A multidimensional regional development index as an alternative allocation mechanism of EU Structural Funds remittances

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Abstract:

Structural Funds, the main instrument to achieve the Regional Policy objectives in the European Union, are allocated by regional Gross Domestic Product (GDP). That is, despite economic and social cohesion being core EU objectives since its foundation, the community regional performance is defined in a strict economic sense by the size and growth of the economy.

This paper presents a multidimensional approach to the measurement of regional performance as an alternative to a single criterion approach based on the GDP per capita. Drawing on the capabilities approach and the recent trends in well-being, we discuss the reasons that justify the revision of the current allocation mechanism of EU Structural Funds and its combination with information on other dimensions relative to people's quality of life, such as inequality in income and gender, education, health, poverty and employment.

Following two distinct multivariate methods (Principal Component Analysis and Distance P_2) and Eurostat information, we estimate a synthetic index of regional development in 2009 for the 269 regions of EU28. Based upon the indicators considered, Stockholm in Sweden is the most developed region with a development level that triples that achieved by the least developed region (Severozapaden in Bulgaria). Hence large territorial disparities exist. Employment (female and male) related aspects and GDP per capita adjusted by inequality are the key determining factors of regional development. Were the Structural Funds allocated by our regional development index instead of the GDP per capita, some regions of Belgium, France, Greece, Germany, Italy and Spain would be considered priority regions; whereas some other regions, mainly from Eastern Europe, would not be considered so.

Keywords: cohesion policy, human development, inequalities, structural funds, synthetic index, quality of life

JEL codes: C43, I31, O15, R15, R58

1. Introduction

In order to promote the European Union (EU) overall harmonious development, the EU Regional Policy –or Cohesion Policy- focuses on reducing disparities between the levels of development of the various regions and the backwardness of the least favoured regions (Treaty on the Functioning of the EU, Article 174). The budgetary effort devoted to Regional Policy during the Multiannual Financial Frame (MFF) 2007-2013 has reached the 35.64% of EU27 Budget (European Commission, Financial Programming and Budget), and it is set to approximate the 33.88% of EU28 Budget during the MFF 2014-2020 (European Council 2013).

That is, the EU Regional Policy is one of the key axes of EU integration, together with the single market and monetary union, which receives a substantial part of the EU Budget (Pellegrini et al. 2013).

Structural Funds constitute the main instrument to achieve the EU Regional Policy objectives. The European Commission has called for indicators that complement Gross Domestic Product (GDP) should be developed so that more comprehensive information supports policy decisions (Commission of the European Communities 2009). However, the allocation of Structural Funds among regions follows the GDP per capita criterion. Regions whose GDP per capita falls short off the threshold of 75% of EU average GDP per capita are eligible for Structural Funds support. For the next planning period 2014-2020, every European region may benefit from Structural Funds, however there will be a distinction between less developed regions (which will receive the largest proportion of Structural Funds), transition regions and more developed regions[1] to ensure that Funds are allocated according to the GDP level (European Commission 2011, 2012; European Union 2011).

This allocation mechanism is in line with traditional theoretical approaches and empirical analyses of regional welfare and inequality. That is, despite economic and social cohesion being core EU objectives since its foundation, the community regional performance is defined in a strict economic sense by the size and growth of the economy.

There is a growing acknowledgement among economists, social scientists and international organizations that GDP is not sufficient to analyse the overall societal

[1] Less developed regions are regions whose GDP per capita is less than 75% of the average GDP of the EU. Transition regions are regions with a GDP per capita between 75% and 90% of the EU average). More developed regions are regions whose GDP per capita is above 90 % of the average GDP of the EU, but are important challenges global competition in the knowledge-based economy and the shift towards the low carbon economy (European Union 2011, p. 5).

development and progress. Several aspects such as general economic, social, political, environmental, and cultural conditions rather than income alone affect quality of life and inequality. Hence, the measurement of regional development has to contend with the multidimensionality of the welfare and inequality concepts (Folmer and Heijman 2005; Neumayer 2003; Nordhaus and Tobin 1972; Nussbaum 2000; Ram 1982; Sen 1987, 1992; Stiglitz et al. 2009; Van den Bergh 2007).

The aim of this paper is to elaborate a synthetic o composite index that measures regional performance in the EU from a multidimensional perspective. Drawing on the recent trends in well-being, we discuss the reasons why the current allocation mechanism of EU Structural Funds should be revised and completed with information on other dimensions relative to people's quality of life, such as inequality in income and gender, education, health, poverty and employment. The regional performance index we propose has two related purposes (see Bell and Morse 2003, p. 49): an useful Structural Funds allocation tool in contrast with a single criterion approach based on the GDP per capita; and a communication tool to raise EU population awareness of the importance of the European Cohesion Policy.

Following two distinct multivariate methods (Principal Component Analysis and Distance P_2), we estimate the composite index of regional performance in 2009 for the 269 regions of EU28. The results provide a ranking of regions from high to low level of development, and show which factors contribute the most to regional development. Moreover, the index calculated with the Distance method P_2 of Pena Trapero (1977) allows a multidimensional analysis of regional inequality. As the DP_2 approach proves to be more robust than traditional approaches because it solves the majority of methodological difficulties arising from the aggregation of indicators of different dimensions (see Montero et al. 2010; Somarriba and Pena 2009), we contrast the DP_2

results of with orthodox GDP measures. Specifically, we discuss the difference between the traditional GDP based allocation mechanism and a multi-dimensional approach, and we analyse if the resulting maps of priority regions significantly differ.

The remainder of this paper is organised as follows. In Sect. 2, we discuss about the GDP per capita alternatives for measuring regional performance. In Sect. 3, we describe the methodology applied. In Sect. 4, we explain the statistical information used to elaborate the synthetic index of regional development. The empirical results are in Sect. 5. In Sect. 6, we discuss some regional policy implications. The final section provides some conclusions.

2. How measure the regional performance?

In the EU context, the socio-economic inequalities between both people and regions have been rising in the majority of Member States over the last three decades and are now higher than in 1980 regardless of consistent objectives for economic and social cohesion (Eurostat 2010). Considerable differences exist in the distribution of income between the Member States (EU27): whereas the first quartile of population owns 10.8% of income -share of national equivalised income-, the fourth quartile receives 45.1% in 2011 (Eurostat). Gender inequalities persist despite the Lisbon strategy also requires the EU to promote equality between men and women in pay, labour market segregation and decision-making jobs. On the basis of the common threshold of the 60% of median equivalised disposable income, a 16.9 % of the population of the EU28 was considered at-risk-of-poverty in 2011 (Eurostat).

This separation between economy and society could be potentially overcome by including a measure of social well-being in models of regional performance (Perrons 2012, p.18). However, in the EU regional performance is measured by GDP per capita.

Regions whose per capita income falls short off the threshold of the 75% of the EU average GDP per capita are regions objective 1 or less developed regions, and are thus eligible for Structural Funds support.

The GDP is an indicator of the productive activity in a territory. Nevertheless, it is at least controversial to link the concept of development to a one-dimensional variable that only measures the aggregate value of the production of goods and services in a particular time period. The GDP must be considered as an estimate of the total cost of all market-related economic activities in a territory, their actual benefits or real welfare effects (Daly 1977; Mishan 1967). A correct economic welfare approach would only characterise changes as real progress if they were accompanied by a sustainable use of environment and nature (Van den Bergh 2007). But the GDP calculates does not take into account the environmental externalities, the depreciation associated with environmental changes (fish stocks, forests, biodiversity) and the depletion of natural resources (Solow 1993). The GDP indicator emphasizes average income and forgets income distribution, and an unequal distribution of income implies unequal opportunities for personal development and well-being (Sen 1976, 1979). Also, the subjective well-being approach calls for the incorporation of subjective well-being indicators (being employed, being healthy, having a stable family, personal freedom, social contacts, leisure, relative welfare and rivalry in consumption, etc.) in any assessment of social performance (Diener 2002; Easterlin 2001; Frey and Stutzer 2002; Kahneman et al. 1999; Oswald 1997).

These arguments suggest that conventional, market-based measures of GDP need to be combined with others indicators of quality of life that provide more comprehensive information to support policy decisions. We next discuss briefly the distinct initiatives to construct multidimensional indexes of development and/or quality of life.

The Human Development Index (HDI), calculated annually by the United Nations Development Program since 1990, measures the average progress achieved by a country in three distinct dimensions: a long and healthy life, knowledge, and a decent standard of living (UNDP 2013). This approach is based on the capabilities concept and focuses on multidimensional aspects of well-being and claims that income and resources do not provide a satisfactory indicator of well-being as they only measure means (instead of ends). The material and non-material circumstances that shape people's opportunity sets, and the circumstances (social institutions, legal norms, other people´s behaviour, environmental factors, etc.) that influence the choices that people make from the capabilities set, receive a central place in capability evaluations (Nussbaum 2000, 2011; Sen 1980, 1990). Also since the 2010 edition, the Human Development Report includes, besides the HDI, three new indexes: the Inequality-adjusted Human Development Index (IHDI), the Gender Inequality Index and the Multidimensional Poverty Index. These state-of-the-art measures incorporate recent advances in theory and measurement and support the centrality of inequality and poverty in the human development framework (UNDP 2011).

The World Bank calculates the adjusted net saving (also known as genuine saving), a sustainability indicator building on the concepts of green national accounts. Adjusted net savings measure the rate of savings in an economy after taking into account investments in human capital, depletion of natural resources and damage caused by pollution. The World Bank has pioneered the inclusion of social and environmental aspects when assessing the wealth of nations. Information on these indicators is available at the World Bank website.

The European Union has started several initiatives to develop indicators that complement GDP in policy making and that include social and environmental achievements (such as improved social cohesion, accessibility and affordability of basic goods and services, education, public health and air quality) and losses (e.g., increasing poverty, more crime, depleting natural resources) (Commission of the European Communities 2009, p. 3). One of these EU initiatives is the development of the Sustainable Development Indicators (SDIs). The SDIs aims to monitor the European Union Sustainable Development Strategy (Council of the European Union, 2006). The SDIs supply información on approximately 100 indicators grouped in 10 themes of the social, economic, environmental and governance spheres (see Eurostat website). One of the limitations of the SDIs is that only provides information for Member States, and primarily at country level. In particular, information on environment indicators is very scarce at regional level or NUTS 2.

In France the reports of the Commission on the Measurement of Economic Performance and Social Progress (CMEPSP), led by Stiglitz, Sen and Fitoussi (Stiglitz et al. 2009), have had a remarkable international impact. To measure quality of life, the CMEPSP (Stiglitz et al. 2009, p. 42) considers useful three conceptual approaches: the capabilities approach (interdisciplinary character); the subjective well-being, in close connection with psychology (Diener 2002; Easterlin 2001; Kahneman et al. 1999); and the notion of fair allocations, the standard approach in economics (Boadway and Bruce 1984). Drawing on the progress achieved in these fields, CMEPSP identifies eight dimensions of well-being that should be considered simultaneously: material living standards, health, education, personal activities including work, political voice and governance, social connections and relationships, environment, and insecurity (of an economic as well as a physical nature).

The OECD has developed the project "Better Life Initiative" where it establishes 11 essential dimensions of well-being, the goal being the measurement of well-being or progress of citizens living in 34 countries. On the basis of 2-4 indicators, an index is calculated per each dimentions (see http://www.oecdbetterlifeindex.org/). The selection of indicators is in line with the recommendations in the Report of the CMEPSP (Stiglitz et al. 2009): includes measures of subjective well-being, such as life satisfaction and self reporting; considers income and consumption rather than production, and discuss income jointly with wealth; besides education, health and income, incorporates indicators of social connections, personal activities, civil engagement, environmental conditions and security.

The starting point of all of the initiatives above is that the GDP is a very specific measure focused solely on market values that can misrepresent well-being. That is, the evaluation of progress requires the equal consideration of social, environmental and economic indicators. Drawing on these arguments, we present a Regional Development Index (RDI) to estimate regional performance in the EU as an alternative to the GDP per capita. The RDI is a multidimensional index that incorporates indicators of both monetary and non-monetary dimensions relative to people's quality of life, such as income, inequality in income and gender, education, health, poverty and employment. Thus, the RDI aims to offer a more accurate view on the diversity of economic and social development in the EU than that offered by the GDP per capita, and it will be analysed as an alternative allocation mechanism of the EU Structural Funds remittances.

3. Methodology

In this paper we apply the DP_2 synthetic index proposed by Pena Trapero (1977) that measures regional development according to recent trends in development and well-being discussed in the previous section. The main pros of using synthetic or composite indexes are (OECD 2008, 13-14) that: summarise complex, multi-dimensional realities with a view to supporting decision-makers; are easier to interpret than a battery of many separate indicators: assess progress of territories over time, and facilitate communication with general public and promote accountability. The most troubling issues concerning the elaboration of synthetic indexes (see Booysen 2002; Cherchye et al. 2008; Permanyer 2011; Ravallion 2010) are the treatment of measurement units (how to aggregate variables expressed in different units), and the weighting of variables in the synthetic index (how to aggregate the variables into a single index).

The Pena Distance (DP_2) is a multidimensional index capable of aggregating various indicators of regional development expressed in different measurement units, objectively determining the weighting of each of the indicators in the index. Furthermore, DP_2 is a quantitative distance index that allows to compare regional development across several spatial and/or temporal units.

The point of departure of this method is a matrix X of order (m, n), in which m is the number of EU regions and n is the number of indicators. Each element of this matrix, x_{ji}, represents the state of the indicator i in the region j. Those indicators negatively related with regional development are incorporated into the model changing the sign (all their data must be multiplied by -1). Conversely, those indicators positively related with regional development remain unchanged. Thus, the increase (decrease) in the values of any indicator indicates an improvement (worsening) in regional development.

In a second stage, we compute a distance matrix D such that each element, d_i, for each region is defined as:

$$d_i = d_i\,(j,*) = |\,x_{ji} - x_{*i}\,| \qquad (1)$$

where d_i is the difference in the region j with respect to the reference vector $X_*=\{x_{*1}, x_{*2}, \ldots, x_{*n}\}$. The synthetic index measures the distance, in terms of regional development, between each region and a fictitious reference. In our case, the reference vector comprises the results of a (hopefully) theoretical region with the worst possible scenario for all the indicators (the minimum of the indicators) and would therefore be attributed a value of zero in the synthetic development index (see Sánchez-Domínguez and Rodríguez-Ferrero 2003; Zarzosa Espina and Somarriba Arechavala 2013). Thus, a higher DP_2 value indicates a higher level of development as it represents a greater distance from the "least desirable" theoretical situation. In addition, this property entails that spatial units may be ranked in terms of regional development.

In a third stage, with the view of expressing all of the indicators in comparable abstract units, a first global index is computed, the Frechet Distance (DF), which is defined as:

$$DF = \sum_{i=1}^{n} (d_i / \sigma_i) = \sum_{i=1}^{n} (|\,x_{ji} - x_{*i}\,| / \sigma_i)\ ; \qquad j = 1, 2, \ldots, m \qquad (2)$$

where σi is the standard deviation of the simple indicator i. For each indicator, the distance between two spatial units d_i is weighted by the inverse of σ_i. That is, the contribution of each d_i to the synthetic index is inversely proportional to the standard deviation of its corresponding indicator. In this way, the distances corresponding to the indicators with a higher dispersion to the mean are less important in determining the synthetic index[2]. Also, by dividing distance by σi, i.e., d_i/σ_i, the indicator is expressed in abstract units, which solves the treatment of measurement units.

[2] This weighting scheme, which is similar to those used in heteroskedastic models, accords less importance to those distances with more variability, and vice versa (Montero et al 2010, p. 444).

DF is a valid concept of distance only in a theoretical situation of uncorrelated indicators. When there is a direct relationship between the indicators (as it is usual), DF will include some duplicated information. Therefore, DF must be corrected so as to eliminate this dependence effect (i.e. the redundant information existent in other variables), which is assumed to be linear. This is why, for each spatial unit j, DF is the maximum value that DP_2 can reach, which is defined as (Pena Trapero 1977; Zarzosa Espina 1996):

$$DP_2 = \sum_{i=1}^{n} (d_i / \sigma_i)\left(1 - R^2_{i,i-1,\dots1}\right) \quad (3)$$

with $R_1^2=0$, and where $R^2_{i,i-1, \dots 1}$ is the coefficient of determination in the multiple linear regression of x_i over x_{i-1}, x_{i-2}, ... x_1, already included.

The coefficient of determination, $R^2_{i.i-1, \dots 1}$, measures the percentage of the variance of each indicator explained by the linear regression estimated using the preceding variables (x_{i-1}, x_{i-2}, ... x_1). As a result, the correction factor ($1-R^2_{i.i-1, \dots 1}$) avoids the duplication of information by eliminating the information contained in the preceding indicators. That is, as ($1-R^2_{i,i-1, \dots 1}$) expresses the part of the variance of the indicator x_i not explained by x_{i-1}, x_{i-2}, ... x_1, the part already explained by the preceding indicators is obtained by multiplying each simple indicator by the corresponding coefficient of determination $R^2_{i.i-1, \dots 1}$. Notice that R^2 is an abstract concept unrelated to the measurement units of the indicators.

The result of the DP_2 varies when the entry order of the indicators changes. In this process, the first indicator (i = 1) will contribute all of its information to the synthetic index (d_1/ σ_1). However, the second indicator (i = 2) will only add that part of its variance that is not correlated with the first indicator: $(d_2/\sigma_2)(1-R^2_{2.1})$. Similarly, the third indicator will contribute to DP_2 the part of its variance that is not correlated with either the first or the second indicators: $(d_3/\sigma_3)(1-R^2_{3.2,1})$ and so forth. It is therefore necessary to order the indicators attending to the information that each one of them contributes to the synthetic index (highest to lowest). That is, the first indicator to be included will be that which provides the greatest amount of information concerning the objective to be measured, and then so on and so forth.

We follow the ranking method proposed by Pena Trapero (1977), which is an iterative method based on the DF (2). In the fourth stage, we estimate the pairwise correlation coefficients r between each indicator and DF, and then sort the indicators from highest to lowest according to the absolute values of the pairwise correlation coefficient. Next, we calculate the first DP_2 for each region, incorporating the indicators in the resulting order. The classification of indicators is then performed by ordering them from highest to lowest in terms of the absolute value of the pairwise correlation coefficient between each indicator and the DP_2. The process continues iteratively until the difference between two adjacent DP_2s is zero. In the case of non convergent DP_2 values, one can choose the first DP_2 index or even the average of several calculates DP_2 (Zarzosa Espina 1996, p. 88).

The numerical value of the DP_2 index has no real meaning, but it is useful for comparing the state of different regions in terms of development. The results allow the ranking of regions from high to low level of development, and to identify which factors contribute the most to regional development. In addition, if the DP_2 method uses the same variables, it can compare the results for EU28 regions with those obtained for other regions or even at other points of time. DP_2 can be used to compare changes in relative positions and even to detect their causes.

The DP_2 synthetic index verifies the necessary properties for a multidimensional index to provide an acceptable measure or estimate: existence and determination, monotony, uniqueness, quantification, invariance, homogeneity, transitivity, exhaustiveness, additivity, and invariance compared to the base of reference (see Zarzosa Espina and Somarriba Arechavala 2013).

There are other approaches to aggregate the information on several indicators into a single index. The geometric mean in conjunction with the arithmetic mean is used by the HDI of the United Nations and by Biehl (1986) to quantify the EU infrastructures. The data envelopment analysis (DEA) has been used to estimate quality of life in Spanish provinces (Murias et al. 2006) and municipalities (González et al. 2012). The Principal Component Analysis (PCA) has been applied in a variety of welfare studies such as Maasoumi and Nickelsburg (1988), and Boelhouwer and Stoop (1999); and to estimate a multidimensional approach to regional inequality in the EU (Folmer and Heijman 2005).

DP_2 has some advantages over the alternative methods stated above. With respect to the geometric mean, the DP_2 method presents at least two advantages. First, whereas the DP_2 index verifies all of the necessary properties for an acceptable aggregation method, the HDI and the Biehl index do not obey uniqueness; the means, both arithmetic and geometric, are not unique to scale changes, hence they are affected by the measurement units of the variables. Second, the DP_2 method objectively assigns weights to the indicators, in the HDI all the indicators have the same weight. This is an arbitrary approach and, moreover, there is no rationale for assigning the same weight to different indicators (Folmer and Heijman, 2005, p. 342).

The primary limitation of the DEA method to elaborate a synthetic index is that it does not include a formal criterion for variables selection (Ganley and Cibin 1992). Furthermore, the DEA is very sensitive to the selection of variables (Leibstein and Maital 1992). The DP_2 method, however, incorporates an objective way for variables selection: those variables that do not provide new information on the studied phenomenon are left out of the model.

Probably, the mayor limitation of the PCA with respect to the DP_2 method is that it does not measure disparities between spatial units and/or periods of time, since it is an ordinary-type indicator (Montero et al. 2010, pp. 42-3; Somarriba and Pena 2009). So the PCA only establishes a ranking of the geographic or temporal aspects being analysed with respect to the object of study (infrastructures, development level, well-being level, etc.). In fact, this kind of analysis is usually accompanied by a distance analysis, such as the cluster analysis (see Del Campo et al. 2008). However, DP_2 is a cardinal measure, and as such it is also capable of determining how much higher/ lower is the development level in region A with respect region B.

4. Data

To elaborate the Regional Development Index (RDI), we focus on Eurostat information on the 269 regions (NUTS 2) of 28 Member States in 2009, except four regions of France for wich information is not available for all the analyzed variables (Guadeloupe, Martinique, Guyane and Réunion).

Indicators have to be chosen carefully, meeting the following criteria (Advisory Committee on Official Statistics 2009; Bell and Morse, 2003; Guy and Kibert, 1998):

- Relevance: an indicator must be relevant for an issue according to the definition used.
- Statistically sound: an indicator measurement needs to be methodologically sound and fit for the purpose to which it is being applied.

- Intelligible and easily interpreted: indicators should be sufficiently simple to be interpreted in practice and intuitively in the sense that it is obvious what the indicator is measuring.
- Relate where appropriate to other indicators: a single indicator often tends to show part of a phenomenon and is best interpreted alongside other similar indicators.
- Reliability: the data is of sufficiently reliable quality as to provide a basis for confident decision-making.
- Allow international comparison: indicators need to reflect the project specific goals, but where possible should also be consistent with those used in international indicator programs so that comparisons can be made.

Complementary, Ivanovic (1974) states that an indicator should be have a high power of discrimination, that is, its value varies in all geographical areas studied, because otherwise its contribution to regional development measurement would be reduced. To check this property, Ivanovic (1974) propose the discrimination coefficient (DC):

$$DC_i = \frac{2}{m(m-1)} \sum_{j,l>j}^{ki} m_{ji} m_{li} \left| \frac{x_{ji} - x_{li}}{\overline{X}_i} \right| \quad (4)$$

where m is the number of regions, x_{ji} is the value of indicator x_i in the region j, m_{ji} is the absolute frequency of x_{ji}, $\bar{X}_i$ is the mean of x_i, and k_i is the number of different values taken by x_i.

This coefficient ranges between 0 and 2 (Zarzosa 1996). If an indicator takes the same value for all regions, DC equals zero, indicating that this indicator holds zero discriminant power. By contrast, if an indicator only has a value other than zero for one region (and in the remainder, m - 1 is equal to zero), DC is equal to two and the indicator has full discriminant power.

Taking into account these criteria, the indicators used in the international indicators programs shown in Section 2 and the recommendations of Stiglitz et al. (2009), we have included with 16 indicators of different dimensions (Table 1). In any case, DP_2 can eliminate all the superfluous common variance selecting only that part of the information that is original. This property allows the inclusion of a great number of indicators since all useless redundant variance will be removed by the DP_2 process itself, so avoiding multicollinearity (Montero et al. 2010, p. 443).

Table 1 shows the 16 indicators: title, definition, the relation between the indicator and the index RDI (what affects RDI the increase/decrease in the indicator), rationale (why the indicator is needed and useful to measure regional performance), the international programs that use the indicator, and the discrimination coefficients of Ivanovic (1974). Those indicators positively related with regional development are incorporated into the model without change of sign, while those negatively related with regional development must be multiplied by -1 to changing the sign. Thus, the increase (decrease) in the values of any indicator indicates an improvement (worsening) in regional development (colum "Relation indicator/index", Table 1).

The comparison of the selected indicators with the criteria outlined above shows that all indicators meet most of the criteria. However there are three deviations: infant mortality, GDP per capita adjusted by the Gini index, and gender inequality employment. Infant mortality has virtually no discriminatory power (DC is very close to zero), as recorded values very close in most regions of the Member States. However it has been included because it is an indicator of poverty and child well-being included in various international programs. With respect to the second, the Report of CMEPSP (Stiglitz et al. 2009) recommends to analyse the average measure of income together with indicators that reflect it distribution. In the context of the UE, it is appropriate to include regional income inequality in the model of regional development, given that regional disparities in EU are positively correlated with personal income inequality (Montfort 2009). Also, the economic inequality (independently of the absolute level of income) is associated with a wide range of social ills, including higher rates of crime, ill-health, mortality and drug abuse (Wilkinson and Picket 2009). The indicator GDP per capita adjusted by the Gini index, proposed by Sen (1976), incorporates economic inequality, penalizing those Member States' GDP with inequality in the income distribution.

Besides income inequality, it is necessary to bring into the model other kinds of inequality, as "the extend of real inequality of opportunities that people face be readily deduced from the magnitude of inequality of incomes", because the variety of physical and social characteristics also affect people's life (Sen 1992, p. 28). In all the 269 European regions analyzed, the females employment rate is lower than that for males (in means: females = 46.53, standard deviation = 7.98; males = 59.84, standard deviation = 5.76, see Table 2); and the difference is statistically significant (ANOVA test: $F = 492.24$, $p=0.0000$). That is, what a person can do depends, to some extent, on her gender. Hence, the central capability "affiliation", pointed by Nussbaum (2011, p. 34), which would imply protection against sex-based discrimination, is not respected. The model incorporates the indicator gender inequality employment, with a negative sign, reflecting females disadvantage in employment. This indicator is equal to zero when women have the same opportunities than men, and it is equal to 1 when women do as badly as possible.

Table 1. Indicators of regional performance

Title	Definition	Relation indicator/index	Rationale	International programs that use the indicator	DC_i
1 Life expectancy	Life expectancy at the age "less than 1 year" (numbers of years)	Positive	Measure of health, although it only takes into account the length of people's life and not their quality of life. It is an indicator of social development.	HDI, OECD, EU SDS, WB	0.03
2 Death rate	Crude death rate per 100,000 inhabitants	Negative	Measure of health.	WB	0.19
3 Infant mostality	Infant mortality rate per 100,000 inhabitants	Negative	Measure of child well-being and poverty.	MPI, WB	0.00
4 Transport accident	Transport accidents. Crude death rate per 100,000 inhabitants	Negative	Measure of sustainable transport.	EU SDS	0.56
5 Youth rate	Youth rate (% population under 15 years / total population)	Positive	Contributes positively to the labor market. It is an indicator of education for the WB.	WB	0.16
6 Rate of aging	Rate of aging (% population over 65 years / total population)	Negative	It represents a risk to the sustainability of the current welfare state.	EU SDS, WB	0.20
7 Poverty	At-risk-of-poverty rate (% of total population)	Negative	Poverty represents a risk to health, a capability limitation of consume, of social connections, and of educational opportunities and employment.	EU SDS, WB	0.43
8 Males employment	Males employment rate 15 and over (%)	Positive	Work has economic benefits, helps individuals stay connected with society, build self-esteem and develop skills and competencies. Societies with high levels of employment are also richer, more	EU SDS, WB	0.11

