	7357	6806
R2	0.3157	0.3108	0.3151	0.3465
Wald	146418.48	145526.74	129122.69	1.47e+10

P-values between parentheses.

Table 4
Explanation of the differences in technological capabilities (part II)

	Pool	EF	TWE	EA	TWE-PCSE
Scala2	.408648 (0.000)	.8915019 (0.000)	.8844751 (0.000)	.5716248 (0.000)	.8844751 (0.161)
Partner	-.0161764 (0.017)	-.0198331 (0.002)	-.041499 (0.000)	-.0197683 (0.002)	-.041499 (0.001)
Regimen	-.0320443 (0.000)	-.0282779 (0.000)	-.016966 (0.000)	-.028618 (0.000)	-.016966 (0.012)
Constant	.2862467 (0.000)	.2534225 (0.000)	.1958796 (0.000)	.276895 (0.000)	.1043842 (0.327)
Observations	8267	8267	8267	8267	8267
Adjusted R2	0.0145	0.0125	0.0395	0.0139	0.3082
Wald	40.62	23.81	9.48	74.62	8.90e+06

P-values between parentheses.

The robustness of results across the selected variables was tested using, in fist place, the substitution of Scala2 for the variable related to structural differences, φ^E. In second place, we substituted Partner for the three alternative geographical variables. All new variables are time invariant, so that we estimated by means of pool OLS. Table 5 shows the results. Once again all the variables are significant and with the expected sign.

Table 5
Explanation of the differences in technological capabilities (part III)

	1	2	3	4
φ^E	.0269106 (0.000)			
Scala2		.3094159 (0.000)	.4093255 (0.000)	.4054104 (0.000)
Partner	-.0184961 (0.145)			
Regimen	-.0334642 (0.000)	-.0331685 (0.000)	-.0306728 (0.000)	-.0303313 (0.000)
Distance		.000013 (0.000)		
Border			-.0166858 (0.000)	
Area				.011152 (0.005)
Constant	.2825022 (0.000)	.2399167 (0.000)	.275537 (0.000)	.2607126 (0.000)
Observations	8267	8267	8267	8267
Adjust R2	0.0214	0.0229	0.0144	0.0159
Wald	36.45	55.48	48.68	45.07

All regressions are pool OLS-PCSE.
P-values between parentheses.

6. Conclusions

The evidence of this paper do not indicate a clear convergence of divergence trends among Latin American countries for the last four decades, but a slight convergence process until the middle of the 70´s, and global divergence afterward. In turn, transitory convergence clubs were formed during the 1960-1974 and 1990-1994 periods. Then, the lower income countries were converging to the more developed economies, but in an environment of increasing per capita income dispersion.

The development accounting allows us to explain such results. This indicates that differences in technological capabilities can explain the dynamics of relative per capita GDP. In turn, differences in development level are a key factor to explain such capabilities, and therefore that dynamics. The intuition is that the relative more developed economies were in better conditions to catch up technological advances in the last decades.

A second interesting result is that the efforts to integrate the economies were not enough. From 1975 all countries were formally associated in political and trade agreements. Nevertheless, our evidence shows that from that time a divergence process took place in the region, and this was explained mainly by technological factors. Nonetheless, the significance and sign of this variable showed that the divergence in technological capabilities would have been worst without the integration process.

On the other hand, differences in the role of State, openness and economic stability were not significant. In fact, differences in political regimes were associated with fewer differences in technological capabilities.

In short, our findings suggest differences between the integration experiences of developed and emerging economies. While in the first case the evidence show a convergence process, like in the U.E., in Latin American and the Caribbean economies we do not verify such dynamics. This states an interesting subject in the agenda of future studies of convergence, which is to carry out a comparative analysis among blocks of developed and developing countries, to find the explanatory factors of such differences between both integration processes.

7. References

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APPENDIX

Simbol	Specification	Calculus or transformation	Source
Y/P	Per capita product	= Y/P	Our own elaboration
Y	GDP, 2000 constant prices, US$		World Bank Development Indicator Online (WBDI Online)
P	Total population		World Bank Development Indicator 2007 (WBDI 2007)
L	Employment	= (1-U%/100)LF where LF is population with working age, and U% is unemployment rate.	Employment data: (1) Marcel P. Timmer and Gaaitzen J. de Vries (2007), 'A Cross-Country Database For Sectoral Employment And Productivity In Asia And Latin America, 1950-2005', Groningen Growth and Development Centre Research Memorandum GD-98, Groningen: University of Groningen, August 2007. (2) The Conference Board, Total Economy Database, June 2009 (3) ILO, LABORSTA Labour Statistics Database. (4) ILO, ICMT, 5 edition. Unemployment rate: (i) CEPAL, (ii) ILO, LABORSTA Labour Statistics Database (iii) WBDI 2007 y (iv) WBDI Online
L/P	Labour participation rate	=L /P	Our own elaboration
K/Y	Physical capital intensity	=K/GDP	Our own elaboration
K	Stock of physical capital	King y Levine (1994)'s "preferred" methodology.	Our own elaboration based on the following sources:

		Initial K/Y estimated using: average inversion rate, average growth rates for completed period. Parameters value as the original (delta= 0,25 y depreciation rate=0,07). We supposed that K/Y in time t-1 was exactly the K/Y of steady state.	(1) Gross fixed capital formation (constant 2000 US$)-- WBDI Online. (2) Estadísticas e Indicadores Económicos [BADECON] of CEPAL, or PENN World Tables 6.2
H/Y	Human Capital intensity	Mankiw et al (1992)'s methodology: $\frac{H}{Y} = \frac{I_H / Y}{n + g_{st} + \delta}$ where numerator is the human capital inversion rate proxied by the ratio between the secondary enrolment population and population with working age. The values of the parameters are the same that the used in the K/Y estimation process.	Our own elaboration based on the following sources: Secondary enrolment: (1) Ferreres, O. Dos Siglos de Economía Argentina. (2) Della Paollera and Taylor, Statistic Appendix. (3) CEPAL. (4) Oxford Latin America Economic History Database (5) UNESCO, Institute for Statistics. (6) UNESCO estimates [code 25540]. (7) Secondary education, pupils-- WBDI 2007. (8) Secundary enrolment by level BANKS dataset 2005. Population with working age: population between 15 and 64 years old, and total population, WBDI 2007.
Scala2	Relative development level	= abs(1-ratio(lnGDP))	Our own elaboration
Distance	Geodesic distance (Kms) between two economies	See details in "Notes on CEPII's distances measures", G. Gaulier, T. Mayer y S. Zignago (2004)	CEPII
Border	Dichotomy variable	1 if the economies are neighbours 0 if not	Our own elaboration
Area	Categorical variable	0 if the economies are in the same subcontinent 1 if the combination is South America-Central America, Central-North or North-Caribbean 2 if South-North or Central-Caribbean 3 if South-Caribbean	Our own elaboration
Partner	Dichotomy variable	1if the economies share political or trade agreements 0 if not.	Our own elaboration based on INTAL database.
Openness	Ratio	=abs(1-ratio(Residual)), where Residual = Residual of the following cross-section	Our own elaboration. Oil dummy from CEPII and WBDI 2007

		pool OLS regresión: [(M+X)/GDP]t = a+b*[ln(P)]t+c*(KM2)+d*ln(Y/P)t+g*Oil_dummy+g*Island_dummy+residual See Pritchet (1996) and Blyde y Fernandez Arias (2005).	
Government	Ratio	=abs(1-ratio(lnGP)), GP=public expenditure on GDP	Our own elaboration based on: Government Share of CGDP, % in Current Prices, Alan Heston, Robert Summers and Bettina Aten, Penn World Table Version 6.2, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, September 2006.
Inflation	Ratio	=abs(1-ratio(Inf)), Inf=ln(1+inflation rate/100)	Our own elaboration based on: Inflation, consumer prices (annual %) WBDI 2007
Conflict	Difference	=abs(CBi-CBj), CB=Conflict indicator	Our own elaboration based on: conflict indicator from Banks' Cross-National Time-Series Data Archive
Regimen	Difference	=abs(Regi-Regj), Reg is the regimen type: (1) Civil (2) Militar-Civil (3) Militar (4) Other	Our own elaboration based on: regimen from Banks' Cross-National Time-Series Data Archive
Polity3	Difference	=abs(POLi-POLj) POL=Polity2+10	Our own elaboration based on: Polity2 of Polity IV Project Center for Global Policy School of Public Policy George Mason University
Pluralism	Difference	=abs(PLi-PLj) PL = pluralism indicator	Our own elaboration based on: pluralism indicator from Banks' Cross-National Time-Series Data Archive
Democracy	Difference	=abs(DEMOi-DEMOj), DEMO = indicator of quality of democracy	Our own elaboration based on: Democracy from Vanhanen (2002) Polyarchy Database