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Title:

The features of development in Central America and the Caribbean

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Abstract
Among the many formulas for measuring the degree of economic development of countries, use is increasingly being made of instruments that consider not only the traditional economic variables like Gross Domestic Product, but also the effects of other variables, through which a more realistic profile of the situation of those countries can be obtained. In this article we present a proposal for measuring social welfare, applied to Central America and the Caribbean countries, a region that is characterized by its proximity and its economic, social and geographical similarities, among other factors. Our index contributes the novelty of having been constructed on the basis of a larger number of variables than the most widely used welfare indices. For this purpose we will use the P_2 distance method for the year 2008, which integrates socio-economic variables that permit territorial ranking of countries.

Keywords Goals of the Millennium, Economic development, Measurement of distance P_2, Synthetic indicators, Welfare.

JEL Classification I38-N96-O19.

The features of development in Central America and the Caribbean

1 Introduction

In The Wealth of Nations, published in 1776, Adam Smith predicted that globalization would be a force for economic progress (Sachs 2000). The history of social and economic welfare has been covered by numerous studies (Coatsworth 1997)[1], especially following that by Pigou (1920), *The Economics of Welfare*, with an economic vision of the term. This posture gradually shifted in the second half of the 20th century, with outstanding contributions by A. Sen in the Tanner Lectures of the late 1970s, a multidisciplinary conception of welfare acquiring theoretical solidity, as against the approach in terms of utility, income or wealth (Sen 1976; 1982). The capability approach defends that the level of welfare depends on the available set of functional capabilities and, for this reason, Sen uses a concept of welfare closely linked to the ethical notion of the good life, unlike what happens in the standard economic theories of development and of welfare (Cejudo 2007).

In this sense, matters affecting the everyday life of a community touch many aspects: economic, but also social, political, etc. (González 1999). The situation of poverty and the lack of welfare of the citizens of a territory refer to their level of income, but also to other factors such as health, el employment, housing conditions, etc. (World Bank 2001).

The notion of welfare is currently characterized by being complex (Pena 2009); (Somarriba and Pena 2008), with a broader vision of the concept, exceeding the traditional identification of development or welfare with production or per capita income (Sen 1999), following the methodology of social indicators (UN 1975). In this line, Bauer (1966) considers social indicators to be the means by which a society can affirm where it stands at the present time, and provide a basis for anticipation rather than for planning, with regard to evolution in a number of domains.

Social indicators are statistical measurements of aspects of welfare specific to a society (Mazaira 2008). Thus, to evaluate the conditions of life, from considering simple indicators like income, we have moved on to other composite indicators that are more informative and include additional variables (mortality rates, propensity for morbidity, level of school enrolment, nutrition status, women's participation in politics, etc.) (Casas, Cortés and Gamboa 2003).

In this framework, a multitude of proposals have been made for measuring welfare, among them "The measure of Sustainable Economic Welfare" by Nordhaus and Tobin (1972); the Index of Sustainable Economic Welfare and its successive versions (Stockhammer 1997); or the Measure of Economic Welfare of the Levy Institute (Wolf 2004).

The methodology used in our study is based on the construction of a synthetic index, from a set of intermediate social variables that contribute to quantifying some aspect of the concept to be synthesized, following the methodology of the OECD (2002), in our case, fulfilling the Millennium Development Goals of the UN.

The results are tested by classifying countries according to the level of basic human capability attained in each one, in terms of the Human Development Index (HDI), drawn up by the United Nations Development Program (UNDP). The HDI is an overall index ranging from a minimum value of zero and a maximum of one, calculated from partial indicators reflecting longevity, education and real income per capita. All countries are classified, according to their HDI, into three groups: "high human development" (HDI: 0.800 to 1); "medium human development" (HDI: 0.500 to 0.799); and "low human development" (HDI: 0 to 0.499).

We first set out the procedure and the main mathematical properties and advantages of the synthetic indicator of distance DP_2. Second, we propose to construct an overall indicator of social welfare in Central America and the Caribbean, with the P_2 distance method. Finally, we present the results obtained and the main conclusions drawn.