			politically stable and healthier.		
9 Females employment	Females employment rate 15 and over (%)	Positive		EU SDS, WB	0.19
10 Gender inequality employment	Gender inequality employment [1-(female employment rate/male employment rate)]	Negative	Condition for a full and balanced development of individuals and society at large.		0.13
11 Long-term unemployment	Long-term unemployment rate (% unemployed for 12 months or longer over total unemployment)	Negative	Long-term unemployment can have a large negative effect on feelings of well-being and self-worth and result in a loss of skills, further reducing employability.	EU SDS, OECD, WB	0.34
12 Males unemployment	Males unemployment rate 15 years or over (%)	Negative	Access to the labour market is a condition for well-being for all people.	EU SDS, WB	0.48
13 Females unemployment	Females unemployment rate 15 years or over (%)	Negative		EU SDS, WB	0.54
14 Males terciary education	Males tertiary educational attainment (% age group 25-64)	Positive	Education plays a key role in providing individuals with the knowledge, skills and competences needed to participate effectively in society and in the economy. Higher educational attainment levels increase employability and reduce poverty.	EU SDS, WB	0.41
15 Females terciary education	Females tertiary educational attainment (% age group 25-64)	Positive		EU SDS, WB	0.40
16 GDP per capita adjusted	Gross Domestic Product (GDP) per inhabitant at current market prices adjusted by the Gini index [GDP per	Positive	Money is an important means to achieving higher living standards and thus greater well-being. Fair distribution of		0.53

	inhabitant*(1-Gini index)]. Gini index of income distribution in every country.		prosperity is a condition for sustainability.		

HDI: Human Development Index of United Nations Development Program.
EU SDS: Strategy of Development Sustainable of European Union.
MPI: Multidimensional Poverty Index of United Nations Development Program.
OECD: project Better Life Initiative of OECD.
WB: project Working for a World Free of Poverty of World Bank.

Source: Eurostat and the author.

Table 2 shows the descriptive statistics of the indicators.

Table 2. Descriptive statistics, 2009 (N=269)

Indicators	Mean	Standard deviation	Median	Maxim	Minimun
life	79.58	2.59	80.40	83.30	72.90
death	1.00	0.17	0.99	1.82	0.52
infant	4.07	1.84	3.70	13.20	0.00
accident	7.66	4.02	6.93	25.85	1.31
youth	15.58	2.17	15.46	21.83	10.35
aging	17.46	3.07	17.27	26.78	9.20
poverty	17.03	6.59	16.00	39.90	3.00
malemp	59.84	5.76	59.50	79.20	45.90
fememp	46.53	7.98	47.30	67.90	20.90
genderine	0.23	0.09	0.20	0.55	0.04
long	37.80	11.35	38.10	66.80	5.00
malune	8.44	3.84	7.80	25.50	1.90
femune	8.83	4.62	7.70	33.60	2.40
maledu	23.86	8.66	24.60	52.20	7.70
femedu	25.49	9.03	24.90	50.70	7.40
GDPadjusted	15,955.41	7,892.52	16,029.00	53,241.60	1,931.40

Source: Eurostat and the author.

5. Results

Based on the statistic information supplied by the 16 indicators selected for the 269 regions in the EU28, and applying the methodology of the synthetic index DP_2, we calculate the RDI to compare regional performance. Out of the 269 regions, 129 regions comprising 47.06% of the EU28's population are in 2009 below the EU average RDI (24.16). To obtain the mean EU28 RDI, the weighted arithmetic mean of the RDI is the sum of the DP2 value for each region multiplied by the region relative population with

respect to the total population of all of the analysed regions : μ=□piDP_2 (Pena Trapero 1977, pp. 201-220).

In addition, a Principal components analysis (PCA) was carried out to obtain an alternative estimate to the RDI. The 16 indicators chosen passed the suitability test; that is, they are sufficiently related to warrant inclusion in a synthetic index (measure of Sampling Adequacy KMO=0.631, and p=0.000 in Bartlett's test of sphericity; N=269). Using PCA, we take as synthetic index RDI the first factor or component that explains the 35% of the variance.

With both methods, Stockholm in Sweden is the most developed region in 2009; in contrast, Severozapaden in Bulgaria is the least developed región in 2009. Based on the DP_2' additivity property[3], it can be inferred that the most developed region -Stockholm with a RDI equal to 36.02- triples that of the least developed region –Severozapaden with a RDI equal to 11.09-, showing the existence of large territorial disparities on the analysed indicators. Bulgary's low level of economic and social development is confirmed; five out of the six Bulgarian regions belong to the group of the 15 least developed regions in EU. Except for Sicily in Italy and two other regions in Greece, the remaining 15 least developed regions are in Eastern Europe.

