

# Stochastic Multiattribute Acceptability Analysis: an application to the ranking of Italian regions

## APPENDIX A

## A.1 Multidimensional polarisation indices

The multidimensional Gini index has been developed as follows. We build upon the polarisation index proposed by Esteban and Ray (1994) corrected as proposed by Esteban *et al.* (2007). More precisely, with respect to the upward cumulative rank acceptability index  $b_{\succeq l}^k$ ,  $l=1,\dots,n-1$ , we computed the mean value  $b_{\succeq l}^M$  of the upward cumulative rank acceptability indices  $b_{\succeq l}^k$ ,  $k=1,\dots,n$ , that is

$$b_{\succeq l}^M = \frac{\sum_{k=1}^n P_k b_{\succeq l}^k}{\sum_{k=1}^n P_k}, \quad \text{eq. (A1)}$$

With  $P_k$ , being the population of the  $k$ -th region,  $k=1,\dots,n$ . After we calculated the normalized upward cumulative rank acceptability indices  $\tilde{b}_{\succeq l}^k$ , that is

$$\tilde{b}_{\succeq l}^k = \frac{b_{\succeq l}^k}{b_{\succeq l}^M}. \quad \text{eq. (A2)}$$

On the basis of values  $\tilde{b}_{\succeq l}^k$ , we defined the cumulative distribution  $F^{\succeq l} : [0,1] \rightarrow [0,1]$  such that for all  $x \in [0,1]$

$$F^{\succeq l}(x) = \frac{\sum_{k: \tilde{b}_{\succeq l}^k \geq x} P_k}{\sum_{k=1}^n P_k}. \quad \text{eq. (A3)}$$

Following the methodology proposed by Aghevli and Mehran (1981) and Davies and Shorrocks (1989), we found also an optimal partition  $\rho^{\succeq l}$  of the distribution  $F^{\succeq l}$  in  $r$  groups minimise the Gini index value of within-group inequality,  $r \leq n$ , that is

$$\rho^{\underline{l}} = (z_0^{\underline{l}}, z_1^{\underline{l}}, \dots, z_{r-1}^{\underline{l}} \leq z_r^{\underline{l}} = 1; y_1^{\underline{l}}, \dots, y_r^{\underline{l}}; p_1^{\underline{l}}, \dots, p_r^{\underline{l}}) \quad \text{eq. (A4)}$$

with  $0 = z_0^{\underline{l}} \leq z_1^{\underline{l}} \leq \dots \leq z_{r-1}^{\underline{l}} \leq z_r^{\underline{l}} = 1$  and  $y_1^{\underline{l}}$  and  $p_1^{\underline{l}}$  being the average value of the normalized cumulative rank acceptability indices  $\tilde{b}_{\underline{l}}^k$  and the population shares in the interval  $[z_{i-1}^{\underline{l}}, z_i^{\underline{l}}]$  of  $\tilde{b}_{\underline{l}}^k$  values.

Finally we computed the polarization index  $EGR^{\underline{l}}$  as follows:

$$EGR^{\underline{l}}(F, \alpha, \beta, \rho^{\underline{l}}) = \sum_{i=1}^r \sum_{j=1}^r \left( p_i^{\underline{l}} \right)^{1+\alpha} p_j^{\underline{l}} \left| y_i^{\underline{l}} - y_j^{\underline{l}} \right| - \beta \left[ G(F) - G(\rho^{\underline{l}}) \right] \quad \text{eq. (A5)}$$

with  $\alpha \in [1, 1.16]$  is the sensitivity to polarization and  $\beta \geq 0$ . In our application to the study of Italian regions we considered 2 groups in the partition  $\rho^{\underline{l}}$ ,  $\alpha=1$  and  $\beta=1$ . Analogous polarization indices  $EGR^{\underline{l}}$ ,  $l=1, \dots, n-1$ , can be defined with respect to the downward cumulative rank acceptability index  $b_{\underline{l}}^k$ .

## A.2 Data and normalisation procedure

Table A.1 reports variables description along with summary statistics. Please note also that the last column of Table A.1 reports the categorization of each variable according the good/bad nature of the considered criteria.

Taking inspiration from Mazziotta and Pareto (2016), to make comparable variables expressed on different metric we normalised them according to the following formula

that assigns to each value  $x$  on a “good criterion”, that is a criterion with a preference increasing with respect to the assigned value (e.g. gross domestic product), the normalized value

$$\bar{x} = \begin{cases} 0 & \text{if } z \leq -3 \\ \frac{z+3}{6} & -3 < z < 3 \\ 1 & z \geq 3 \end{cases} \quad \text{eq. (A6)}$$

where  $z$  is the z-score

$$z = \frac{x - M}{\sigma} \quad \text{eq. (A7)}$$

with  $M$  and  $\sigma$  being the mean and the standard deviation of the considered criterion, respectively, so that

$$\bar{x} = \begin{cases} 0 & \text{if } x \leq M - 3\sigma \\ \frac{x - M + 3\sigma}{6\sigma} = 0.5 + \frac{z}{6} & \text{if } M - 3\sigma < x < M + 3\sigma \\ 1 & \text{if } x \geq M + 3\sigma \end{cases} \quad \text{eq. (A8)}$$

In case of a “bad criterion”, that is a criterion with a preference decreasing with respect to the assigned value (e.g. the social exclusion), the normalized value  $\bar{x}$  of  $x$  is given by

eq. (A9)

$$\bar{x} = \begin{cases} 1 & \text{if } z \leq -3 \\ \frac{3-z}{6} & -3 < z < 3 \\ 0 & z \geq 3 \end{cases}$$

that is,

$$\bar{x} = \begin{cases} 1 & \text{if } x \leq M - 3\sigma \\ \frac{M - x + 3\sigma}{6\sigma} = 0.5 - \frac{z}{6} & \text{if } M - 3\sigma < x < M + 3\sigma \\ 0 & \text{if } x \geq M + 3\sigma \end{cases} \quad \text{eq. (A10)}$$

The idea is to consider as extreme of the normalization scales the values  $M-3\sigma$  and  $M+3\sigma$  within which lie 99,73% of values in case of normal distribution and, by the Chebyshev's inequality, 89% of values for any distribution for which an average and standard deviation are defined.

For illustrative purposes, we begin with the evaluation according to the usual arithmetic mean (equal weights) of the performances normalized on the interval having as extreme the minimum and the maximum evaluations, that is

$$\tilde{x}_l = \frac{x_l - x_{min}}{x_{max} - x_{min}}; \quad \text{eq. (A11)}$$

in case of a “good criterion”, or

$$\tilde{x}_l = \frac{x_{max} - x_l}{x_{max} - x_{min}} \quad \text{eq. (A12)}$$

in case of a “bad criterion”.

### A.3 Robustness checks

#### *Stability of central weights.*

We have tested the stability of the central weight vectors for the four regions for which is not null the probability to be the most preferred by computing the relative confidence factor. We proceeded as follows. We generated perturbed evaluations on considered criteria for all the regions by extracting random values in the interval

$$[g_i(a) - 0.25\sigma_i, g_i(a) + 0.25\sigma_i]$$

for the evaluations of each region  $a$  on considered criteria  $g_i$ , where  $\sigma_i$  is the standard deviation of the criterion  $g_i$ ,  $i=1, \dots, 65$ . Taking the central weight vector of the region  $a^*$  for which we test the stability of the weight vector giving it the best position, we computed the new ranking corresponding to the perturbed evaluations. We repeated this procedure 1,000,000 times and we got an estimation that the region  $a^*$  remains the best. This probability is 100% for Trentino Alto Adige, 87.2% for Toscana, 84.5% for Emilia Romagna and 80% for Friuli-Venezia Giulia.

#### *Measurement error.*

To test the robustness to measurement error we have taken in consideration perturbations in the values assigned to each region by the 65 variables of the BES dataset. More precisely, we considered an interval of variation

$$[g_i(a)-k\sigma_i, g_i(a)+k\sigma_i]$$

for the evaluations of each region  $a$  on considered criteria  $g_i$ , where  $\sigma_i$  is the standard deviation of the criterion  $g_i$ ,  $i=1, \dots, 65$  and  $k \geq 0$ . The case  $k=0$  corresponds to the absence of any perturbation. We further considered the case  $k=0.25$ ,  $k=0.5$  and  $k=1$ . In each one of these case and in each one of 1,000,000 of iterations we randomly extracted not only a vector of weights for the 65 criteria, but also a perturbed evaluation  $\tilde{g}_i(a)$  in the considered range for each region  $a$  on each criterion  $g_i$ ,  $i=1, \dots, 65$ . On the basis of the perturbed values, for each one of the 65 criteria considered by BES, we computed the “perturbed mean” and the “perturbed standard deviation” and we normalized according to equations (8) and (9) the perturbed evaluations  $\tilde{g}_i(a)$ . The RF and the PWI corresponding to  $k=0.25$  are shown in Table A.3 and Table A.4, respectively. The analogous tables for  $k=0.5$  and  $k=1$  can be found in the electronic appendix.

In order to assess the consistency and reliability of the resulting ranking, the Intraclass Correlation Coefficient (ICC) has been computed considering the above  $k=0.25$ ,  $0.5$ , and  $1$  as resulting from alternative evaluation exercises performed by 3 additional raters with respect to

the actual measurement released by the Italian National Institute of Statistics. To this end, the consistency-of-agreement ICC (CA-ICC) has been used. The rationale for adopting the CA-ICC is that different measurements are considered consistent if the scores from any two measurements (or *raters*) give the same ranking to all the regions (Shrout and Fleiss, 1979; McGraw and Wong, 1996a, 1996b). The results reported in Table A.4 show that our ranking exercise is robust to the substantial differences in measurement here hypothesised. Indeed, both the individual and the average coefficients are in no occasion<sup>1</sup> lower than 0.60 with 15 out of the 20 ranking here considered showing a ICC higher than 0.80.

## References

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<sup>1</sup> All the ICC are statistically significant according to related F-test.

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## APPENDIX TABLES

Table A1 - Variables description and descriptive statistics

Variable	Description	Categorisation	Mean	Std. Dev.	Min	Max
Health						
HEALTH1	Life expectancy without limitations in activities at age 65	Good	44.69	4.532909	38.6	52.6
HEALTH2	Rate of mortality from dementia and diseases of the nervous system	Bad	19.795	1.616519	16.5	22.3
HEALTH3	People aged 14 and older who have at least one risk behaviour in alcohol consumption	Bad	16.83	3.635946	10.7	24.3
HEALTH4	People aged 14 and over who do not practice any physical activity	Bad	39.135	11.79966	17.6	60.4
HEALTH5	People aged 3 years and older who consume at least 4 daily servings of fruits and / or vegetables	Good	17.62	5.246713	6.2	28.3
Education						
EDU1	People 25-64 who have completed at least the secondary school	Good	59.565	6.690155	47.2	70.1
EDU2	People aged 30-34 who have completed a university degree	Good	24.2	4.166533	17.4	31.6
EDU3	Graduates who enrol for the first time at the university in the same year in which they graduated	Good	13.995	4.328665	8.4	24
EDU4	People 15-29 years neither in education, employment or training (Neet)	Bad	25.115	7.691915	14.3	40.3
EDU5	People aged 25-64 who participated in education and training in the 4 weeks preceding the interview	Good	8.275	1.695776	5.1	12
EDU6	People aged 6 and over who have practiced three or more cultural activities in the preceding 12 months	Good	26.295	7.74627	14.8	42.1
Working Conditions						
WORK1	Employment rate of the population aged 20-64 years	Good	60.08	10.70015	42.4	73.6
WORK2	Rate of non-participation in the work of the population aged 15-74 years	Good	22.92	11.26805	9	42.7
WORK3	Fixed-term employees and employees who started their current job for at least five years	Good	20.205	7.301008	10.1	38

Variable	Description	Categorisation	Mean	Std. Dev.	Min	Max
WORK4	Rate of low-pay employees	Bad	11.28	4.651497	6.8	22.4
WORK5	Rate of overeducated employees	Bad	23.16	2.860327	17.6	29.4
WORK6	Employment rate of women aged 25-49 with at least one child aged 6-14 over total number of women	Good	81.13	6.629844	67.3	92
WORK7	Work satisfaction	Good	7.245	0.213923	6.9	7.7
WORK8	Employment insecurity perception	Good	10.74	2.627466	5.9	17
WORK9	Share of involuntary part-time to total employment by gender	Bad	11.845	2.518244	7	16.7
Economic Welfare						
ECONW1	Average disposable income of households	Good	17223.9	3245.781	12343	21286
ECONW2	Index of inequality in disposable income	Bad	5.16	1.302386	3.6	8.9
ECONW3	People at risk of poverty	Bad	19.36	10.29913	7.7	40.1
ECONW4	People living in households with severe material deprivation	Bad	10.96	6.194684	3.1	26
ECONW5	People living in overcrowding situations, in dwellings without some services and with structural problems	Bad	9.44	2.845569	5.5	15.7
ECONW6	People under 60 years living in households with very low work intensity	Bad	12.09	6.605811	4.6	25
ECONW7	Subjective evaluation index of economic difficulty	Bad	16.61	9.040896	4.6	38.4
Social Capital						
SOC1	People aged 14 and over who declare themselves very satisfied of family relationships	Good	33.73	6.012452	20.9	46.3
SOC2	People aged 14 and over who declare themselves very satisfied with the friendly relations	Good	24.02	4.593657	15.4	35.3
SOC3	People aged 14 and over who have relatives, friends or neighbours you can count on	Good	81.88	3.134461	74.5	88
SOC4	People aged 14 and over who during the last 12 months they have played at least one social participation activities	Good	24.015	5.632825	14.9	40
SOC5	People aged 14 and over who talk about politics or that you inform policy at least once a week, who participated in online consultations or vote on social or political issues or	Good	66.915	7.447166	53.7	75.7

Variable	Description	Categorisation	Mean	Std. Dev.	Min	Max
SOC6	have read and posted opinions on social and political problems on the web in recent 3 months People aged 14 and over who during the last 12 months have carried out unpaid work for organizations or volunteer groups	Good	10.255	3.782296	5	21.9
SOC7	People aged 14 and over who during the last 12 months have funded associations	Good	14.91	5.775802	5.7	28.8
SOC8	People aged 14 and over who trust others	Good	23.1	4.450429	17.3	33.6
Politics						
POL1	People aged 18 and over who have voted in the European Parliament elections	Good	57.46	9.097912	42	70.5
POL2	People aged 14 and over who express confidence in the Italian Parliament	Good	3.41	0.305907	2.8	4
POL3	People aged 14 and over who express confidence in the judicial system	Good	4.215	0.297843	3.4	4.8
POL4	People aged 14 and over who express confidence in parties	Good	2.355	0.230503	1.9	2.8
POL5	People aged 14 and over who express confidence in the regional government, the provincial government or in their own town	Good	3.72	0.503253	2.9	4.9
POL6	People aged 14 and over who express confidence in the police and fire brigade	Good	7.055	0.24165	6.6	7.5
POL7	Average age of MPs - XVII Legislature - January 2014	Bad	49.925	1.560322	45.9	52.5
Safety						
SFTY1	Rate of theft in dwelling	Bad	16.125	6.641724	4.9	31.9
SFTY2	Rate of pickpocketing	Bad	5.96	4.291289	0.9	16.5
SFTY3	Rate of robbery	Bad	1.56	1.132487	0.1	4.6
SFTY4	Women 16-70 years old who have experienced physical violence in the last five years	Bad	7.015	1.468359	4.3	9.3
SFTY5	Women 16-70 years old who have suffered sexual violence	Bad	6.165	1.361994	3.9	9.1
SFTY6	Women 16-70 years old who have suffered physical or sexual violence in the last five years by region and division	Bad	4.885	1.227867	2.4	7.6

Variable	Description	Categorisation	Mean	Std. Dev.	Min	Max
SFTY7	People aged 14 and over who feel safe walking alone at night in the area where they live	Good	61.225	8.897361	49.8	82.6
Social Welfare						
SWEL1	People aged 14 and over who have expressed a satisfaction score for life between 8 and 10	Good	36.55	7.224993	20.6	54
SWEL2	People aged 14 and over who say they are very or fairly satisfied Leisure	Good	65.24	5.196497	56.3	75.7
SWEL3	People aged 14 and over who feel that their situation will improve in the next five years	Good	26.455	3.034273	22.3	34.6
SWEL4	People aged 14 and over who feel that their situation will worsen over the next five years	Bad	18.605	2.487331	13.5	22.9
Land Use						
LAND1	People aged 14 and over who feel the landscape of the place in which they live is suffering from obvious degradation	Bad	18.61	6.7765	7.8	32.6
LAND2	People aged 14 and over who declare among the 5 environmental problems for which express their concern for the landscape there is the ruin caused by excessive building activity	Bad	16.665	4.363397	9.4	24.2
Environment						
ENV1	Municipal waste landfilled	Bad	39.83	28.26601	6.1	111
ENV2	People aged 14 and over believe that the extinction of plant species or animal is between 5 their concerns	Bad	17.385	3.36816	12.6	24
ENV3	Electricity consumption covered by renewable sources	Good	62.24	72.42566	10.4	310.2
ENV4	People aged 14 and over who are very or fairly satisfied the environmental situation of the area in which they live	Good	74.72	8.568276	57.2	89.6

Variable	Description	Categorisation	Mean	Std. Dev.	Min	Max
R&D						
RD1	Employed with university education in Scientific or Technological professions	Good	14.97	1.622896	12.4	20
RD2	People of 16-74 years who have used the Internet at least once a week in the preceding 3 months	Good	58.95	6.595174	48.4	66.5
Quality of Life and social conditions						
Ql1	Households reporting that the house is connected to the natural gas network	Good	9.35	7.47068	1.4	30.7
Ql2	Recycled municipal waste	Good	43.77	16.16729	12.5	67.6
Ql3	Index of overcrowding of prisons	Bad	105.03	21.4091	56.8	138
Ql4	Households by great difficulty in reaching at least 3 essential services	Bad	6.835	2.894328	3.2	12.3

Source: Authors' elaboration on ISTAT (2015).

Table A2 - Rank Frequency (robustness test, k=0.25)

Rank	PI	VA	LO	TR	VE	FR	LI	ER	TO	UM	MA	LA	AB	MO	CM	PU	BA	CA	SI	SA
1	0	0	0	998815	0	166	0	341	678	0	0	0	0	0	0	0	0	0	0	0
2	1	4108	0	1002	2	445152	0	184418	365317	0	0	0	0	0	0	0	0	0	0	0
3	190	17410	129	171	64	307539	1	261237	413255	1	0	4	0	1	0	0	0	0	0	0
4	11131	68928	2805	12	584	242603	89	462256	211434	58	9	83	0	3	0	0	0	0	0	3
5	435991	293305	153725	0	9297	4424	5045	78754	8784	7382	651	2501	0	86	0	0	0	0	0	57
6	393362	204409	312966	0	20750	112	21629	11129	469	24965	2504	7068	3	293	0	0	0	0	0	340
7	136168	218117	409982	0	53052	4	75953	1672	57	67130	9556	25305	7	1061	0	0	0	0	0	1937
8	21202	92997	90856	0	198641	0	282672	185	6	181407	39316	73612	68	3858	0	0	1	0	0	15178
9	1626	48897	21816	0	137070	0	243843	8	0	261397	109332	137741	332	10556	0	0	2	1	0	27379
10	296	30792	6292	0	130486	0	176477	0	0	235060	190695	163269	1736	23101	0	0	8	8	0	41781
11	30	14480	1192	0	146759	0	129479	0	0	144362	254416	178354	8370	50893	0	0	30	13	0	71621
12	3	5601	206	0	133506	0	49066	0	0	58667	240715	231382	32046	108336	0	0	105	46	0	140321
13	0	784	29	0	80402	0	13395	0	0	17196	108877	119802	129500	233520	0	0	550	174	0	295772
14	0	158	2	0	51442	0	2109	0	0	2281	36081	49578	295192	330359	0	0	3897	1040	0	227859
15	0	14	0	0	33640	0	230	0	0	88	7734	10836	500080	233752	0	0	35021	5925	0	172680
16	0	0	0	0	3139	0	11	0	0	6	107	441	28293	3850	8	18	862737	96525	3	4862
17	0	0	0	0	1150	0	1	0	0	0	7	24	4372	331	1527	6393	97577	888164	244	210
18	0	0	0	0	12	0	0	0	0	0	0	0	1	0	226384	673688	69	7717	92129	0
19	0	0	0	0	3	0	0	0	0	0	0	0	0	0	555747	235253	3	367	208629	0
20	0	0	0	0	1	0	0	0	0	0	0	0	0	0	216334	84648	0	20	698995	0

Source: Authors' elaboration on ISTAT (2015).

Table A3 - Pairwise Comparison Index (robustness test, k=0.25)

	PI	VA	LO	TR	VE	FR	LI	ER	TO	UM	MA	LA	AB	MO	CM	PU	BA	CA	SI	SA	APCI
PI	1.000	0.577	0.743	0.000	0.967	0.001	0.989	0.019	0.001	0.986	0.997	0.995	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.764
VA	0.423	1.000	0.574	0.000	0.932	0.010	0.885	0.086	0.022	0.884	0.969	0.933	0.999	0.997	1.000	1.000	1.000	1.000	1.000	0.999	0.736
LO	0.257	0.426	1.000	0.000	0.950	0.000	0.936	0.005	0.001	0.934	0.983	0.983	1.000	0.997	1.000	1.000	1.000	1.000	1.000	0.997	0.723
TR	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
VE	0.033	0.068	0.050	0.000	1.000	0.000	0.384	0.001	0.000	0.413	0.622	0.581	0.934	0.858	1.000	1.000	0.996	0.998	1.000	0.833	0.539
FR	0.999	0.990	1.000	0.000	1.000	1.000	1.000	0.679	0.526	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.910
LI	0.011	0.115	0.064	0.000	0.616	0.000	1.000	0.000	0.000	0.559	0.789	0.808	0.998	0.976	1.000	1.000	1.000	1.000	1.000	0.934	0.594
ER	0.981	0.914	0.995	0.000	0.999	0.321	1.000	1.000	0.314	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.876
TO	0.999	0.978	0.999	0.001	1.000	0.474	1.000	0.686	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.907
UM	0.014	0.116	0.066	0.000	0.587	0.000	0.441	0.000	0.000	1.000	0.809	0.720	0.999	0.972	1.000	1.000	1.000	1.000	1.000	0.917	0.582
MA	0.003	0.031	0.017	0.000	0.378	0.000	0.211	0.000	0.000	0.191	1.000	0.486	0.968	0.882	1.000	1.000	1.000	1.000	1.000	0.817	0.499
LA	0.005	0.067	0.017	0.000	0.419	0.000	0.192	0.000	0.000	0.280	0.514	1.000	0.969	0.871	1.000	1.000	0.999	1.000	1.000	0.814	0.507
AB	0.000	0.001	0.000	0.000	0.066	0.000	0.002	0.000	0.000	0.001	0.032	0.031	1.000	0.311	1.000	1.000	0.969	0.992	1.000	0.253	0.333
MO	0.000	0.003	0.003	0.000	0.142	0.000	0.024	0.000	0.000	0.028	0.118	0.129	0.689	1.000	1.000	1.000	0.995	0.999	1.000	0.410	0.377
CM	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	1.000	0.266	0.000	0.002	0.745	0.000	0.101
PU	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	0.734	1.000	0.000	0.007	0.862	0.000	0.130
BA	0.000	0.000	0.000	0.000	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.031	0.005	1.000	1.000	1.000	0.900	1.000	0.006	0.247
CA	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008	0.001	0.998	0.993	0.100	1.000	1.000	0.001	0.205
SI	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	0.255	0.138	0.000	0.000	1.000	0.000	0.070
SA	0.000	0.001	0.003	0.000	0.167	0.000	0.066	0.000	0.000	0.083	0.183	0.186	0.747	0.590	1.000	1.000	0.994	0.999	1.000	1.000	0.401

Source: Authors' elaboration on ISTAT (2015).



Table A4 – Intraclass correlation coefficients

	Rank																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
individual	1.00	0.99	0.98	0.88	0.92	0.94	0.89	0.91	0.94	0.94	0.90	0.84	0.91	0.79	0.62	0.70	0.67	0.80	0.77	0.65
Average	1.00	1.00	0.99	0.97	0.98	0.98	0.97	0.97	0.98	0.98	0.97	0.96	0.97	0.94	0.87	0.90	0.89	0.94	0.93	0.88
F- test (19, 19)	803.94	354.44	196.93	29.82	45.34	58.79	32.39	39.81	61.10	63.29	36.18	22.47	39.28	16.46	7.56	10.13	9.19	16.73	14.53	8.37
p-value	(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)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Source: authors' elaboration on data from ISTAT (2015)

Table A5 - Regions abbreviations and macro-areas composition

Nord-West		
Piedmont		PI
Aosta Valley		VA
Liguria		LI
Lombardy		LO
Nord-East		
South Tyrol -Trentino		TR
Veneto		VE
Friuli-Venezia Giulia		FR
Emilia-Romagna		ER
Centre		
Tuscany		TO
Umbria		UM
Marche		MA
Lazio		LA
South		
Abruzzi		AB
Molise		MO
Campania		CM
Apuglia		PU
Basilicata		BA
Calabria		CL
Islands		
Sicily		SI
Sardinia		SA

Table A6 – Disparities in social, economic, and environmental indicators

Disparities in Social, economic, and environmental indicators											
Health			Education			Working Conditions			Economic Welfare		
Variable	Gini	EGR	Variable	Gini	EGR	Variable	Gini	EGR	Variable	Gini	EGR
Health1	0.06	0.03	Edu1	0.06	0.03	Work1	0.10	0.05	Econw1	0.10	0.06
Health2	0.05	0.02	Edu2	0.09	0.05	Work2	0.26	0.15	Econw2	0.13	0.06
Health3	0.12	0.06	Edu3	0.16	0.08	Work3	0.19	0.09	Econw3	0.29	0.15
Health4	0.17	0.08	Edu4	0.17	0.08	Work4	0.22	0.11	Econw4	0.29	0.14
Health5	0.16	0.07	Edu5	0.11	0.05	Work5	0.07	0.03	Econw5	0.16	0.07
			Edu6	0.16	0.08	Work6	0.04	0.02	Econw6	0.29	0.15
						Work7	0.02	0.01	Econw7	0.28	0.13
						Work8	0.13	0.06			
						Work9	0.12	0.05			
Social Capital			Politics			Safety			Social Welfare		
Variable	Gini	EGR	Variable	Gini	EGR	Variable	Gini	EGR	Variable	Gini	EGR
Soc1	0.10	0.04	Pol1	0.09	0.04	Sfty1	0.22	0.11	Swel1	0.10	0.05
Soc2	0.10	0.05	Pol2	0.05	0.02	Sfty2	0.38	0.19	Swel2	0.04	0.02
Soc3	0.02	0.01	Pol3	0.04	0.02	Sfty3	0.39	0.18	Swel3	0.06	0.03
Soc4	0.12	0.05	Pol4	0.05	0.02	Sfty4	0.12	0.05	Swel4	0.07	0.03
Soc5	0.06	0.03	Pol5	0.07	0.03	Sfty5	0.12	0.06			
Soc6	0.19	0.08	Pol6	0.02	0.01	Sfty6	0.13	0.07			
Soc7	0.21	0.10	Pol7	0.02	0.01	Sfty7	0.08	0.04			
Soc8	0.11	0.05									

Source: Authors' elaboration on ISTAT (2015)

Table A6 – Disparities in Social, economic, and environmental indicators (cont.)

Disparities in Social, economic, and environmental indicators (cont.)											
Land Use			Environment			R&D			Quality of Life and SOC8al conditions		
Variable	Gini	EGR	Variable	Gini	EGR	Variable	Gini	EGR	Variable	Gini	EGR
Land1	0.20	0.10	Env1	0.38	0.18	Rd1	0.05	0.02	Ql1	0.39	0.21
Land2	0.15	0.07	Env2	0.11	0.05	Rd2	0.06	0.03	Ql2	0.20	0.10
			Env3	0.47	0.23				Ql3	0.11	0.05
			Env4	0.06	0.03				Ql4	0.22	0.12

Source: Authors' elaboration on ISTAT (2015)

Table A7 – Social, economic and environmental performance index (SEEPI)

Region	Aritmetic mean on original values normalized on the interval [min,max]		Geometric mean of z values normalized on the interval [M-3 $\sigma$ , M+3 $\sigma$ ]	Rank
		Rank		
Piedmont	0.528	7	0.515	5
Valle d'Aosta	0.552	5	0.513	6
Lombardy	0.530	6	0.510	7
South Tyrol - Trentino	0.644	1	0.597	1
Veneto	0.525	8	0.486	10
Friuli-Venezia Giulia	0.566	2	0.545	2
Liguria	0.508	9	0.491	8
Emilia-Romagna	0.560	3	0.538	4
Tuscany	0.557	4	0.544	3
Umbria	0.507	10	0.489	9
Marche	0.500	12	0.479	12
Lazio	0.504	11	0.480	11
Abruzzo	0.468	15	0.451	15
Molise	0.475	14	0.459	14
Campania	0.398	20	0.357	19
Apulia	0.400	18	0,367	18
Basilicata	0.445	17	0.421	16
Calabria	0.446	16	0.404	17
Sicily	0.486	13	0.349	20
Sardinia	0.400	19	0.463	13

Source: authors' elaboration on ISTAT (2015)

Table A8 – Criteria with the five greatest average weights in the set of vector of weights assigning to the corresponding region the best position

	HEALTH1	POL5	WORK4	SFTY2	LAND2
Abruzzo	0.03	0.03	0.029	0.029	0.029
	WORK3	SQ3	WORK8	SOC7	WORK5
Basilicata	0.033	0.032	0.031	0.031	0.03
	WORK8	SFTY6	SFTY2	WORK2	LAND2
Calabria	0.031	0.031	0.03	0.027	0.026
	POL4	LAND2	SQ1	WORK5	SQ2
Campania	0.034	0.033	0.033	0.032	0.032
	WORK8	HEALTH3	HEALTH1	POL1	POL7
Emilia-Romagna	0.027	0.026	0.024	0.023	0.023
	WORK8	WORK6	SFTY3	HEALTH3	SFTY6
Friuli-Venezia Giulia	0.027	0.026	0.024	0.023	0.023
	ECONW3	HEALTH3	POL3	SFTY1	SOC3
Lazio	0.03	0.029	0.029	0.028	0.027
	EDU2	SFTY1	HEALTH2	POL3	RD2
Liguria	0.026	0.026	0.024	0.024	0.024
	SFTY1	ECONW7	SWEL2	SWEL4	SQ1
Lombardy	0.035	0.034	0.034	0.034	0.034
	SFTY6	SFTY1	RD1	HEALTH3	LAND1
Marche	0.035	0.034	0.033	0.032	0.032
	POL1	LAND2	HEALTH3	SFTY5	WORK2
Molise	0.038	0.037	0.035	0.033	0.032
	SFTY4	POL7	SFTY1	HEALTH5	ECONW5
Piedmont	0.029	0.026	0.026	0.025	0.024
	POL5	WORK5	SQ2	POL7	POL3
Apuglia	0.031	0.03	0.028	0.027	0.026
	SFTY1	EDU3	ECONW3	SWEL3	SQ1
Sardinia	0.024	0.023	0.023	0.023	0.023

	WORK4	ECONW5	LAND1	HEALTH5	POL6
Sicily	0.026	0.026	0.024	0.022	0.022
	HEALTH3	WORK6	POL2	WORK8	ENV2
Tuscany	0.026	0.024	0.024	0.023	0.023
	HEALTH1	HEALTH2	HEALTH3	HEALTH4	HEALTH5
South Tyrol - Trentino/Südtirol	0.015	0.015	0.015	0.015	0.015
	SFTY1	WORK6	ECONW3	HEALTH5	SQ1
Umbria	0.03	0.027	0.026	0.024	0.024
	ENV3	SQ3	WORK5	SFTY7	SFTY1
Aosta Valley	0.023	0.022	0.021	0.021	0.02
	HEALTH2	HEALTH5	POL7	SWEL3	RD1
Veneto	0.035	0.034	0.034	0.034	0.034

Source: Authors' elaboration on data from ISTAT (2015)

Table A9 – Criteria with the five greatest average weights in the set of vector of weights assigning to the corresponding region the worst position

