Measuring Sustainable Well-being Dimensions Using Multiple Correspondence Analysis

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Abstract

This paper deals with Sustainable Well-being dimensions' measurement, based on the philosophical approach of central capabilities proposed by Martha Nussbaum and using the statistical techniques of Multiple Correspondence Analysis (MCA). In order to do so, and given the complexity of the operationalization of dimensions based on a philosophical approach, it develops a particular perspective of statistical measurement, which starts with the capture of the associated data and continues all the way through the approach of the analysis techniques, that allows its enhancement. The measurement starts with the hypothesis that there will be a greater Sustainable Well-being to the extent that there are more liberties and opportunities; and one way of expressing it is through the conditions associated with the capabilities, opportunities and freedoms of their individuals in time and space. To achieve this measurement, it will be demonstrated that the Multiple Correspondence Analysis (MCA) technique is appropriate to aggregate and analyze the group of identified indicators that satisfy the multidimensional approach and they are validated through an empirical application. Likewise, the feasibility and potential of the statistical techniques will be tested to satisfy a philosophical approach to welfare.

Keywords: Capability, Martha Nussbaum, Well-being Indicators, Factorial Analysis, Latin America.

1. Dimensions of Sustainable Well-being

In order to achieve Sustainable Well-being in societies, it is necessary to expand the capabilities, opportunities and liberties for their individuals, being a way of expressing it through the quantitative measurement of their associated conditions. Sustainability is the "sustenance" that allows to guarantee the base or its well-being conditions over time. On the other hand, well-being is to achieve a full life according to individual values and social conditions that allow it.

In general terms, the conditions are all those that allow the opportunities and liberties for "human flourishing", where individuals can take advantage of their capabilities. At this point, the philosophical approach of central capabilities of Martha Nussbaum (2011) is very useful; since it expresses that the innate and internal capabilities of the individuals, together with the external conditions, are those that allow obtaining the combined capabilities. These external conditions are what determine what the individual can "be" and "do" freely, and for that reason it is fundamental to consider them.

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Martha Nussbaum (2011) states 10 central capacities that a government must minimally fulfill: Life; Bodily Health; Bodily Integrity; Senses, Imagination and Thought; Emotions; Practical Reason; Affiliation; Other species; Play; Control over one's Environment. Each of them has its justification. These core capacities are based on *essentialism* and allow universal coverage (Nussbaum, 1992). In this sense and after a detailed analysis of various authors and approaches, according to what has been described above, they are considered suitable to represent the **Dimensions of Sustainable Well-being**.

Of these 10 central capabilities, this paper will concentrate on the analysis of one of them: "Dimension **Life**", which Nussbaum defines as "*Being able to live to the end of a human life of normal length; not dying prematurely, or before one's life is so reduced as to be not worth living*". It is important to emphasize the subjective meaning that implies the "reduced" life, which is why it is important to consider subjective variables. It is also necessary to expand the concept of the dimension a little more and based on what is described by Nussbaum (2011) of being 'minimal' aspects, gives freedom to expand its philosophical conception.

In that sense, we considered necessary to add aspects of life associated with not only living, but living fully and responsibly. It is also important that in addition to the full life while alive, individuals should have the possibility to an adequate end of life. For these reasons, we have adapted the description of the dimension to the following form: **Being able to live fully and responsibly until the end of a human life of normal duration or before life itself is so reduced that it is not worth living. Not to die prematurely or in precarious conditions**.

2. Measuring Sustainable Well-being

Measuring requires two main stages: Identification of variables and their analysis. Both associated with the philosophical approach.

Identification of variables requires to developing a particular perspective of statistical measurement. In this sense, indicators should not only be "results" of policies, as traditionally selected in international indexes or other approaches, but also must consider indicators of inputs, access and conditions of individuals "to be" and "to do".

In addition, the approach is in terms of positive perspectives, i.e., instead of "infant mortality" "child survival". Not associated with the approach would be: deaths caused by HIV, while associated with the approach would be: searches for preventive information about HIV or percentage of people infected with HIV who seek and receive ART drugs from the total number of patients. That is to say, variables more related to the "being able" to maintain life for its normal duration, seeking preventive and responsible information about a disease, or voluntarily and responsibly taking medicines.

Data comes from search should be managed in several international reliable sources. Variables should be continuous using both objective and subjective information. As sources are diverse, a previous treatment of the data was necessary to adjust scales and direction, and sometimes imputation of absent data (as long as it does not exceed 5%).

Subsequently, the **analysis** stage begins, where the approach calls for a combination of all variables for each dimension. There must be conciliation between the philosophical approach and the statistical technique. It is important to emphasize that for the philosophy of Sustainable Well-being there is no one variable more important than another, all are intertwined creating balance among them.

Therefore, the adequate statistical technique should allow the multiple combinations of variables and their relationships. For this, the techniques of factor analysis are appropriate and from them we

considered the Multiple Correspondence Analysis (MCA) as it adds, relates and analyzes the group of identified indicators that satisfy the multidimensional approach.