For the 269 regions, the Spearman´s rank correlation coefficient between the RDI resulting from DP_2 and PCA is equal to 0.9926 (p=0.0000, N=269); that is, the ranking of regions in terms of regional performance obtained through DP_2 and PCA is basically the same. When comparing the ranking of regions between the RDI and the GDP per capita, one observes a lower, though also high, correlation (between GDP per

[3] Additivity (Zarzosa Espina and Somarriba Arechavala 2013): The distance index defined for the comparison between the two territorial/temporary units has to be such that the difference obtained between them directly by the distance indicator is equal to which would be obtained comparing the synthetic indices of each territorial/temporary unit.

capita and the RDI calculated viaDP_2: rho = 0.8009, p = 0.0000; between GDP per capita and the RDI calculated via PCA: rho = 0.7743, p = 0.0000).

Table 3 shows the 16 indicators ranked according to their correlation with the first PCA component, and by entry order in the DP_2, the weight or correction factor (1-R^2) of each one of them, the absolute value of the pairwise correlation and the p-values. The p-values show that, in the DP_2 method, all of the indicators have a statistically significant relationship at the 1% level with the RDI, except for *aging* (p=0.0251). Specifically, the correlation values of the RDI are, respectively: 0.8154 with female employment; 0.7735 with GDP per capita adjusted; 0.7499 with male employment; etc.

Table 3. Mains results of DP_2 and PCA computations for RDI (N=269)

Indicators	Ranking PCA	Ranking DP_2	Correction factor DP^2 (1-R^2)	Correlation coefficient |r| DP_2 (p-value)
fememp	1	1	1.0000	0.8154 (0.000)
GDPadjusted	4	2	0.7819	0.7735 (0.000)
malemp	3	3	0.3929	0.7499 (0.000)
maledu	2	4	0.4990	0.7206 (0.000)
long	6	5	0.6415	0.6216 (0.000)
death	10	6	0.6184	0.5990 (0.000)
accident	9	7	0.6116	0.5896 (0.000)
genderine	5	8	0.0103	0.5787 (0.000)
life	11	9	0.4822	0.5725 (0.000)
femune	7	10	0.4663	0.5509 (0.000)
femedu	8	11	0.2496	0.5385 (0.000)
poverty	12	12	0.5834	0.5107 (0.000)
infant	13	13	0.3705	0.4976 (0.000)
youth	15	14	0.4910	0.4161 (0.000)
malune	14	15	0.1614	0.3851 (0.000)
aging	16	16	0.0459	0.1366 (0.0251)

Fuente: the author.

Following both methods, the indicator most correlated with the composite index of regional performance is the female employment rate, and the least correlated is the rate of aging. The group of the four most influential factors of regional performance includes, besides female employment, adjusted GDP per capita, male unemployment, and male education. This implies that, despite the GDP per capita limitations as unique indicator of development or wellbeing, families' income and employment are the most influential aspects on human development in the studied regions.

In the DP_2 method, as R^2 measures the information of each indicator that has already been explained by the preceding indicators, an indicator's correction factor ($1-R^2$) captures the new information explained by this indicator. For example, the correction factor of the indicator adjusted GDP per capita is 0.7819 because, approximately, the 31.81% of this indicator's information has already been explained by the preceding indicator, female employment. Another example is youth that, with a correction factor equal to 0.4910 and despite having the 14th order in the ranking, incorporates, approximately, a 49% of new information not supplied by the 13 preceding indicators.

6. Discussion and regional policy implications

The synthetic indicator derived from PCA is exclusively an ordinal indicator, so it does not allow to make inter-spatial or inter-temporary comparisons, only ordinal comparisons. Additionally, this procedure does not take into account all the non-redundant information as it only explains the variance in the first component (35% in this case) and can therefore remove useful information in the synthetic indicator (Montero et al. 2010; Somarriba and Pena 2009). On the basis of the PCA limitations with respect to the DP_2, in this section we will only consider the RDI obtained via DP_2.

Following the orthodox Structural Funds allocation mechanism, 75 regions of the EU28 are classified as priority regions because their 2009 GDP per capita falls below the 75% of the community average. This implies that a population equivalent to the 28.97% of the total EU28 population is susceptible of Structural Funds support. Now, the RDI could be the allocation mechanism of the Structural Funds by choosing a threshold such that a similar percentage of population would be covered. That is, one could select the least developed regions in terms of the RDI until encompassing, approximately, the 28.97% of the EU28 population. Following this method, 84 regions with an RDI below a value of 21.84 (equivalent to the 90.37% of the EU average RDI), representing the 28.76% of the total EU28 population, would be recipients of the Structural Funds.

Comparing the two allocation mechanisms of the Structural Funds, the percentage of population benefited would be similar, but with the RDI more regions would be covered (84 instead of 75) and located in different Member States. More specifically, only 15 out of all of the regions that do not achieve the threshold of the 75% of the EU average GDP per capita would surpass the 90.37% of the EU average RDI (see Table 4). These 15 regions –primarily located in Member States of the previous Eastern Europe-, representing the 6% of the EU28 total population, would be negatively affected by this change in the rules of the game. However, 24 regions of the old and Mediterranean Europe would be positively affected since, despite surpassing the 75% of the EU average GDP per capita, have lower levels of regional performance in RDI terms than other regions with lower GDP per capita (Table 5). Thus, following the threshold of the 90.37% of the EU average RDI as allocation criterion, three regions of Belgium, two regions of France, three regions of Germany, three regions of Greece, six regions of Italy and seven regions of Spain, encompassing altogether the 5.80% of the total EU28 population, could be considered priority regions.

Table 4. Regions with RDI greater than 90.37% EU28 average RDI and GDP per capita lower 75% EU28 average GDP per capita

Region (Member State)	RDI	GDP per capita *
Yugozapaden (Bulgaria)	22.20	7.900
Strední Cechy (Czech Republic)	24.03	12.100
Jihozápad (Czech Republic)	23.47	11.600
Severovýchod (Czech Republic)	22.71	10.900
Jihovýchod (Czech Republic)	23.38	12.200

Észak-Magyarország (Hungary)	22.35	15.300
Mazowieckie (Poland)	23.49	13.000
Pomorskie (Poland)	22.09	7.900
Norte (Portugal)	22.59	12.600
Centro (Portugal)	22.19	13.200
Região Autónoma dos Açores (Portugal)	22.41	14.900
Bucuresti – Ilfov (Romania)	24.49	13.000
Vzhodna Slovenija (Slovenia)	23.03	14.200
Cornwall and Isles of Scilly (United Kingdom)	24.88	16.500
West Wales and The Valleys (United Kingdom)	24.15	15.700
90.37% EU28 average RDI	21.84	
75% EU28 average GDP per capita		17,536.29

*Euros at current market prices.
Source: Eurostat and the author.

Table 5. Regions with RDI lower 90.37% EU28 average RDI and GDP per capita greater than 75% EU28 average GDP per capita

Region (Member State)	RDI	Per capita GDP*
Prov. Hainaut (Belgium)	18.63	20.600
Prov. Liège (Belgium)	21.26	23.700
Prov. Luxembourg (Belgium)	21.59	21.400
Languedoc-Roussillon (France)	21.43	23.300
Corse (France)	18.95	24.400
Mecklenburg-Vorpommern (Germany)	20.55	27.900
Chemnitz (NUTS 2006) (Germany)	20.78	28.800
Sachsen-Anhalt (Germany)	19.55	28.200
Dytiki Makedonia (Greece)	18.13	21.200
Ionia Nisia (Greece)	20.43	20.900
Sterea Ellada (Greece)	15.57	21.100
Liguria (Italy)	21.83	27.100
Umbria (NUTS 2006) (Italy)	21.61	23.400
Abruzzo (Italy)	19.58	21.000
Molise (Italy)	17.82	20.500
Basilicata (Italy)	16.45	18.300
Sardegna (Italy)	18.65	19.500
Galicia (Spain)	21.65	20.500
Principado de Asturias (Spain)	21.43	21.200
Castilla y León (Spain)	21.45	21.900
Castilla-La Mancha (Spain)	20.58	18.500
Ciudad Autónoma de Ceuta (Spain)	19.49	20.700
Ciudad Autónoma de Melilla (Spain)	18.82	19.100
Canarias (Spain)	20.98	19.300
90.37% EU28 average RDI	21.84	
75% EU28 average GDP per capita		17,536.29

*Euros at current market prices.
Source: Eurostat and the author.

That is, since the RDI has been constructed taking into account the most recent trends in development and wellbeing and, in addition, incorporates some of the targets set out by the Europe 2020 Strategy (European Commission 2010) to exit stronger from the economic crisis (for instance, employment, education and poverty), the RDI resulting map of priority regions is more linked to the actual reality or development of the regions immersed in the economic crisis than the GDP per capita map.

The differences in the map of priority regions could be a source of debate on the introduction of new game rules in terms of community regional policy. Specially so in the current institutional context in which the European Commission and the European Council co-decide or co-legislate at the same level everything relative to the Structural and Cohesion Funds; and, moreover, accounting for the predictable reduction in the EU budget for the nex period 2014-2020[4].

5. Conclusions

Despite European Union objectives for economic and social cohesion, current measures of regional development are defined in a strictly economic sense, reflecting the separation in policy and academia between economic and social issues. Taking into consideration the GDP per capita limitations as a unique indicator of development, wellbeing or social progress, this paper constructs a measure of regional development (RDI) for the EU28 regions via two distinct methodologies (DP_2 and PCA), and contrasts the results with orthodox GDP measures. To construct the RDI, we have considered information on the economic and social dimensions that affect the development of societies (Stiglitz et al. 2009), as well as inequalities in income and gender (Nussbaum 2000; Sen 1992).

[4] The Multiannual Financial Frame 2007-2013, reports commitment appropriations that amount to the 1.048% of Gross Nacional Income (GNI), and, approximately the 35.64% of that total is devoted to regional development policy. (European Commission, Financial Programming and Budget). The next Multiannual Financial Frame 2014-2020 agreed by the European Council in february 2013 diminishes the commitment appropriations to the 1% of GNI; and plans devoting the 33.88% of the EU28 budget to economic, social and territorial cohesion (European Council 2013).

Both methods, DP_2 and PCA, imply that the most influential indicators on the regional development index are female employment, adjusted GDP per capita, male employment, and male education. The RDI results via DP_2 show that, in 2009, inequalities between the most and the least developed regions are very high (more than triple). The most developed region is Stockholm in Sweden (RDI=36.02), and the least developed region is Severozapaden in Bulgaria (RDI=11.09).

The regional rankings obtained from both DP_2 and PCA RDI are basically the same, whereas sensible differences arise with respect to the ranking obtained via GDP per capita.

Implementing the RDI –via DP_2 method- as allocation mechanism of the structural funds, instead of the GDP per capita, and with an equivalent budgetary effort regarding the population benefited from these funds, a distinct map of priority regions results. Specifically, a reference threshold of the 90.37% of the RDI, instead of the 75% of the GDP per capita, benefits the same percentage of the total population (approximately the 29% of the EU28 total population), does not benefit 15 regions mainly located in the previous Eastern Europe, and does benefit 24 regions located in Belgium, France, Germany, Greece, Italy and Spain. This change in the rules of the game would affect about the 6% of the EU28 population, but would probably imply an EU decision making mechanism in agreement with criteria more linked to the complexity of the economic and social development.

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