	SFTY6	SFTY5	SFTY4	HEALTH2	SOC3
Abruzzo	0.025	0.024	0.023	0.02	0.02
	POL6	POL7	HEALTH5	POL4	HEALTH3
Basilicata	0.026	0.026	0.025	0.025	0.024
	EDU6	WORK4	POL5	ENV2	HEALTH4
Calabria	0.032	0.03	0.029	0.028	0.025
	SFTY5	HEALTH2	ECONW7	SOC1	SOC2
Campania	0.018	0.017	0.017	0.017	0.017
	SFTY1	SFTY4	SFTY6	WORK6	ECONW5
Emilia-Romagna	0.031	0.027	0.025	0.022	0.021
	WORK3	ECONW3	SOC5	SQ3	POL3
Friuli-Venezia Giulia	0.031	0.031	0.03	0.03	0.029
	SFTY2	HEALTH2	WORK8	SFTY4	SFTY7
Lazio	0.029	0.025	0.025	0.025	0.025
	SWEL4	HEALTH1	LAND2	SFTY2	SWEL3
Liguria	0.031	0.027	0.027	0.026	0.025
	WORK3	LAND2	WORK8	WORK6	SFTY7
Lombardy	0.027	0.027	0.025	0.024	0.024
	SOC1	SWEL4	LAND2	WORK9	POL4
Marche	0.032	0.032	0.032	0.031	0.031
	ENV1	SFTY6	WORK6	SFTY4	WORK8
Molise	0.029	0.026	0.025	0.023	0.021
	ENV2	HEALTH1	EDU2	ENV3	RD2
Piedmont	0.031	0.028	0.028	0.026	0.026
	SFTY3	SOC3	HEALTH5	SQ3	SQ4
Apuglia	0.023	0.019	0.018	0.018	0.017
	HEALTH1	EDU1	EDU2	WORK3	ECONW7



Sardinia	0.022	0.022	0.022	0.022	0.022
	ECONW2	WORK9	ECONW4	ENV1	SQ2
Sicily	0.018	0.016	0.016	0.016	0.016
	SFTY4	LAND1	WORK7	SOC5	POL7
Tuscany	0.032	0.03	0.029	0.027	0.027
	HEALTH3	WORK8	WORK6	HEALTH5	POL2
South Tyrol - Trentino/Südtirol	0.03	0.03	0.029	0.025	0.025
	WORK5	ECONW3	SFTY1	ENV3	HEALTH2
Umbria	0.03	0.025	0.025	0.025	0.024
	POL7	LAND2	SQ1	HEALTH3	ECONW3
Aosta Valley	0.03	0.03	0.027	0.026	0.026
	SFTY1	WORK2	SFTY2	HEALTH3	POL2
Veneto	0.037	0.036	0.036	0.035	0.035

Source: Authors' elaboration on data from ISTAT (2015)

Table A10 – Cumulated Rank Acceptability Index

	Rank																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
PI	0.000	0.000	0.000	0.002	0.462	0.880	0.986	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
VA	0.000	0.003	0.017	0.077	0.394	0.592	0.823	0.911	0.955	0.983	0.995	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
LO	0.000	0.000	0.000	0.001	0.131	0.452	0.909	0.982	0.996	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TR	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
VE	0.000	0.000	0.000	0.000	0.008	0.024	0.070	0.295	0.436	0.571	0.734	0.875	0.948	0.985	0.999	1.000	1.000	1.000	1.000	1.000
FR	0.000	0.456	0.759	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
LI	0.000	0.000	0.000	0.000	0.003	0.019	0.084	0.387	0.640	0.815	0.946	0.989	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000
ER	0.000	0.176	0.425	0.926	0.996	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TO	0.000	0.365	0.799	0.995	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
UM	0.000	0.000	0.000	0.000	0.005	0.026	0.087	0.270	0.547	0.795	0.938	0.987	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000
MA	0.000	0.000	0.000	0.000	0.000	0.002	0.008	0.038	0.137	0.326	0.589	0.852	0.962	0.994	1.000	1.000	1.000	1.000	1.000	1.000
LA	0.000	0.000	0.000	0.000	0.002	0.007	0.030	0.098	0.236	0.400	0.575	0.828	0.949	0.993	1.000	1.000	1.000	1.000	1.000	1.000
AB	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.006	0.027	0.143	0.434	0.975	0.997	1.000	1.000	1.000	1.000
MO	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.012	0.032	0.077	0.172	0.411	0.770	0.999	1.000	1.000	1.000	1.000	1.000
CM	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	0.000	0.000	0.001	0.194	0.747	1.000
PU	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	0.000	0.000	0.003	0.710	0.918	1.000
BA	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	0.002	0.026	0.922	1.000	1.000	1.000	1.000
CA	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	0.001	0.005	0.082	0.997	1.000	1.000	1.000
SI	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	0.000	0.000	0.000	0.096	0.335	1.000
SA	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.016	0.041	0.077	0.141	0.269	0.587	0.820	0.997	1.000	1.000	1.000	1.000	1.000

Source: Authors' elaboration on ISTAT (2015).