**Table 8** Region contribution to clusters

| Region | Cluster 1 | Cluster 2 | Cluster 3 | Total |
|---|---|---|---|---|
| Abruzzo | | | 4 | 4 |
| Basilicata | | | 2 | 2 |
| Calabria | | | 5 | 5 |
| Campania | | | 5 | 5 |
| Emilia Romagna | 7 | 2 | | 9 |
| Friuli Venezia Giulia | 3 | 1 | | 4 |
| Lazio | 1 | | 4 | 5 |
| Liguria | | 3 | 1 | 4 |
| Lombardia | 12 | | | 12 |
| Marche | 1 | 4 | | 5 |
| Molise | | | 2 | 2 |
| Piemonte | 4 | 4 | | 8 |
| Puglia | | | 6 | 6 |
| Sardegna | | 1 | 3 | 4 |
| Sicilia | | | 9 | 9 |
| Toscana | 2 | 8 | | 10 |
| Trentino Alto Adige | 2 | | | 2 |
| Umbria | | 2 | | 2 |
| Valle d'Aosta | 1 | | | 1 |
| Veneto | 5 | 2 | | 7 |
| total | 38 | 27 | 41 | 106 |

**Fig. 4** Ternary plot
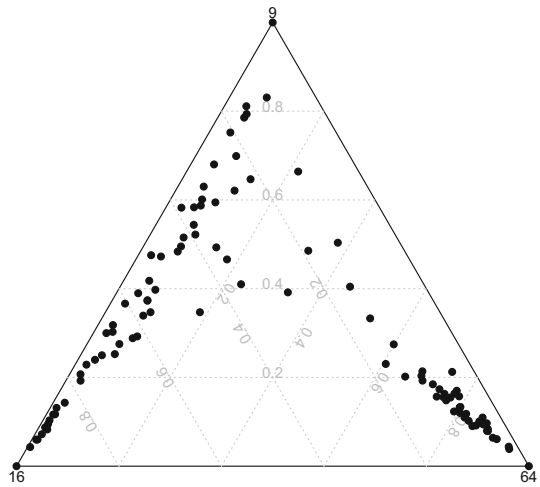
**Table 9** Fuzzy C-medoids with contiguity constraints

|  | Pillar I | Pillar II | Pillar III | Pillar IV | Pillar V | Pillar VI | Pillar VII | Pillar VIII | Pillar IX | Pillar X | Pillar XI |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cluster 1 | 0.45 | 0.01 | − 0.35 | 0.18 | 1.14 | 0.25 | 0.37 | 0.11 | − 0.02 | 0.52 | − 0.23 |
| Cluster 2 | 0.03 | − 0.25 | − 0.50 | 0.20 | 0.40 | 0.32 | 0.00 | − 0.74 | − 0.30 | 0.53 | − 0.42 |
| Cluster 3 | − 0.99 | − 0.42 | − 0.29 | − 0.47 | − 0.73 | 0.05 | − 0.62 | − 0.54 | − 0.80 | − 0.50 | − 0.87 |

**Table 10** Basic, Efficiency and Innovation profiling of the clusters - contiguity

|  | Basic | Efficiency | Innovation |
|---|---|---|---|
| Cluster 1 (Bergamo) | 0.25 | 0.15 | 0.10 |
| Cluster 3 (Fermo) | 0.06 | − 0.10 | − 0.18 |
| Cluster 2 (Avellino) | − 0.59 | − 0.60 | − 0.72 |

0.1, and the value of $\beta$ corresponding to the greatest $\rho_{overall}$ index has been selected. A value of $\beta = 0.8$ has been chosen, related to a correlation value $\rho_{overall} = 0.53$.

The numerosity of the clusters is: cluster 1 55 provinces, cluster 2 10 provinces, cluster 3 41 provinces.

The medoids are presented in Table 9.

As a complementary profiling information the average values of the three subindexes within each cluster is computed (Table 10).

Overwhelmingly, with respect to the partitioning without spatial contraints in which there is one cluster with very good, one with medium and one with low competitiveness, the grouping of provinces in the same geographic area gives rise to one cluster with very good and two with low/very low competitiveness.

Cluster 1, has medoid Bergamo, as in the partition without spatial constraint. The average value of the Innovation subindex is smaller than in cluster 1 without contiguity constraints, being the medoid the same. We underline that with respect to the partition without contiguity constraints Roma, which has among the greatest values of the indicators in the subindexes Efficiency and Innovation, has moved to cluster 3.

Cluster 2, with medoid Fermo, is characterised by values of the indicators under zero. Pillars IV, V, VI, X show a positive values. Provinces in cluster 2 show negative values of the Efficiency and Innovation competititveness subindexes.

Cluster 3, has medoid Avellino, as in the partition without spatial constraint.

The greatest membership and the cluster are presented in Table 11 (in bold the medoids) and shown in Fig. 5. There is only one province, