Exploring environmental urban policies: a methodological proposal to build a composite indicator measuring urban environmental virtuosity

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Abstract

Synthesizing the complex phenomenon of "environment" into a single indicator could leads to a loss of information, which inhibit his use as a reference for the resolution of several issues such as, for example, the allocation of resources. On the other hand it allows to represent the overall environmental performance of cities and to highlight relationships between different sectors. We consider "process oriented" variables instead of aggregated and "outcome oriented" ones, generally used to measure environmental sustainability strictu sensu. In this sense we refers specifically to the concept of "environmental virtuosity", that allows to rank statistical units (i.e. Italian main municipalities), considering their policy efforts for improving urban environmental quality. Generally an indicator of environmental quality should combine partial information to summarize the main subject. This paper proposes to measure urban environmental virtuosity by multivariate analysis, following OECD (2008) procedure. This methodology will try to overcome the main methodological issues in building up indicators, consisting in the choice of weights and in the common practice of simply adding sub-indicators.

1. Object of the research paper

In order to manage resources in a sustainably way and to ensure an appropriate level of environmental quality, decision makers need to: identify objectives to be pursued; choose the most suitable tools (policies, persuasive and dissuasive actions, command and control, environmental taxation) to achieve that goals, then monitor and evaluate results. It would be suitable to take decisions and to evaluate responses by referring to a system of environmental indicators, by which immediately and easily to identify actions to be sorted out, so to improve the state of the environment at local level.

Generally an indicator of environmental quality should combine partial information to summarize the main subject (Rostirolla P., 1998). Currently a huge number of environmental indicators are available (Saisana M., Tarantola S., 2002), but, in the following we will attempt to define an effective indicator in monitoring results of "Environmentally-friendly" policies and interventions, implemented at local level, to mitigate or to avoid negative externalities on environment caused by key sectors for economic and social growth, as public utilities are. In this sense we refers specifically to the concept of "environmental virtuosity", that allows to rank statistical units (*i.e.* Italian main municipalities), considering their policy efforts for improving urban environmental quality. We consider "process oriented" variables instead of aggregated and "outcome oriented" ones, generally used to measure environmental sustainability *strictu sensu*, because they are purely physical parameters.

Based on these considerations, this paper proposes to measure urban environmental virtuosity by multivariate analysis, following OECD (2008) procedure. First, we will categorize statistical units by cluster analysis as a function of a set of indicators, considered explanatory of the phenomenon; then we will determine a composite indicator of environmental virtuosity at local level by factor analysis.

By cluster analysis we will reduce the size of data to be analyzed: from the total number of statistical units to the number of clusters, providing a description of the statistical units, by features as common elements of the same group, but not common for the others. Cluster analysis results will be compared with an indicator of environmental virtuosity, as well as to verify the consistency.

Synthesizing the complex phenomenon of "environment" into a single indicator could leads to a loss of information, which inhibit his use as a reference for the resolution of several issues such as, for example, the allocation of resources. On the other hand it allows to represent the overall environmental performance of cities and to highlight relationships between different sectors.

Conscious of the limits of composite indicators in describing a phenomenon, our purpose is to put in practice a methodology illustrated by OECD by which to obtain an indicator of virtuosity, rather than sustainability one. This methodology will try to overcome the main methodological issues in building up indicators, consisting in the choice of weights and in the common practice of simply adding sub-indicators.

2. Backgrounds on Urban environmental indicators

Local level has always been a starting point for the implementation of policies related to the achievement of environmental sustainability; moreover international organizations (UN: Rio de Janeiro Conference in 1992, Habitat Istanbul Conference in 1996; OECD: Cities for Citizens. Improving Metropolitan Governance, 2000) and European Union (Aalborg Charter, 1994, Framework Programmes) strongly promote urban sustainability. Currently there are several indicators measuring urban environmental sustainability (Singh RK et al. 2009), developed from nineties; some examples are provided: Stanners, D., Bourdeau, P., (1991) define 3 categories of indicators, considering 55 sub indicators: 1) Indicators of urban patterns, as the sum of Urban population; Urban land cover; Derelict areas; Urban renewal areas; Urban mobility; Commuting patterns; traffic volumes; 2) Indicators of urban flows, considering Water: water consumption, Wastewater; Energy; Materials and products (transportation of goods); Waste; 3) Indicators of urban environmental quality: Quality of water; Quality of air; Acoustic quality ; Traffic safety (fatalities and casualties from traffic accidents); Housing quality; Accessibility of green space; Quality of urban wildlife (number of bird species).

Indicators on urban environmental quality by OECD (1993) are divided in three types of indicators: Environmental pressures (urban air emissions SOx, NOx, VOC, traffic density, degree of urbanisation), Environmental conditions (exposure of population to air pollutants, noise, ambient water conditions in urban areas, concentration of air pollutants), societal responses (changes in green space as a percentage of total urban area/total urban population, regulations on emissions and noise levels for new cars, expenditure on water treatment and noise abatement).

Legambiente (1994) in "Urban Ecosystem" report measures urban sustainability based on 25 indicators of environmental quality, representative of factors of pressure, quality of environment, capacity of response and environmental management. Data collection is based on interviews submitted periodically to provincial municipalities and on the basis of other statistical sources. Indicators cover all major environmental components: air, water, waste, energy and allow to make a ranking of the cities analyzed.

Synthetic Environmental Indices (Isla M.,1996) are defined in order to assist the local municipalities of Barcelona to monitor and evaluate their environmental performance. Author calculates a structural and a functional composite indicator, by the arithmetic average of 22 sub-indicators. (Saisana M., Tarantola S., 2002).

Environmental statistics of Helsinki (1998) is a report that provides a study of the impact of human activities on the environment. Environmental indicators are: City structure, Pollution load from urban activities (traffic, energy consumption of traffic, emissions from traffic, traffic noise, accidents, jobs and industry, energy production and distribution system, energy consumption, emissions from energy production and manufacturing, waste from energy production and beneficial use of this waste, water provision, drinking water quality, waste water load, waste and its management), State of the environment (total emissions by source, carbon dioxide, climate change, air quality, acid deposition of sulphur and nitrogen, water quality), Biodiversity (plants, birds).

European Common Indicators (ECI), by Expert Group on Urban DG Environment of European Commission (Rapporto Ambiente Italia, 2003), are taken on basis of data provided by interviews to different urban areas. Indicators put highlights on the possible lack of facilities services, allow to increase awareness on issues of environmental management, stimulate interest in development of sustainable products, etc.

Istat (2009), in the "Environmental data in the cities" report ranks provincial municipalities looking at a synthetic indicator of eco-friendly, calculated from the average of the standardized indicators. These are defined using DPSIR method (Istat, 2009). Data collection is carried out periodically since 2000. It consists of the compilation online by public and private urban bodies of seven questionnaires, each of which relates to a specific environmental theme.

Considering this few examples of urban environmental indicators, we set out some remarks about the choice of data and on methodology used to calculate a composite indicator: two issue that we will try to handle in this paper.

The choice of data as sub indicators is crucial for a correct definition of a certain phenomenon: obviously the same phenomenon could be represented by several indicators, considering the availability of data of statistical units considered. This means that even if indicators have the same purpose, for instance measuring environmental quality of cities, they will be different from each others and not comparable. The choice of sub indicators and the availability of data are not the only issue in defining composite indicators. There is also a methodological problem consisting in assigning, by a personal judgment, weights and in adding sub indicators in order to find out a composite one. As OECD (2008) claims, in the building up of a composite indicators, there are several suitable techniques to be applied, as multivariate analysis, able to overcome that issue and to provide a more efficient indicator from a structural point of view.

3. Measuring Urban Environmental Virtuosity (UEV): data and methodology

In the following paragraph we attempt to identify a methodological strategy to overcome the problems concerning in the composite indicators by means of a multivariate approach; the empirical test will be performed on the Italian urban contest.

More specifically, the analysis involves 111 provincial municipalities, according to the availability of data on environmental subjects provided by ISTAT. Municipalities considered covers capitals of 6.6% of Italian surface and the 29.5% of the total population of the country (about 17 million people)[1].

For the variables choice we try to identify indicators directly related to policy choice for each municipality in the environmental domain (see tab. 1); more specifically the selected indicators concern all the available responses defined by local public body in order to improve environmental quality, regardless of specific morphological characteristics.

[1] The considered municipalities represent the main urban context in each regions.

Policy choices in environmental domain can be divided in 6 sub-domains; for each one we analyze several indicators as follow:

- Transport (Pedestrian areas, Bycicle path, Urban Trafic Plan, Seats in public tran sport, Local Public transport)
- Waste (Separate Waste Collection, Waste Disposal, Waste Incinerator, Composting Treatment, Recovered waste)
- Water (Water treatment plants, Rationing water for domestic use)
- Energy (Urban Energetic Plan, District heating on public buildings, Solar thermic panel on public buildings, Power of photovoltaic panel on public buildings)
- Green[2] (Green Local Public Plan)
- Urban environmental (Soundproof asphalt, Noise-canceling barriers, Noise monitoring stations, Pollutant detected, Diffusion air monitoring Stations, Density of Air Monitoring Stations, Days with anomalous values of PM10)

The empirical strategy to define the different behavior of municipalities in term of virtuosity will be carried out by two approaches. First of all a cluster analysis will be provided: it allows to classify statistical units, highlighting features as common elements of the same group and that make each group distinct from the others. The main advantage is to synthesize the phenomenon into categories characterized by the presence or absence of certain relevant dimensions and to reduce the size of data: from the total number of statistical units to the number of clusters. The grouping is done by the method of hierarchical classification.

Then, using factorial analysis techniques it will be possible to identify a urban environmental virtuosity index (UEVI), overcoming the problem of choosing weights as currently happens for the definition of composite indicators (OECD 2008).

Variables selected for each sub domain are analyzed by means of PCA with *varimax* rotation (Linting *et al.*, 2007; Svedin, 2009).

As is well known, PCA permits to identify a certain number of latent factors representing the data and their variance. Each one of them depends on a set of coefficients (loadings) that measure the correlation between the original variables and the latent factor.

Following various practices, factors (*subdomains*) may be extracted in an optimal number in order to represent the original data minimizing the loss of variance in the dataset. V*arimax* rotation may be used to minimize the number of indicators that have a high loading on the same factor and so to obtain a "simpler structure" of the factors that helps their interpretation (OECD, 2008). As well known, the eigenvalue represents the explained variance of each factor. The first one has the maximum variance (fig. 1), so it could represents a good synthesis of the phenomenon; on the other hand, each factor is characterized by the different contributions of the original values (see coefficient in tab 2). To merge different information, captured by each factor, we will try to build a composite index for Urban Enveiromental Virtuosity following the methodology proposed by the Oecd (2008) and few papers (Nicoletti et al, 2000; Coco and Russo, 2006; Ercolano and Gaeta, 2010, De Simone et al 2010). For each *j-th* municipality the index value is calculated as follows:

[2] For green domain in a first analysis we had used other variables (such as gree avaibility and green density); but these ones were too much infected by geo-morphological characteristics of municipality and they did not reflect the effective policy choices.

$$R_j = \left(\sum_{i=1}^{n} x_i * \alpha_i\right) * \lambda_\alpha + \left(\sum_{i=1}^{n} x_i * \beta_i\right) * \lambda_\beta + \ .... + \left(\sum_{i=1}^{n} x_i * \omega_i\right) * \lambda_\omega$$

Where:

R represents the UEV indicators for each *j-th* municipalities

x represents the original variables

α, β and ω rapresent the coordinates of each i-th original variables on extracted factors

λ represents the eigenvalue associated to each excracted factor

The approach followed consists in *" weighting each detailed indicator according to the proportion of its variance that is explained by the factor it is associated to (i.e. the normalised squared loading), while each factor [subdomain] was weighted according to its contribution to the portion of the explained variance in the dataset [*in the *domain]"* [Nicoletti et al, 2000].

4. First results

Performing cluster analysis, by means of a parti-decla procedure, we are able to generate a partition that minimize the intra-cluster inertia (variability) and maximize the inter-cluster inertia. Following this procedure, we obtain 3 cluster as reported in tab 2. We report also the factorial plan with the projection of the municipalities and the centre of the clusters (see fig. 2) and the characterization of first factorial analysis in table 3. On the top we find the main municipality represented in each cluster, while in the bottom part we find the variables that characterize the cluster for their presence (positive t-value) or absence (negative t-value). The first one is characterized by "positive" and "negative" aspects; it has an effective policy in the waste (crucial variables show positive high T-value for all separate waste collection and negative T Vale for waste disposal in landfill); sustainable mobility policies and energy sectors show good value too; but it seems not to have a good quality of the air.

Second cluster is composed just by 2 municipalities that shows the higher coordinate on the two factorial axis extracted by the analysis; it is characterized by positive and specific aspects, related to infrastructural policy, such as soundproof asphalt, noise changeling barriers, noise monitoring station, district heating and solar thermic panel on public building and bicycle path.

Third cluster, composed by 50 municipalities, is characterized by the lack of effective environmental policies, especially in waste sector (see high negative T Values for separate waste collection and positive T Value for Waste disposal in landfill), but also in energy and sustainable mobility ones. Positive characteristics for this group are: rationing in the delivery of water for domestic use, pollutant detected and days with anomalous values of PM10. Results of the former variables could be influenced by a political control of the scarcity of water resources, while the latter could be given from the average medium-small size of municipalities.

The main strengths of cluster analysis is to offer a way to group countries giving some insight into the structure of the data set, but it is purely a descriptive tool and it is not able to merge all the different information held in the original variables. As we have explained above, factorial axes represents latent variables that synthesize the original selected indicators, but in each extracted factor we find the synthesis of different variables, so we try to merge all the factors by the methodology, explained in the previous

paragraph. This is the main attempt of our composite indicator – Urban Environmental Virtuosity Index (UEVI) – building up following the reported OECD methodology.
In tab 4 we report the ranking achieved by each municipality using UEVI. At first glance in the top position we find north municipalities (except two municipalities of Sardinia region). This is confirmed by aggregated analysis, defined considering South, North and Centre (see tab 5) and the regional level (see tab 6 and fig. 3).

These results are consistent with a preliminary OLS regression results (see tab 7, 8). Considering some crucial variables, in affecting Environmental policy choices, such as social-demographics, spatial, educational and cultural ones, we find out that UEVI is positively affected by two variables: altimetric zone and population density. On the other hand it is negatively influenced by the localization of municipalities in the south of Italy. UEVI seems not to be affected by economic, cultural-educational variables.

5. Conclusions

Currently a crucial issue for decision makers and citizens is to measure what we have called "environmental virtuosity", that implies to verify if actions to improve environmental quality in urban contexts are taken by local public bodies and their level of effectiveness in achieving certain goals. The aim of the first part of the analysis has been to provide a summary of statistical units, in order to consider the level of virtuosity provided by several municipalities, while the second part has provided a ranking of them considering an indicator of environmental performance, able to measure the efficiency of instruments used by decision-makers, obtained by multivariate approach. Even if environmental composite indicators at urban level already exist, their effectiveness depends on the choice of data (sub-indicators) and of methodology applied to built them. In order to overcome methodological issues arisen from weighting and adding them, we construct UEVI by using factorial analysis. It allows to merge all the different information held in the original variables and to better represent a complex phenomenon as the efficacy environmental choices made by decision makers at local level is. Transport, waste, energy, water and other key sectors by a social and economical point of view can be managed in a sustainable way, but the level of environmental quality achieved by municipalities need to be measured. It could be helpful to understand which of these sectors need to be "environmentally" improved. Obviously this level of virtuosity could be affected by other external variables and not only by political choices. Our ranking shows a strong difference among municipalities situated in the north and in the south of Italy, but differently as it can be imagined, as OLS results show, it do not depends from cultural and educational variables.

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Appendix: tables and graphics

tab. 1: considered variables

Label	Variable	Unit
Ped	Pedestrian areas	m2 / 100 inhabitants
Pist	Density of Bycicle Path	km/100 km2
Dep	Population served by water treatment plants	% on Total production
Erog	Rationing in the delivery of water for domestic use	dummy
PEC	Urban Energetic Plan	dummy
Tel	District heating on public buildings	dummy
PST	Solar thermic panel on public buildings	m2 / 1000 inhabitants
PSF	Power of photovoltaic panel on public buildings	kW/1000 inhabitants
Rum1	Soundproof asphalt	km2 /10.000 km2
Rum2	Noise-canceling barriers	km2/10000 km2
Rum3	Noise monitoring stations	n/ 100 km2
PUT	Urban Trafic Plan	dummy
PV	Local Public Green Plan	dummy
Diff	Separate Waste Collection	% on Total production
Disc	Waste Disposal	kg per capita
Inc	Waste Incinerator	kg per capita
Comp	Composting Treatment	kg per capita
Rec	Recovered waste	kg per capita
Tras1	Seats in public transport	Seats km pc
Tras2	Local Public transport (Bus, Tram)	n / 10.000 inhabitants
Inq	Pollutant detected	n pc
Cent_pc	Diffusion air monitoring Stations	n/ 100.000 inhabitatnts
Cent_d	Desnity of Air Monitoring Stations	n/ Km2
Sup_PM10	Days with anomalous values of PM10	n

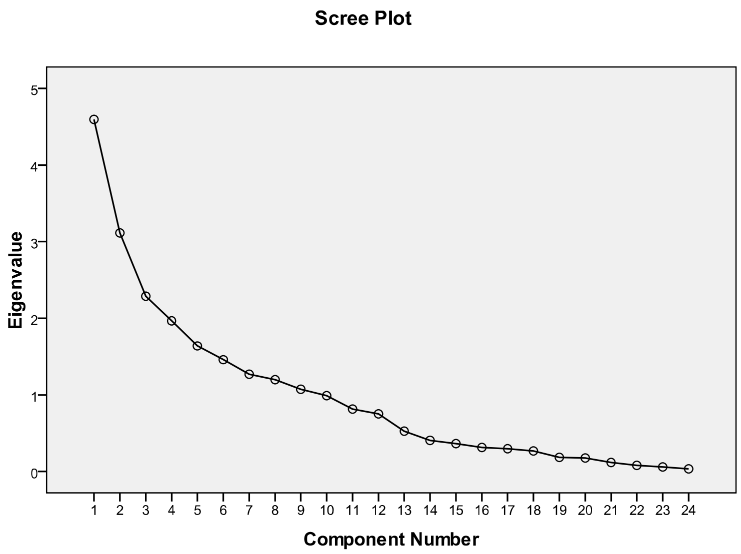

fig. 1: plot of eigenvalue

	Component								
	1	2	3	4	5	6	7	8	9
Ped	,059	-,249	,602	,382	,066	-,134	,178	-,006	,196
Pist	,480	,302	-,011	,356	,231	,142	,085	,398	-,067
Dep	,102	,022	-,052	-,052	-,025	,759	,193	-,060	,050
Erog	-,218	-,028	-,041	-,002	-,025	-,132	-,745	-,502	-,058
PEC	,255	,030	,555	-,099	-,451	-,088	-,243	-,155	,057
Tel	,275	,499	,224	,306	,101	,332	-,261	,283	-,230
PST	-,068	,179	-,090	,130	-,047	,061	,461	-,155	-,290
PSF	-,300	-,150	-,207	-,141	-,035	,541	,076	-,087	,492
Rum1	,155	,780	,220	-,088	-,075	-,005	,047	,009	,256
Rum2	,030	,898	,052	,041	,062	,012	,148	,011	-,060
Rum3	-,224	,806	-,045	,038	,000	-,238	,034	-,155	-,063
PUT	,255	,066	,141	,142	,133	,021	,731	-,244	-,109
PV	,017	,102	,020	,226	-,120	-,030	-,219	,076	,835
Diff	,876	-,032	-,003	,357	-,005	-,003	,100	,017	-,013
Disc	-,485	-,034	-,012	-,814	,111	,037	-,131	,029	,002
Inc	,080	,037	,030	,909	-,100	-,126	,079	,081	,159
Comp	,847	,009	-,120	-,013	-,031	-,155	,112	,022	,046
Rec	,555	-,147	,109	,393	-,071	,267	,099	,390	-,172
Tras1	-,082	,096	,885	-,006	,019	-,167	,084	,054	-,021
Tras2	-,128	,274	,813	-,020	,176	,085	-,031	,078	-,107
Inq	,358	,235	,172	,068	,082	-,674	,224	,059	,301
Cent_pc	,103	-,153	,013	-,026	,863	-,026	-,025	-,052	-,016
Cent_d	-,102	,224	,143	-,163	,812	-,075	,078	-,087	-,091
Sup_PM10	,042	-,084	,038	,040	-,132	-,183	-,128	,885	,088

Tab. 2: Cluster Analysis results

Cluster 1 / 3 Count: 55		Cluster 2 / 3 Count: 2		Cluster 3 / 3 Count: 50	
Rank	**Case identifier**	**Rank**	**Case identifier**	**Rank**	**Case identifier**
1	Pavia	1	Bolzano	1	Brindisi
2	Rimini	2	Bologna	2	Salerno
3	Livorno			3	Chieti
4	Lecco			4	Messina
5	Verona			5	Lecce
6	Belluno			6	Catanzaro
7	Pordenone			7	Campobasso
8	Alessandria			8	Agrigento
9	Firenze			9	Avellino
10	Pisa			10	Taranto
Characteristic variables	**Test-value**	**Characteristic variables**	**Test-value**	**Characteristic variables**	**Test-value**
Diff	7,99	Rum1	7,10	Disc	7,57
Rec	7,47	Rum3	6,86	Erog	4,78
Pist	5,38	Rum2	6,29		
Inc	5,27	Tel	3,52	Ped	-2,68
Comp	5,25	Pist	2,85	PEC	-2,84
Sup_PM10	4,92	PST	2,57	Tel	-3,34
Inq	3,28			Inq	-3,81
Ped	2,69			Sup_PM10	-4,92
PEC	2,64			Comp	-5,36
Tel	2,38			Inc	-5,72
				Pist	-6,16
Rum3	-2,46			Rec	-7,41
Erog	-4,58			Diff	-8,17
Disc	-7,15				