2 Methodology

In this study we develop a synthetic indicator known as the P_2 distance method (Rodríguez 2011a; Cuenca and Rodríguez 2010); to measure fulfilment of the Millennium Goals (Table 1). A synthetic or overall indicator is a mathematical function of partial indicators in the form $I=F(X_1, X_2,\ldots X_n)$, where I is the synthetic indicator and n the number of variables or partial indicators that contribute information.

2.1. A synthetic indicator of welfare: The P_2 distance

The first difficulties emerging in the construction of synthetic indicators are the refining of the weighting assigned to each observable variable and size effect in the synthetic index. The DP_2 distance method used here, defined in Pena (1977), synthesizes the information contained in a series of social indicators, weighting the differences between the indicators and their reference values by the percentage of new information provided by each variable when it is included in the overall average. This eliminates the information provided by the i-th indicator, which is already contained in the preceding i-1 indicators. In other words, by means of a correcting mechanism, from each variable only the new information that it contributes is retained, employing the useful information and avoiding duplication (Zarzosa 1996); (Merino and Somarriba 2008). As regards the size effect, in general, the larger the country the higher the values of the observable variables, therefore, to relativize the observed values, it is enough to express the variables as a function of the population or of the surface area, according to whether their respective values increase with the population or with the surface area (Cuenca et al. 2010).

2.1.1 Mathematical Properties of the Synthetic Indicator DP_2

A synthetic indicator should have a series of mathematical properties to be able to provide a good measurement or estimation of the object to be measured. The synthetic indicator DP_2 fulfils these properties, as analyzed by Rodríguez (2011b); (Escobar 2006), among others:

a) Existence and determination of the synthetic indicator for all the partial indicators. Given the mathematical function defined by DP_2, it exists and takes a certain value because the variance of each and every one of the partial indicators is finite and other than zero.

b) Monotony, in the sense that if an improvement occurs in any of the partial indicators, the rest remaining constant, the synthetic indicator DP_2 will reflect that improvement.

c) Uniqueness, so that for a given situation the synthetic indicator must provide a single value or verify the invariance to changes of origin and/or scale. Therefore we can conclude that when a change is made in the scale of measurement of one or more components the result of DP_2 is not altered.

d) Grade one Homogeneity of the DP_2 function in order to reflect cardinality, i.e., if the partial indicators are multiplied by a constant, the synthetic indicator is also multiplied by that same constant. The DP_2 function is a grade one homogeneous function that verifies the property of homogeneity.

e) Transitivity, i.e., given three values of the synthetic indicator, if the first is greater than the second, and the second in turn greater than the third, it must be verified that the first is greater than the third. Since DP_2 is a numerical value, it verifies this property.

f) Neutrality. The weight of each single indicator would be given by the useful information contained in each one. In general, it is demonstrated that the ordering of the variables in the DP_2 method corresponds to their relative importance, measured in terms of linear correlation with the final synthetic indicator.

g) Completeness. The DP_2 index maximizes the useful information provided by each of the simple indicators incorporated into the overall index.

This enables the components to be ranked using a non-random method according to their degree of importance in the object to be measured; in our case the welfare in Central America and the Caribbean in the year 2008.

2.1.2 Description of the Statistical Model

We take as reference a theoretical country that achieves the worst values of the variables being studied. Thus, if "*m*" is the number of countries, there will exist a matrix *X* of observations, of the order "$m \times n$", in which the element X_{ij} will represent the state of variable *i* in country *j*.

The DP_2 indicator will give us the distances of each country from this theoretical country of reference and is defined as follows:

Let σ_i = the standard deviation of variable *i*; $R_{i,i-1,\ldots,1}^2$ = Coefficient of Determination or Coefficient of Multiple Linear Correlation squared in the Regression of X_i over X_{i-1}, $X_{i-2},\ldots,X_1$, and expresses the part of variance or variation of X_i explained linearly by the variables X_{i-1}, $X_{i-2},\ldots,X_1$.
This indicator is defined, for any i-th area, as:

$$DP2_i = \sum_{j=1}^{m} \frac{d_{ij}}{\sigma_j}\left(1 - R^2_{j;1,\ldots,j-2,j-1}\right)$$

with $i = 1,\ldots,n$

and, by definition, $R_1^2 = 0$

where:

$d_{ij} = x_{ij} - x_{i(1)}$, is the difference between the value taken by the j-th variable in the country and the minimum of the variable in the least desirable theoretical situation, taken as reference base.

