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# Composite Indicator of Social Inclusion for the EU Countries

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## Abstract

Social inclusion is one of the key challenges of the European Union Sustainable Development Strategy (EU SDS). We use the main indicators identified by Eurostat within the operational objectives of the specific European policies to measure social inclusion for the 27 member countries of the European Union. In particular, we aggregate four basic indicators in a multiplicative composite indicator via a DEA-BoD approach with weights determined endogenously with proportion constraints. We obtain a score of social inclusion that allows us to grade the 27 EU countries from 2006 to 2010. In this way, we highlight the specific role played by the four indicators in determining improvements and deteriorations of social inclusion during the European phase of the financial and economic crisis.

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## 1 Introduction

The European Commission defines social inclusion as “a process which ensures that those at risk of poverty and social exclusion gain the opportunities and resources necessary to participate fully in economic, social and cultural life and to enjoy a standard of living and well-being that is considered normal in the society in which they live. It ensures that they have a greater participation in decision making which affects their lives and access to their fundamental rights” [1, p. 10]. Social inclusion is, therefore, complementary concept to social exclusion, that is: “a process

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whereby certain individuals are pushed to the edge of society and prevented from participating fully by virtue of their poverty, or lack of basic competencies and lifelong learning opportunities, or as a result of discrimination. This distances them from job, income and education and training opportunities, as well as social and community networks and activities. They have little access to power and decision making bodies and thus feel powerless and unable to take control over the decisions that affect their day to day lives” [1, p. 10]. Multidimensionality of the social inclusion concept is evident. This complexity is manifested in the use of multiple measures. For example, the Lisbon European Council already in 2000 has suggested the use of a set of indicators to measure progress in relation to poverty and social exclusion [2]. The theme and its measurement is highly topical; it represents one of the key challenges of the European Union Sustainable Development Strategy (EU SDS) in order to achieve a socially inclusive society, to increase the quality of life of citizens and individual well-being. In particular, reduction of poverty and reduction of social exclusion is one of the five main targets of “Europe 2020”, that is, the EU’s strategy for a sustainable and inclusive growth for the next years [3].

In line with this strategy, the European debate has focused on four main pillars or dimensions from which derive four specific policy actions for a higher social inclusion of individuals: (a) reduction of monetary poverty; (b) improvement of living conditions; (c) greater access to labour markets and (d) better education [4–7]. However, in order to monitor levels, deteriorations and improvements of social inclusion in Europe, it appears useful to identify a single measure that can summarize these four pillars to determine a ranking of countries and, consequently, to compare the intensity of social inclusion. For this purpose, we construct a composite indicator of social inclusion at macro level for the 27 member countries of the European Union by aggregating the pillars represented, each, by one specific basic indicator related to the operational objectives and targets (so-called level 2) of the European policies identified by Eurostat [6, 8]. These four indicators are listed below.

- 1(pove). People at risk of poverty after social transfers (percentage of total population). This indicator measures the share of persons at risk of monetary poverty. Persons are at risk of poverty if their equivalized disposable income is below the risk-of-poverty threshold, which is set at 60 % of the national median after social transfers.
- 2(depr). Severely materially deprived people (percentage of total population). It covers issues relating to economic strain and durables. Severely materially deprived persons have living conditions greatly constrained by a lack of resources and cannot afford at least four of the following: to pay rent or utility bills; to keep their home adequately warm; to pay unexpected expenses; to eat meat, fish or a protein equivalent every second day; a week holiday away from home; a car; a washing machine; a colour TV or a telephone.

- 3(work). People living in households with very low work intensity (percentage of total population). Persons are defined as living in households with very low work intensity if they are aged 0–59 and the working age members in the household worked less than 20 % of their potential during the past year.
- 4(educ). Early school leavers (percentage of total). It is defined as the percentage of the population aged 18–24 with at most lower secondary education and not in further education or training.<sup>1</sup>

Synthesis of the four indicators in a single measurement of social inclusion appears of great relevance to provide a unique information about the status of the country and to identify directions for improvement in the light of the European policies. Anyhow, aggregation of indicators is not a trivial issue and, still, the best choice of the weights is a topic of interest. Literature proposes two main type of aggregation, additive and multiplicative, and several weighting methods such as equal weights, weights based on statistical models and weights based on public/expert opinion [10]. For our goals, a multiplicative DEA-like model in a benefit-of-doubt (BoD) approach seems the most appropriate alternative. In effect, this method allows varying weights determined endogenously according to an optimal solution looking for the best possible outcome for the country under analysis. In our case, this implies that the composite indicator of social inclusion combines the four sub-indicators in the best interest of the country. Of course, this does not mean that the obtained weighting, certainly optimal from a mathematical point of view, is also optimal from the point of view of politics, but it is certainly independent from subjective experiences of the decision maker.

Finally, the composite indicator of social inclusion is calculated over the years 2006–2010, the longest available period at the time of writing without missing data or data breaks for all the 27 EU countries, precisely: Austria (AT), Belgium (BE), Bulgaria (BG), Cyprus (CY), Czech Republic (CZ), Germany (DE), Denmark (DK), Estonia (EE), Greece (EL), Spain (ES), Finland (FI), France (FR), Hungary (HU), Ireland (IE), Italy (IT), Lithuania (LT), Luxembourg (LU), Latvia (LV), Malta (MT), Netherlands (NL), Poland (PL), Portugal (PT), Romania (RO), Sweden (SE), Slovenia (SI), Slovakia (SK) and United Kingdom (UK). Interestingly, this period covers the severe phase of the financial and economic crisis in Europe.

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<sup>1</sup>We note that although the multidimensional nature of social inclusion is widely shared, some dimensions are neglected in the time of measurement. In effect, EU social indicators are much better developed for poverty, material deprivation, labour market and level of education than for political or cultural dimensions [9]. However, the use of the same four basic indicators selected by Eurostat allows us to maintain a strong connection with the objectives set by the European strategies and allows us an easy comparability of the results.

## 2 Multiplicative Composite Indicator

The construction of a composite indicator is not a trivial argument. The advantage of an immediate synthesis presents also some disadvantages and risks. Synthesis, inevitably, reduces information and, often, uses subjective options open to criticism. However, in many cases, it may represent a very useful tool to provide a clear view of analysis for defining appropriate policies.<sup>2</sup> The weighted arithmetic mean

$\sum_{j=1}^n w_j I_{ij}$  is the easiest way to create a composite indicator, though the traditional

additive approach shows some important limitations. An undesirable feature of additive aggregations is the full compensability that they imply, since low values in some dimensions can be compensated by high values in other dimensions. On the contrary, the geometric aggregation is a less compensatory approach, and it offers better incentives to countries to improve underperforming dimensions. In fact, marginal utility on the multiplicative composite indicator is higher if the indicator value is low, this reflecting the auspices of the European policy for a progressive improvement of all the dimensions of social inclusion [10].<sup>3</sup> With this primary motivation, we use a weighted product method in construction of the composite indicator of social inclusion ( $SI$ ), formulated as

$$SI_i = \prod_{j=1}^n I_{ij}^{w_j} \quad (1)$$

where  $I_{ij}$  is the  $j$ -th basic indicator of social inclusion ( $j = 1, \dots, n$ ) for the  $i$ -th country ( $i = 1, \dots, m$ ) with weight  $w_j$ . Here,  $n = 4$  and  $m = 27$ .  $SI_i$  looks like a geometric mean.<sup>4</sup>

<sup>2</sup>Many composite indicators exist in literature with varying degrees of methodological complexity. For example, the “Corruption Perceptions Index” by Transparency International [11], the “Human Development Index” by UN [12], the “Composite Leading Indicators” by OECD [13] and so on. A good starting point on the issue is OECD [10].

<sup>3</sup>Geometric aggregation is a good compromise between methods with full compensability and non-compensatory approaches, for example, MCDA (Multiple-Criteria Decision Analysis) [14]. In general terms, geometric aggregation is preferable to approaches MCDA because it can lead to the minimum information loss [15]. Furthermore, using the social choice theory, Ebert and Welsch [16] found that geometric aggregation is particularly relevant in composite indicator construction when the ordinal information is involved.

<sup>4</sup>With multiplicative aggregation, the sub-indicators must be larger than 1 otherwise the logarithmic transformation obtains negative values. Therefore, it is necessary to normalize the data of the four basic indicators extracted from Eurostat. In particular, we use a min–max transformation in a continuous scale from 2 (minimum) to 10 (maximum) where higher values correspond to better social inclusion. In other words, we apply the transformation:  $(\max(y) - y) / (\max(y) - \min(y)) \cdot 8 + 2$ . Furthermore, we note that in this way the direction of the sub-indicators is reversed so that higher values represent, in more intuitive terms, greater social inclusion and not greater social exclusion as in the original scale of the Eurostat indicators. For our purposes, given the techniques used here, this does not distort the final result as it will be clear later. Finally, it should be noted

Anyhow, results can depend strongly on the selected weights. To avoid subjective choices easily criticized, in this paper the weights  $w_j$  are determined endogenously with an automatic mechanism based on a multiplicative optimization model similar to a DEA-BoD model written as follows:

$$\begin{aligned}
 SI_i &= \max_w \prod_{j=1}^n I_{ij}^{w_j} \\
 \text{s.t.} & \\
 \prod_{j=1}^n I_{ij}^{w_j} &\leq e \\
 w_j &\geq 0
 \end{aligned} \tag{2}$$

where  $e$  is the Napier's constant [17–19].<sup>5</sup>

In this way, the composite indicator is obtained by multiplying the four basic indicators of social inclusion with weights calculated in the best possible conditions, i.e. increasing as much as possible the composite score of social inclusion for a given country.<sup>6</sup> In short, a low value of the composite indicator  $SI_i$ , then low social inclusion for the  $i$ -th country, is due to low values of the indicators that compose it and not attributable to specific weights, always calculated to obtain the best, i.e. maximum, possible result for the  $i$ -th country compared to the benchmark country. In fact, the composite indicator is defined as the ratio of a country's actual performance to its benchmark performance and its maximum score is at most equal to  $e = 2.718281828$ .<sup>7</sup>

Searching for the best values, the optimization problem could give zero weight to some indicators and attribute too much weight to other indicators (curse of dimensionality): this is not desirable if all the four dimensions are theoretically relevant. Besides, this involves no unique ranking and, in some special cases, no

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immediately that correlations among the four sub-indicators are moderate; in fact, there is no risk of double-counting: this is an ideal condition in the construction of a composite indicator.

<sup>5</sup>The Benefit-of-the-Doubt (BoD) logic assumes a favourable judgement in the absence of full evidence using a model similar to Data Envelopment Analysis (DEA) [20]. In fact, we are not sure about the appropriate weights, rather we look for BoD weights such that the country's performance of social inclusion is as high as possible [21, 22, 18, 17, 23, 24, 25, 26, 27, 28]. In brief, model (2) is like an output-oriented DEA model where indicators  $y$  are outputs and a variable always equal to one is the only input: it is the Koopmans "helmsman", by which countries have an apparatus responsible for the conduct of their social policies [29]. Therefore, the social inclusion performance is evaluated in terms of the ability of the helmsman in each country to maximize the levels of the four basic indicators (obviously normalized in terms of social inclusion) [30].

<sup>6</sup>It should be noted that DEA typically does not require normalization of the data, made here for the unique needs of greater convenience of analysis. It is not even mandatory that the unit of measurement is identical, since the weights take into account the unit of measurement of the sub-indicators [30].

<sup>7</sup>This means a preference for an internal benchmark as the best practice country, rather than an external benchmark that could not be realistically achievable in specific local contexts.

feasible solution. For these reasons, we add specific constraints on the weights; in particular, we add proportion constraints to the model (2):

$$\left( \prod_{j=1}^n I_{ij}^{w_j} \right)^L \leq I_{ij}^{w_j} \leq \left( \prod_{j=1}^n I_{ij}^{w_j} \right)^U \quad (3)$$

where  $L$  and  $U$ , ranging between 0 and 1, represent the lower and upper bound for the contribution (in percentage terms) of the  $j$ -th sub-indicator [17].<sup>8</sup> To avoid zero weights, we impose  $L = 20\%$  with  $U$  determined accordingly for all the 27 countries and the four sub-indicators.<sup>9</sup> Different limits do not give solution to the mathematical problem or lead to an excessive number of benchmark countries or, also, to an unjustifiable imbalance of the indicators' role.

We note that the multiplicative optimization problem (2) and (3) is nonlinear, then we solve the equivalent linear problem by taking logarithms with base  $e$ ; at the end, it is easy to obtain the original multiplicative indicator  $SI$ . If social inclusion is higher,  $SI$  value is higher, where  $SI = e$  indicates the benchmark country. We remark that the maximum score is always  $e$ , but the empirical minimum can change; so, for easy and accurate comparison, the scores are normalized by their range of variation.

### 3 Results

Table 1 shows the social inclusion ( $SI$ ) score for the 27 EU countries over the years 2006–2010. For reasons of easy comparability,  $SI$  is normalized by its range; therefore, the score is now between 0 (the lowest level of social inclusion) and 1 (the maximum level of social inclusion, i.e. benchmark country). For convenience of the reader, here is also shown the additive case and the simple arithmetic mean without weights, but for the sake of brevity we focus only on the multiplicative scores. In detail, Table 2 shows the final multiplicative scores and their decomposition in the four sub-indicators of social inclusion just at the beginning and at the end of the period.

<sup>8</sup>Without constraints on the weights, the DEA model could reset the contribution of the underperforming dimensions to find the best solution. Thus, the results could depend even on a single indicator and, consequently, we could have a large number of insignificant benchmarks. This event occurs more likely when the sample is not large as in our case. Specific constraints on the weights and use of a few indicators, compared to the number of countries, avoid this “curse of dimensionality” [20]. Here, in particular, we use proportion constraints which offer a very intuitive interpretation that we consider preferable to the available alternatives such as absolute, relative or ordinal restrictions.

<sup>9</sup>For example, if in a given country three indicators reach the minimum contribution of 20%, the contribution of the fourth indicator will necessarily have an upper bound of 40%. In fact, the specification of the upper bound is not necessary since the sum of the contributions of the four indicators must be 100%.

**Table 1** Normalized social inclusion scores for the EU countries (2006–2010)

Countries	Multiplicative aggregation				Additive aggregation				Arithmetic mean									
	2006	2007	2008	2009	2010	+/-	2006	2007	2008	2009	2010	+/-	2006	2007	2008	2009	2010	+/-
AT: Austria	0.944	0.941	0.890	0.921	0.928	-	0.925	0.919	0.854	0.893	0.898	-	0.893	0.899	0.800	0.827	0.830	-
BE: Belgium	0.423	0.632	0.577	0.739	0.750	+	0.388	0.565	0.490	0.665	0.671	+	0.544	0.611	0.500	0.549	0.543	-
BG: Bulgaria	0.000	0.000	0.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.020	+
CY: Cyprus	0.955	0.943	0.913	0.874	0.791	-	0.921	0.915	0.880	0.825	0.718	-	0.844	0.861	0.808	0.732	0.636	-
CZ: Czech Republic	0.970	0.991	1.000	1.000	1.000	+	0.964	0.988	1.000	1.000	1.000	+	0.944	0.976	1.000	1.000	1.000	+
DE: Germany	0.586	0.772	0.584	0.759	0.756	+	0.537	0.709	0.497	0.687	0.676	+	0.631	0.687	0.494	0.567	0.561	-
DK: Denmark	0.921	0.880	0.897	0.883	0.862	-	0.899	0.842	0.866	0.842	0.809	-	0.880	0.826	0.809	0.744	0.703	-
EE: Estonia	0.809	0.782	0.775	0.694	0.731	-	0.748	0.714	0.705	0.604	0.648	-	0.707	0.717	0.677	0.553	0.554	-
EL: Greece	0.671	0.686	0.622	0.645	0.423	-	0.585	0.601	0.533	0.548	0.335	-	0.553	0.597	0.454	0.456	0.365	-
ES: Spain	0.617	0.590	0.466	0.412	0.242	-	0.514	0.491	0.355	0.303	0.169	-	0.526	0.540	0.380	0.276	0.178	-
FI: Finland	0.919	0.921	0.919	0.883	0.889	-	0.894	0.894	0.890	0.840	0.844	-	0.862	0.871	0.831	0.749	0.749	-
FR: France	0.877	0.868	0.838	0.850	0.825	-	0.839	0.827	0.789	0.800	0.764	-	0.794	0.798	0.728	0.702	0.652	-
HU: Hungary	0.548	0.766	0.493	0.662	0.662	+	0.473	0.702	0.412	0.576	0.575	+	0.455	0.674	0.404	0.458	0.460	+
IE: Ireland	0.587	0.574	0.138	0.121	0.173	-	0.516	0.505	0.160	0.147	0.165	-	0.515	0.562	0.385	0.283	0.216	-
IT: Italy	0.620	0.651	0.571	0.636	0.570	-	0.530	0.564	0.485	0.536	0.462	-	0.449	0.520	0.338	0.398	0.358	-
LT: Lithuania	0.677	0.799	0.755	0.611	0.371	-	0.591	0.733	0.693	0.513	0.285	-	0.541	0.723	0.681	0.458	0.294	-
LU: Luxembourg	0.989	0.989	1.000	0.924	0.934	-	0.974	0.982	1.000	0.892	0.900	-	0.926	0.954	0.957	0.831	0.863	-
LV: Latvia	0.478	0.640	0.119	0.063	0.074	-	0.393	0.549	0.121	0.060	0.048	-	0.389	0.539	0.301	0.150	0.000	-
MT: Malta	0.269	0.291	0.110	0.096	0.178	-	0.249	0.273	0.117	0.100	0.160	-	0.453	0.484	0.299	0.253	0.262	-
NL: Netherlands	0.878	0.927	0.944	0.932	0.970	+	0.848	0.905	0.925	0.907	0.954	+	0.846	0.900	0.883	0.826	0.888	+
PL: Poland	0.567	0.762	0.754	0.768	0.673	+	0.484	0.697	0.684	0.697	0.581	+	0.431	0.644	0.593	0.615	0.546	+
PT: Portugal	0.313	0.373	0.299	0.418	0.457	+	0.261	0.311	0.220	0.310	0.340	+	0.398	0.443	0.265	0.258	0.241	-
RO: Romania	0.208	0.227	0.207	0.291	0.082	-	0.183	0.198	0.122	0.186	0.049	-	0.210	0.277	0.021	0.047	0.022	-

(continued)

**Table 1** (continued)

Countries	Multiplicative aggregation					Additive aggregation					Arithmetic mean							
	2006	2007	2008	2009	2010	+/-	2006	2007	2008	2009	2010	+/-	2006	2007	2008	2009	2010	+/-
SE: Sweden	0.971	1.000	1.000	0.931	0.953	-	0.957	1.000	1.000	0.902	0.927	-	0.927	0.995	0.966	0.828	0.865	-
SI: Slovenia	1.000	1.000	0.976	0.974	0.925	-	1.000	1.000	0.962	0.963	0.894	-	1.000	1.000	0.935	0.935	0.853	-
SK: Slovakia	0.971	0.987	1.000	0.948	0.890	-	0.953	0.978	1.000	0.930	0.852	-	0.919	0.963	0.981	0.889	0.785	-
UK: United Kingdom	0.638	0.716	0.584	0.651	0.639	+	0.564	0.638	0.499	0.558	0.538	-	0.543	0.595	0.385	0.411	0.409	-
Mean	0.682	0.730	0.646	0.655	0.620	-	0.637	0.685	0.602	0.603	0.565	-	0.636	0.691	0.588	0.548	0.513	-
Median	0.671	0.772	0.754	0.739	0.731	+	0.585	0.709	0.684	0.665	0.648	+	0.553	0.687	0.593	0.553	0.546	-
Std. deviation	0.269	0.254	0.315	0.301	0.312	+	0.278	0.262	0.320	0.301	0.313	+	0.249	0.233	0.288	0.273	0.288	+
Coeff. of variation	0.395	0.348	0.487	0.460	0.503	+	0.437	0.383	0.532	0.500	0.554	+	0.392	0.337	0.490	0.499	0.561	+