In order to use MCA, each variable or condition must be categorized into three levels associated with its contribution to Sustainable Well-being: high (3), medium (2) and low (1). Three categories will suffice, as recommended by the OECD Handbook for Indicator Development (2008). This manual also indicates that MCA techniques are suitable for exploratory analysis, and since the measurement of Sustainable Well-being is associated with opportunities and freedoms, with broad subjective aspects, is a propitious technique for approaching the methodology. Categorizing the variables allows to illustrate not only the individuals and the variables, but also to illustrate the categories of these variables in the factorial plane, an aspect that contributes a lot to the analysis and which is not possible through other techniques.

From the MCA, a measure called "coordinate" is obtained, which indicates the contribution to explain the inertia to the factors, both of the countries and of the categories of the variables, according to their distance between them and the origin of the factors. Likewise, the distance between countries will determine similarities or differences between them.

The way to elaborate the indicator will be by means of a formula that captures the information. To each category of the variable is assigned a coordinate in the factorial plane. To obtain the value of the Index for each country, the coordinates of the categories of the variables that have associated are added.

$$S_i = \sum_{q=1}^{Q} H_{jq\alpha}$$

Source: Own elaboration.

Where:
S_i = Sum of the coordinates of the i-th country.
$H_{jq\alpha}$ = Coordinate of the i-th country in the j-th category of the q-th variable for the factor α.
Being α = 1 = First factor that collects the highest percentage of variability

Then, to adjust the Index (which we can call Z) on a scale between [0, 10], the following formula is applied:

$$Z_i = \frac{S_i - MinS}{MaxS - MinS} x10$$

Where:
Z_i= Value for the i-th country.
$MinS$ = Min {S1, S2, … , Sn}
$MaxS$ = Max {S1, S2, … , Sn}

In this sense, if the analysis is developed by dimensions, it can be determined according to the direction of the data towards the favorable conditions. Results closer to 10 for each country, would have a greater association to the Sustainable Well-being.

2.1. Identification of variables

To analyze the "Life" dimension, Latin American countries and the selection of the variables associated with the approach will be considered. Figure 1 illustrates countries and variables identified for the analysis:

Figure 1

C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14
Argentina	2	3	3	2	1	2	1	2	3	1	2	2	2
Bolivia	1	1	1	1	1	1	3	1	3	1	1	1	2
Brasil	1	1	3	3	1	1	3	2	2	1	1	3	2
Chile	3	3	3	1	1	1	3	1	2	3	1	1	3
Colombia	1	2	2	1	2	3	1	1	2	2	1	1	1
Costa Rica	3	2	3	3	3	3	2	1	2	3	2	3	3
Ecuador	2	1	1	1	2	2	3	2	1	3	1	1	2
El Salvador	1	1	1	3	3	1	1	1	3	2	3	1	1
Guatemala	1	1	2	2	1	1	1	1	1	1	1	1	1
Honduras	1	1	1	1	2	1	1	1	1	2	1	2	3
México	2	2	2	1	1	1	3	1	1	1	3	1	3
Nicaragua	2	1	1	1	2	2	1	3	3	1	3	3	1
Panamá	3	3	2	3	1	3	2	2	1	2	2	2	1
Paraguay	1	1	1	2	3	2	2	1	1	1	3	1	2
Perú	2	2	1	1	2	1	2	3	1	3	1	1	1
Rep. Dominicana	1	1	1	1	1	3	2	3	2	1	1	1	1
Uruguay	3	3	2	2	1	2	2	2	3	1	3	2	3
Venezuela	1	2	1	2	3	1	1	3	1	1	2	2	3

The variables from their respective sources[2], illustrated in Figure 1, are already categorized into three levels according to the distribution of the data, and all of them went through a previous treatment of scale and direction adjustment, as well as imputation of 4 isolated missing values. The respective variables are: C2 (Life expectancy at birth), C3 (% of HIV-infected persons who seek and receive ART drugs from the total number of patients), C4 (Overall life satisfaction index), C5 (Purpose Well-Being. Thriving (%)), C6(Psychological and Mental Well-being in individuals over 50 years),C7 (Overall satisfaction with the life of young people between 16 and 24 years of age), C8 (Absence of severe depressive disorders), C9 (Survival ratio of children in their first 5 years of life), C10 (% of surviving children who received the 2 vaccines recommended by WHO), C11 (Probability of surviving between 30 and 70 years of cardiovascular disease, cancer, diabetes, or chronic respiratory), C12 (Perception of quality medical care), C13 (Perception of the effectiveness of the various road safety regulations: speed limit, alcohol control, belt and helmets), C14 (Absence of incidents caused by ingestion of counterfeit medicines, per capita).

It is important to mention that the variables C8, C9, C11 and C14 were modified from their original sources to fit the approach. For example, the variable C8 in its original source is called "Major depressive disorder (MDD)". But adjusting it to the philosophy of the research approach, its data were modified to be denominated like "Absence of serious depressive disorders". Remaining as a condition more associated to guarantee a better "Life".