As the objective is to measure the level of welfare in different countries to establish comparisons, the synthetic indicator DP_2 captures the disparities in social welfare, as in each of the partial indicators the value (x_{ij}) corresponding to the country registering the lowest value is taken as reference base. For its part, the correcting factor ($1 - R_{i.i-1,\ldots1}^2$) avoids duplication of information, since it eliminates from the partial indicators the information contained in the preceding indicators.

A higher value of DP_2 therefore expresses a higher level of welfare, as it represents a greater distance from the "least desired" theoretical situation.

2.1.3 Hierarchy of Variables

A further aspect to be taken into account in drawing up the synthetic indicator DP_2 is that the result varies when the order of entry of the components, variables or partial indicators changes. For this reason, it is necessary to establish an order or hierarchy, in terms of the information that each of them contributes to the DP_2.

The first partial indicator incorporated would be that which contributes most information, and so on.

The variables are arranged in descending order, according to the correlation with this indicator, and once the DP_2 has been calculated, the variables are re-ordered, in accordance with the value registered, until convergence is obtained at a specific value of the indicator, known as the stop criterion. The process ends when the distance between the new indicator and the indicator of the previous step is of negligible magnitude. In our case it was considered reasonable to adopt the rule of stopping the process when the distance took a value of less than 0.01.

Once the first re-ordering has been obtained, the indicator of distance P_2 is calculated, in a first stage for each of the n countries, called DP_2. When we calculate the indicator for the first stage the correlations of each variable with DP_2 are re-calculated and re-arranged in the new order. At this point we verify that the difference between the maximum value of DP_2 and DP_2 is not lower than our stop criterion, which is a value close to zero.

The process continues until the difference between the two contiguous $DP_{2's}$ is nil, i.e. when in two successive iterations, the same value of DP_2 is obtained, so the definitive result would be obtained, with a stop value defined in a positive area around zero, in our model 0.01.

2.2 Discriminating Power of the Variables

With process of calculation as described above, we obtain the value of the indicator DP_2 for each of the countries; however, this estimation does not ensure the convergence of the indicator, as it may happen that two variables have the same correlation with the synthetic indicator, and it is maximum, so we may ask ourselves which of these two results offers values closest to reality.

The most correct decision will be to select the indicator that provides most information.

In this sense, the "Ivanovic Discrimination Coefficient" permits us to measure such information, on the basis that the indicator DP_2 will be good if it has a high power of discrimination in the set of countries observed, and also contains a high volume of new information on the level of social welfare. Furthermore, this coefficient will also serve to quantify the discriminant or informative power of each of the variables. Nonetheless, this criterion is good when the variables are independent, as it contains redundant information.

For this reason, we construct the "Ivanovic—Pena Overall Information Coefficient" (IC), introducing the correction factors seen in the indicator DP_2 (Zarzosa, 1994). The coefficient therefore indicates the quantity of information provided by the variable. The values of this indicator vary between 0 and 2. The lowest value is taken when all the values of the variables are equal and other than zero, and the highest value when all the values are nil except one of them.

That is to say, using the idea of Ivanovic (1974), that a variable is considered to be more informative the more it discriminates: if a variable is constant throughout the set of countries, it will have zero discriminating power (IC = 0), and its information is not relevant for evaluating the relative levels of welfare. On the other hand, if a variable is totally discriminating (IC = 2), it provides very important information on the differences in the degree of welfare of the countries observed.

Below, we will introduce the measurement of the P_2 distance approach into the concept of ''quality of life'', a synthetic indicator that adds the information contained in a set of social indicators which is designed to make inter-spatial and inter-temporary comparisons. In our study, it is applied to the Central America and the Caribbean for 2008.