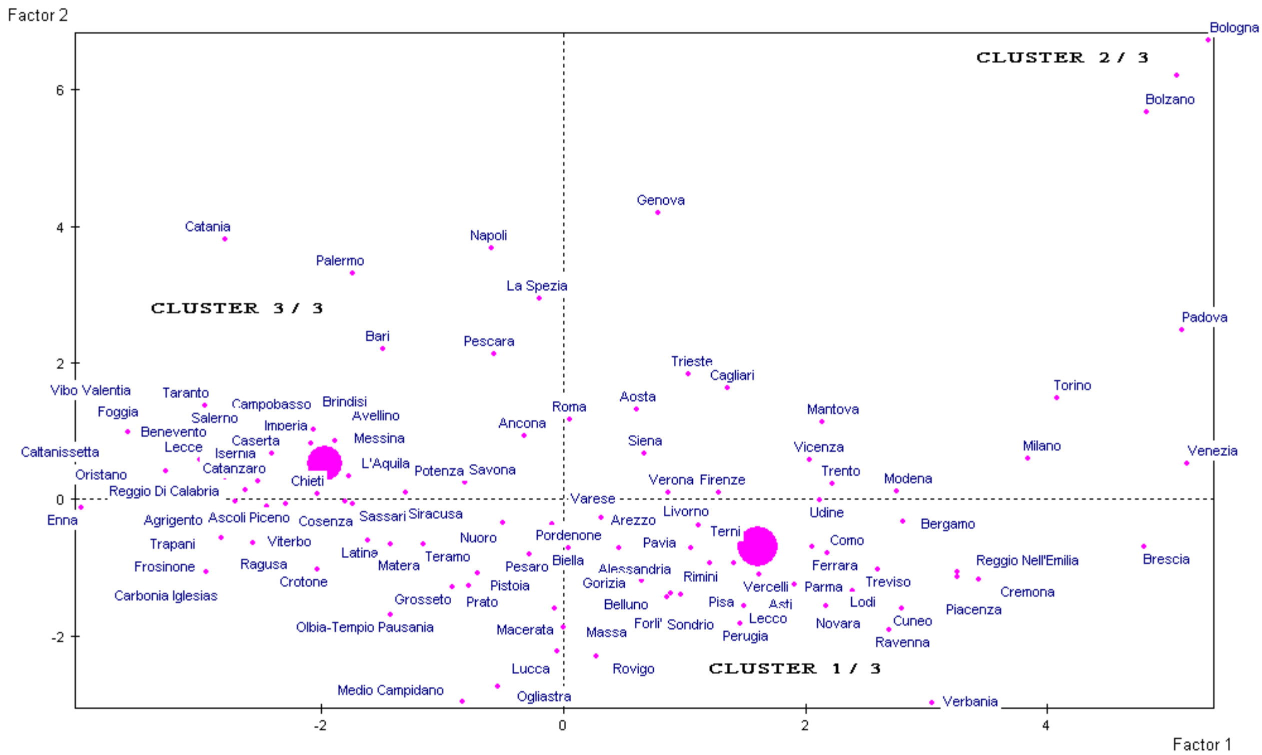

Fig. 2: factorial plan

Tab. 3: characterization of first factorial axis

Variable label	Coordinate
Disc	-0,75
Erog	-0,53
PSF	-0,27
Cent_pc	-0,14
M I D D L E A R E A	
Sup_PM10	0,54
Inq	0,54
Inc	0,62
Diff	0,71
Rec	0,72
Pist	0,73

Tab. 4: UEVI ranking

Rank	Municipality	UEVI	Rank	Municipality	UEVI	Rank	Municipality	UEVI
1	Venezia	67,36295	37	Bergamo	41,63349	73	Trieste	34,5864
2	Massa	58,58535	38	Verona	41,5967	74	Chieti	34,41079
3	Rimini	55,04188	39	Treviso	41,06623	75	Crotone	34,2527
4	Ravenna	54,25123	40	Ancona	40,84767	76	Imperia	34,05143
5	Brescia	54,04574	41	Parma	40,71088	77	Genova	33,92952
6	Reggio Nell'Emilia	51,59164	42	Cuneo	40,50554	78	Viterbo	33,90423
7	Torino	51,53233	43	Bari	40,17672	79	L'Aquila	33,8009
8	Padova	51,52266	44	Pistoia	39,88983	80	Teramo	33,7053
9	Piacenza	50,72276	45	Bolzano	39,58984	81	Aosta	33,52266
10	Lucca	50,32711	46	Cagliari	39,52322	82	Messina	33,31803
11	Pisa	49,71646	47	Palermo	39,4171	83	Lecco	32,84916
12	Mantova	49,55781	48	Pescara	39,24076	84	Sassari	32,46104
13	Alessandria	49,29588	49	Oristano	39,06511	85	Rieti	32,17225
14	Prato	48,91584	50	Perugia	38,76533	86	Caltanissetta	31,93247
15	Cremona	48,6885	51	Napoli	38,74441	87	Caserta	31,89524
16	Forli'	48,4902	52	Sondrio	38,34939	88	Medio Campidano	31,8161
17	Pesaro	47,82155	53	Udine	38,33723	89	Cosenza	31,70531
18	Firenze	47,50523	54	Livorno	38,24346	90	Macerata	31,11444
19	Siracusa	47,37581	55	Brindisi	37,99002	91	Foggia	30,81768
20	Olbia-Tempio Pausania	46,9648	56	Taranto	37,78901	92	Reggio Di Calabria	30,67609
21	Rovigo	45,71611	57	Frosinone	37,61709	93	Avellino	30,67594
22	Verbania	45,66665	58	Como	37,52623	94	Carbonia Iglesias	30,31072
23	Vercelli	45,48692	59	Savona	37,39841	95	Gorizia	29,83578
24	Catania	45,21594	60	Lecce	37,32084	96	Catanzaro	29,36849
25	Ferrara	44,5399	61	Trento	37,14107	97	Nuoro	29,08717
26	Bologna	44,39222	62	La Spezia	37,02818	98	Benevento	28,76909
27	Modena	44,38738	63	Varese	37,00193	99	Ragusa	28,4285
28	Roma	44,38128	64	Arezzo	36,46094	100	Campobasso	27,55304
29	Vicenza	44,13685	65	Latina	36,34615	101	Enna	27,4824
30	Siena	43,60463	66	Pordenone	36,33895	102	Belluno	27,44757
31	Grosseto	43,52498	67	Salerno	36,17448	103	Trapani	27,02759
32	Terni	43,52389	68	Agrigento	35,46521	104	Potenza	26,70072
33	Pavia	43,05946	69	Novara	35,38496	105	Matera	25,89601
34	Milano	42,33893	70	Biella	34,94104	106	Ogliastra	25,74042
35	Ascoli Piceno	42,19345	71	Vibo Valentia	34,82439	107	Isernia	25,23598
36	Lodi	41,80953	72	Asti	34,6816			