**Table 2** Multiplicative social inclusion scores and decomposition for the EU countries (2006 and 2010)

Countries	Multiplicative scores (year 2006)					Multiplicative scores (year 2010)				
	1. Povc	2. Depr	3. Work	4. Educ	Score	1. Povc	2. Depr	3. Work	4. Educ	Score
AT: Austria	1.216	1.479	1.216	1.216	2.659	1.215	1.476	1.215	1.215	2.649
BE: Belgium	1.161	1.273	1.161	1.230	2.110	1.199	1.437	1.199	1.199	2.476
BG: Bulgaria	1.107	1.107	1.107	1.226	1.664	1.118	1.118	1.250	1.118	1.748
CY: Cyprus	1.217	1.217	1.481	1.217	2.670	1.203	1.203	1.446	1.203	2.516
CZ: Czech Republic	1.485	1.219	1.219	1.219	2.687	1.221	1.221	1.221	1.492	2.718
DE: Germany	1.208	1.358	1.179	1.179	2.282	1.199	1.438	1.199	1.199	2.482
DK: Denmark	1.214	1.473	1.214	1.214	2.635	1.209	1.462	1.209	1.209	2.585
EE: Estonia	1.203	1.203	1.447	1.203	2.517	1.197	1.433	1.197	1.197	2.457
EL: Greece	1.188	1.412	1.188	1.188	2.371	1.166	1.166	1.360	1.166	2.158
ES: Spain	1.183	1.183	1.399	1.183	2.314	1.147	1.315	1.147	1.147	1.983
FI: Finland	1.214	1.473	1.214	1.214	2.633	1.212	1.468	1.212	1.212	2.610
FR: France	1.210	1.463	1.210	1.210	2.589	1.206	1.454	1.206	1.206	2.548
HU: Hungary	1.175	1.175	1.175	1.381	2.242	1.190	1.190	1.190	1.417	2.391
IE: Ireland	1.179	1.391	1.179	1.179	2.283	1.139	1.297	1.139	1.139	1.916
IT: Italy	1.183	1.400	1.183	1.183	2.318	1.181	1.396	1.181	1.181	2.301
LT: Lithuania	1.189	1.189	1.189	1.414	2.377	1.161	1.161	1.161	1.348	2.108
LU: Luxembourg	1.220	1.220	1.489	1.220	2.707	1.216	1.478	1.216	1.216	2.655
LV: Latvia	1.167	1.167	1.363	1.167	2.168	1.127	1.127	1.127	1.271	1.820
MT: Malta	1.143	1.306	1.143	1.143	1.948	1.139	1.298	1.139	1.139	1.920
NL: Netherlands	1.463	1.210	1.210	1.210	2.590	1.219	1.485	1.219	1.219	2.689

(continued)

**Table 2** (continued)

Countries	Multiplicative scores (year 2006)				Multiplicative scores (year 2010)				Score	
	1. Pove	2. Depr	3. Work	4. Educ	1. Pove	2. Depr	3. Work	4. Educ		
PL: Poland	1.177	1.177	1.177	1.386	1.191	1.191	1.191	1.420	2.262	2.401
PT: Portugal	1.148	1.148	1.318	1.148	1.170	1.369	1.170	1.170	1.994	2.191
RO: Romania	1.135	1.135	1.288	1.135	1.128	1.128	1.273	1.128	1.883	1.828
SE: Sweden	1.219	1.485	1.219	1.219	1.217	1.482	1.217	1.217	2.688	2.673
SI: Slovenia	1.221	1.221	1.221	1.492	1.215	1.476	1.215	1.215	2.718	2.645
SK: Slovakia	1.222	1.219	1.480	1.219	1.212	1.212	1.212	1.468	2.687	2.612
UK: United Kingdom	1.185	1.404	1.185	1.185	1.188	1.412	1.188	1.188	2.337	2.368

In general terms, between 2006 and 2010, only a few countries appear closer to their benchmark of social inclusion (see, sign + in Table 1). This is enough to raise median of *SI* from 0.671 in 2006 to 0.731 in 2010. However, also variability (coefficient of variation) increases from 0.395 to 0.503, indicating a higher dispersion of the scores with a relative worsening in some countries (mean is reduced from 0.682 to 0.620). Bulgaria occupies the last position in all the years due to poor performances of the four dimensions of social inclusion. Conversely, in 2006, we have Slovenia in the first position (low levels of poverty and school leavers) whereas, in 2007, the leadership is divided between Slovenia and Sweden (especially for their low levels of poverty).