3 Results

As remarked above, the aim of our method is to draw up a synthetic indicator of social welfare, to permit comparison among countries of Central America and the Caribbean. We use as reference the Millennium Development Goals (MDG), set in 2000 by the United Nations to be reached by 2015 (Table 1). In this sense, the Millennium Declaration not only promised to revitalize international cooperation but also offered the hope of definitively conquering extreme poverty and achieving a fairer and safer world (Machinea, Bárcena and León 2005).

To estimate our multidimensional indicator, we opted to include twenty social variables, which we distributed among the eight Millennium Goals, as detailed in Table 1. We include in our indicator some relevant concepts not incorporated into the HDI itself, which we apply to the region, such as Gender Equality or Sustainability of the Environment, with the aim of attempting to approach as close as possible to the reality of the countries (Osberg and Sharpe 2005). To obtain reliable statistical data, we used the Social Statistics (BADEINSO), published by the Economic Commission for Latin America and the Caribbean (ECLAC).

The date of the study is 2008, this being the last year for which data were available, but for those variables for which no information was available at that date, we have taken as an alternative the closest year[2]. There was some difficulty in finding available current data for some of the variables of certain countries.

Finally, it has to be noted that the partial indicators that present an inverse relationship with social welfare figure in the matrix of observations X with negative sign., in particular those linked to goals 1b, 1c, 4a and 5a (Table 1).

In particular, we consider the application of the DP_2 indicator to Central America and the Caribbean, an area characterized by its geographical proximity and certain economic and social similarities, among other factors. Indeed, these countries are grouped in many ECLAC studies relating to the area (ECLAC 2010).

To order the countries by DP_2 value, we must bear in mind that a higher result in the indicator reflects an improvement in the achievement of the Millennium Development Goals. This situation implies a greater distance from the "least desired" theoretical scenario, in which minimum values are obtained in the set of twenty social variables considered in the territory.

Table 1 Variables of social welfare by UN Millennium Development Goals (MDGs) and sign of the relationship of the variables to the increase in countries' welfare

Goal 1. To eradicate extreme poverty and hunger

a) Real per capita GDP (positive sign +)
b) Poverty gap ratio at $1 a day (PPP), percentage (negative sign -)
c) Rate of unemployment (negative sign −)

Goal 2. Achieve Universal Primary Education

a) Net rate of school enrolment (total population) in Primary Education (positive sign +)
b) Public expenditure on education, % of total GDP (positive sign +)
c) Literacy rates of 15-24 years old, both sexes, percentage (positive sign +)

Goal 3. Promote Gender Equality and Empower Women

a) Ratio of girls to boys in primary (positive sign +)
b) Proportion of seats held by women in national parliament (positive sign +)
c) Percentage of women in wage employment in the non-agricultural sector (positive sign +)

Goal 4. Reduce Child mortality

a) Infant mortality rate (0-1 year) per 1,000 live births (negative sign −)
b) Proportion of 1 year old children immunised against measles (positive sign +)
c) Average life expectancy at barth (positive sign +)

Goal 5. Improve Maternal Health
a) Maternal mortality ratio per 100,000 live births (negative sign −)
b) Births attended by skilled health personnel, percentage (positive sign +)

Goal 6. Combat HIV/AIDS, malaria and other diseases

a) Public expenditure on health, % of total GDP (positive sign +)

Goal 7. Ensure Environmental Sustainability

a) Proportion of population using an improved drinking water source (positive sign +)
b) Proportion of population using an improved sanitation facility (positive sign +)
c) Proportion of renewable energy supply (positive sign +)

Goal 8. Develop a Global Partnership for development

a) Number of telephone lines per 1000 inhabitants (positive sign +)
b) Internet users per 100 inhabitants (positive sign +)

Source: Author based on UN (2009).

3.1. Classification by countries

From a territorial viewpoint, through the figures obtained, we observe that Barbados was the country of Central America and the Caribbean with greatest achievement of the Millennium Goals in 2008, with a DP_2 figure of 17.05, occupying the first position in our order, in harmony with the HDI ranking (Table 2).

It is followed by Costa Rica (12.40), Cuba (10.77) and Guyana (9.70), with relatively high values in most of the social indicators, and with a final result above the average distance of the region from the reference base (7.7) (Table 2).