Tab. 5: Average UEVI for macro-zone

Geo Area	Average	Dev St
South	33,7088888	5,684656
North	42,3715595	7,806131
Centre	42,1648163	6,786676

Tab. 6: UEVI at regional level

Rank	Region	Average	Dev.St
1	Emilia Romagna	48,2364543	4,998587
2	Toscana	45,6773823	6,675073
3	Veneto	45,5498677	12,08948
4	Lombardia	42,4418349	6,231189
5	Piemonte	42,186866	6,748531
6	Umbria	41,1446115	3,364814
7	Marche	40,4942751	6,944599
8	Trentino	38,3654544	1,731541
9	Lazio	36,8841991	4,693495
10	Puglia	36,8188551	3,530376
11	Liguria	35,6018836	1,867488
12	Abruzzo	35,2894393	2,652683
13	Friuli	34,7745909	3,631664
14	Sardegna	34,3710722	6,930788
15	Sicilia	33,5359057	6,352066
16	Valle d'Aosta	33,5226575	0
17	Campania	33,2518321	4,101246
18	Calabria	32,1653958	2,328063
19	Molise	26,3945102	1,638409
20	Basilicata	26,2983629	0,569017
	Italia	**39,0926022**	**7,995127**

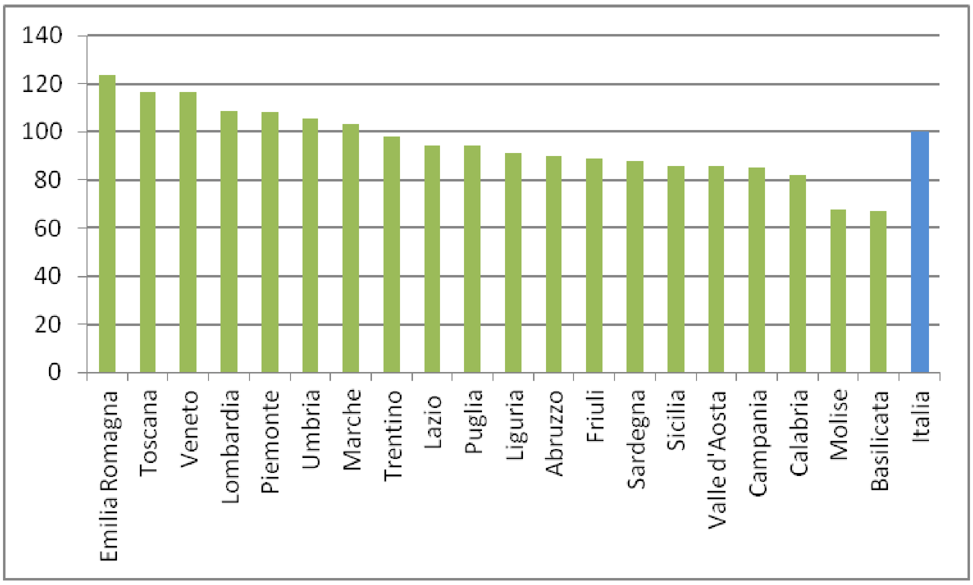

Fig. 3: UEVI at regional level

Tab. 7: Description of variables used in OLS regression

Label	Description
Surface	Municipality surface
AltZone	Atimetric zone of municipality
Pop0_14	Population 0-14 (% of total population)
Part_Assoc_pc	Index of parties and association
GDP_pc	Gross Domestic Product (current price)
South_Dummy	South region
Univ_dummy	Presence of University institution
Den_pop	Population Desnity

Tab. 8: First results of OLS regression (dependent variable UEVI; R-squared 0,40)

	Coefficiente	*Errore Std.*	*rapporto t*	*p-value*	
const	31,8483	11,744	2,7119	0,00794	***
Surface	0,00372699	0,00404048	0,9224	0,35865	
AltZone	1,54283	0,497793	3,0993	0,00255	***
Pop0_14	5,6436	49,4364	0,1142	0,90935	
Part_Assoc_pc	-0,11608	9,10126	-0,0128	0,98985	
GDP_pc	9,19061e-05	0,000328863	0,2795	0,78049	
South_Dummy	-8,59769	3,14685	-2,7322	0,00750	***
Univ_dummy	0,164647	1,39114	0,1184	0,90604	
Den_pop	0,000883177	0,000410063	2,1538	0,03379	**