It should be noted that Latin America is defined as the independent countries of America that speak the languages derived from Latin: Spanish, Portuguese and French. Of the countries illustrated in figure 1, Cuba and Haiti were excluded because they had data missing in a percentage greater than 5% of the total variables.

[2] http://hdr.undp.org/es/composite/HDI; http://aidsinfo.unaids.org/ (Coverage of people receiving ART); UNDP-HDI 2016; http://www.well-beingindex.com/(The Global Well-Being Index); http://www.helpage.org/global-agewatch/(Relative psychological/mental wellbeing); http://dds.cepal.org/juvelac/estadisticas; http://www.fundamentalsdg.org/uploads/3/8/5/0/38504573/gbd_2010_depressive_disorders_supplement__prevalence_by_country_.pdf; http://www.paho.org/data/index.php/es/indicadores/estado-de-salud/466-under-five-es.html; http://www.sdgindex.org/download/; http://apps.who.int/gho/data/node.main.SDG34?lang=en; UNDP-HDI 2016; http://www.who.int/violence_injury_prevention/road_safety_status/2015/en/(Average: Effectiveness of overall enforcement (respondent consensus) (scale 0–10)); https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4455087/(Upper range as value)

2.2. Analysis of the model and results

The MCA was satisfactory with a percentage of variability of 16.08% for the first factor, 13.36% for the second, and 11.57% for the third, for a total of 41.02% among the first three factors. The first factor consists of 7 variables in high categories, 6 in medium categories and 1 in low category.

Figure 2 shows each variable Cn with its category level 1, 2 and 3. The trace of the variable C4 (Overall life satisfaction index) in its route from the low category (C4 = 1) to its category High (C4 = 3), is observed correspondingly more associated to the surrounding countries.

Figure 2

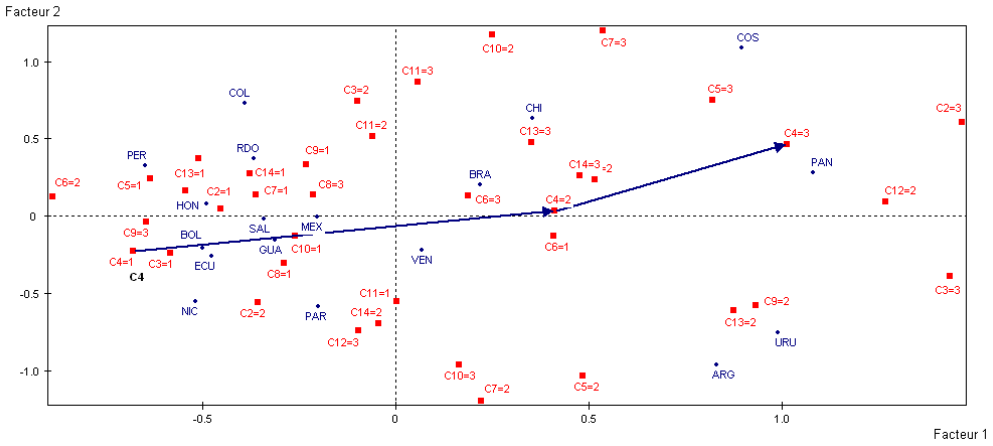
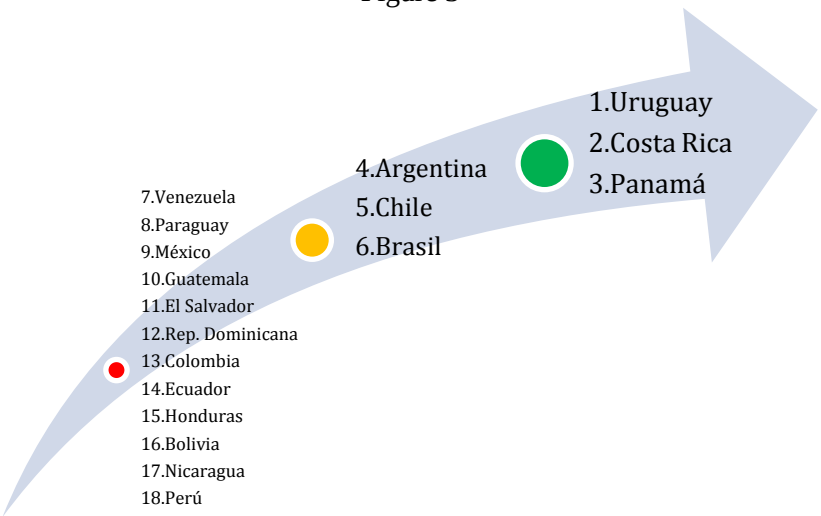


Figure 3



Once the MCA was completed and applying the procedure described in item 2, figure 3 illustrated the results for Latin America. Uruguay stands out as the first in the ranking, of the 18 countries under analysis that resulted gathered in 3 categories. Countries associated with the red circle, are in a low category, the orange category medium and green category high. The latter are the results of the country's most associated with achieving Sustainable Well-being according to their "Life" dimension.

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