On the other hand, according to the DP_2 indicator, Guatemala and Haiti, with indicator figures around 4, are among the furthest from the UN Millennium Goals.

As a consequence, the openness coefficient (ratio between the maximum and minimum DP_2 value attained by a country) was nearly 5, reflecting notable differences in the social variables considered among the territories analyzed.

Furthermore, countries of the Caribbean such as Trinidad and Tobago, the Dominican Republic and the Bahamas, or of Central America, like El Salvador or Honduras, obtained for 2008 a social welfare indicator lower than the average for the area. Though in this case with a different classification from that deriving from the HDI, especially in the case of Belize, Bahamas, Panama and Trinidad and Tobago.

Finally, we should underline that Costa Rica, with a high level of human development according to the HDI, is the country of Central America that reached the most privileged position, presenting higher values than its neighboring countries in a number of the social indicators considered.

Table 2 Synthetic indicators of social welfare in Central America and the Caribbean. 2008 Countries in order of relative DP_2 and UNO Human Development Index (HDI) rank 2007

Classification	Country	DP_2 indicator	HDI	Geographical area of the continent
1	**Barbados**	17.05	0,89	Caribbean
2	**Costa Rica**	12.40	0,85	Central America
3	**Cuba**	10.77	0,84	Caribbean
4	**Guyana**	9.70	0,75	Caribbean
5	**Nicaragua**	8,23	0,71	Central America
6	**Belize**	7,62	0,78	Central America
7	**Jamaica**	7,20	0,74	Caribbean
8	**Panama**	7,10	0,81	Central America
9	**Honduras**	6,44	0,70	Central America
10	**Bahamas**	6,40	0,85	Caribbean
11	**Dominican Republic**	5,36	0,78	Caribbean
12	**El Salvador**	5,05	0,74	Central America
13	**Trinidad and Tobago**	4.90	0,81	Caribbean
14	**Guatemala**	4,25	0,69	Central America
15	**Haiti**	3.40	0,53	Caribbean

Source: Author based on ECLAC data.

3.2 Discriminatory power of the social variables

In this section we use the results of the Ivanovic—Pena Overall Information Coefficient (IC). Table 3 shows the IC values corresponding to the variables. In particular, we estimated the discriminatory power of each of the variables considered.

According to the results obtained, the social variables with the most heterogeneous and least constant values among the countries studied were, in 2008, in order:

-The Proportion of population using an improved drinking water source, with an IC of 0.70;

-The Literacy rates of 15-24 years old, both sexes, percentage, which registered an IC of 0.54;

-The Real per capita GDP, with a value of 0.36.

-The Rate of unemployment (0.29).

These four variables are the ones that present greatest differences in their values among the countries of Central America and the Caribbean in 2008. Among them are to be found two indicators associated with Millennium Goal 1 (To eradicate extreme poverty and hunger).

Next are the variables of Proportion of 1 year old children immunised against measles and Public expenditure on education as a percentage of GDP, with values of 0.17 and 0.15, respectively.

In general, no great inequalities are detected in nearly half the social variables considered among the countries of Central America and the Caribbean, with no differences at all in variables like the Proportion of renewable energy supply, the Percentage of women in wage employment in the non-agricultural sector or Internet users per 100 inhabitants (Table 3). In this case, there are no appreciable differences between the countries.

Table 3 Amount of information of the variables

Variable	Millennium Goal	IC(i)
Proportion of population using an improved drinking water source	7	0,70
Literacy rates of 15-24 years old, both sexes, percentage	2	0,54
Real per capita GDP	1	0,36
Rate of unemployment	1	0,29
Proportion of 1 year old children immunised against measles	4	0,17
Public expenditure on education, % of total GDP	2	0,15
Proportion of population using an improved sanitation facility	7	0,13
Poverty gap ratio at $1 a day (PPP), percentage	1	0,12
Proportion of seats held by women in national parliament	3	0,11
Net rate of school enrolment (total population) in Primary Education	2	0,10
Births attended by skilled health personnel, percentage	5	0,09
Average life expectancy at barth	4	0,08
Infant mortality rate (0-1 year) per 1,000 live births	4	0,06
Maternal mortality ratio per 100,000 live births	5	0,05
Ratio of girls to boys in primary	3	0,05
Number of telephone lines per 1000 inhabitants	8	0,03
Public expenditure on health, % of total GDP	6	0,03
Proportion of renewable energy supply	7	0,02
Percentage of women in wage employment in the non-agricultural sector	3	0,01
Internet users per 100 inhabitants	8	0,01

Source: Author based on ECLAC data.