In 2008, the best countries are three: Czech Republic, Sweden and Slovakia (once again, the low levels of poverty and school leavers play an important role). From this moment on, Czech Republic will be the only benchmark in 2009 and 2010. From 2006 to 2010, only 8 countries are closer to the benchmark, in particular, Belgium (from 0.423 to 0.750, with a strong improvement of the materially deprived people). Differently, it is interesting to note a substantial (relative) worsening in Ireland (from 0.587 to 0.173), Latvia (from 0.478 to 0.074), Spain (from 0.617 to 0.242), Lithuania (from 0.677 to 0.371) and Greece (from 0.671 to 0.423). In short, Lithuania loses 8 positions (from 13 to 21), Greece and Ireland lose 6 positions (from 14 to 20 and from 18 to 24, respectively), whereas Belgium gains 10 positions (from 23 to 13) and the Netherlands gains 8 positions (from 10 to 2). Italy loses 2 positions (from 16 in 2006 to 18 in 2010).

Further consideration should be made on the consistency of the composite indicator with respect to the information provided in the so-called headline indicator (*HI*), that is, “people at risk of poverty or social exclusion”, used by Eurostat to represent in a simple and single measure the level of social inclusion.

The values are consistent but sufficiently different. In effect, the headline indicator is not a composite indicator; in addition, *SI* includes some aspects of education. In fact, *HI* considers people who are at risk of poverty *or* severely materially deprived *or* living in households with very low work intensity and, in case of intersections, a person is counted only once; so, one can say that *SI* is a more broad measure and, at the same time, more fitting for a given country than the headline indicator.

At a glance, the combination of the four sub-indicators of social inclusion is not trivial denoting specificities and characteristics of each country that *SI* considers properly through differentiated weights among indicators and countries without applying external information. Of course, this does not imply that the achieved results are preferable or better from the point of view of politics. Moreover, the

decomposition of the *SI* score is useful to highlight, country by country, the most critical aspects of social inclusion to which policies should be directed.<sup>10</sup>

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## 4 Conclusion

The European Union has adopted the “Europe 2020” strategy aimed at a sustainable and inclusive growth in the 27 member countries, in order to achieve high levels of employment, productivity and social cohesion through five objectives to be reached by 2020, including reduction of the school drop-out rates and poverty to achieve higher levels of social inclusion that, moreover, is a key target of the EU SDS [31]. In fact, social inclusion is a complex concept with a multidimensional perspective that, for purposes of policy, makes useful the synthesis in a single measure.

Therefore, in this paper, we have focused on the construction of a composite indicator of social inclusion able to represent the position of each country and to identify directions for improvement with respect to some benchmarks. In particular, to stay close enough to the strategy of the EU and its translation in the indicators proposed by Eurostat, also to promote greater comparability of our results, we have used data corresponding to the four main operational objectives (or “level 2” targets) as defined in the Sustainable Development Strategy, and related to poverty, material deprivation, labour market and education, although other political or cultural dimensions remain neglected [32]. Our composite indicator of social inclusion (*SI*) is obtained by aggregating these four dimensions using appropriate weights determined with an automatic procedure based on a multiplicative DEA-BoD method with proportion constraints. This optimizes mathematically the results for every country without resorting to external judgments of experts, even if the outcome may not be politically satisfying. Furthermore, the multiplicative aggregation emphasizes the improvements of the countries with worse conditions of social inclusion; in other words, this aggregation implies a partial compensability of the four sub-indicators offering better motivations to improve underperforming dimensions.

Data are collected from 2006 to 2010 for all the 27 EU member countries in the largest time interval available with no missing data at the time of writing. In general terms, from 2006 to 2010, the results show a small shift toward the benchmark values of social inclusion, even if there are significant deteriorations

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<sup>10</sup>It is appropriate to make a final comment about the robustness of the results. Some countries may be outliers and strongly influence the score of *SI*. To verify this vulnerability of the results, we have repeated  $m = 27$  times the calculation of *SI* removing each time a different country. The impact of the  $j$ -th missing country was measured through the sum of the  $m - 1$  squared differences between the score of the  $i$ -th countries ( $i \neq j$ ) computed including the  $j$ -th country and that one computed excluding the  $j$ -th country. So, we obtain 27 values each representing the influence on the *SI* score of the country from time to time excluded from the calculation. The differences are very small in many cases and, sometimes, completely negligible, even when they involve the benchmark countries.

in some countries and greater variability of the SI scores among all the 27 European countries. In fact, an important role is played by changes in the levels of monetary poverty, here measured in relative (not absolute) terms as required by the European policy. Finally, we note that some of these 27 countries worsen their levels of social inclusion since 2008 in relation to the European contagion of the financial and economic crisis.

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