4 Conclusions

This study has followed a holistic approach, not without complexities, to the determination of the most important factors in social welfare in Central America and the Caribbean in 2008, taking into account a wide range of variables, some not included in the HDI, according to the Social Statistics (BADEINSO) published by the ECLAC.

With this aim, we opted for Pena's DP_2 distance method, which permits the evaluation of differences in terms of social welfare among the countries analyzed, according to the values of a number of variables, overcoming the limitations present in the calculation of other indicators such as the duplication of information.

On the basis of twenty social indicators, linked to the eight internationally recognized Millennium Development Goals, defined by the UN, we estimated the synthetic index in fifteen countries of Central America and the Caribbean, for which reliable statistical information was available.

The values calculated give the following results:

By countries, Barbados was the one achieving the highest level of social welfare in the year studied, followed by Costa Rica, Cuba and Guyana, one of the least populated of all. These territories could be considered to have the greatest achievement of the Millennium Goals in the area up to the date of the study and to have obtained highest values in the social variables considered.

On the other hand, Guatemala, El Salvador, Haiti, and Trinidad and Tobago showed indicator values below the mean for the region.

The data rendered by the DP_2 method reflect some differences among the countries in their achievement of the Millennium Goals up to 2008, according to the value reached by the first two, Barbados and Cuba, and the last two, Haiti and Guatemala. This could be taken more into account in the programming of international organizations to raise the levels of social welfare in these territories, especially those in the lowest positions in the classification obtained, according to the DP_2 (Table 2).

With the indicator DP_2 we obtain clearer differences in the classification by countries than in the HDI ranking, which does not include some variables incorporated into our study, such as those linked to the UN's Millennium Goal 3: Promote Gender Equality and Empower Women; Goal 7: Ensure Environmental Sustainability; or Goal 8: Develop a Global Partnership for development.

Finally, according to the method used, the variables with greatest differences in their values among countries were: proportion of population using an improved drinking water source the percentage, the literacy rates of 15-24 years old, both sexes, percentage and real per capita GDP.

We also appreciate a relatively high power of discrimination of variables that are not usually included in other indices devised with similar aims, particularly those included in the domain of Gender Equality or Sustainability of the Environment.

To sum up, in fields of activity such as universal education, improved maternal health, gender equality or reduction of infantile mortality, special attention should be paid to this area in the near future in order to continue advancing in the achievement of the Millennium Development Goals and to improve, to a greater extent, the social welfare of their citizens, on the time horizon of 2015.

Despite the advances made in most countries, there still remain notable differences in the region in the value of certain social indicators, with very unequal progress in some areas basic for social welfare, such as the proportion of the population that is illiterate, access to drinkable water, or infant malnutrition.

To finalize, it only remains to reiterate our intention that this study should constitute a contribution to the attempt, which we share with other researchers, to approach the measurement and the improvement of the social welfare, in this case, of Central America and the Caribbean.

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Footnotes

[1] Social welfare has been a subject of study by Economics since its origins, but the greatest advances in the study of it were made in the early years of the 20th century, notably by Pareto (1906) and later, among others, by Arrow (1951).

[2] This has occurred in the variables: Illiteracy rate of the population from 15 to 24 years; Illiterate population of 15 years of age and over; Women; Life expectancy at birth, both sexes; Net Enrolment in Primary Education; Births attended by qualified personnel (%);Public spending on education (% of GDP); Proportion of women among remunerated employees in the non-agricultural sector; and Public spending on education (% of GDP), for which the available information is from 2007, while for the Percentage of total energy from renewable sources we use data from 2006.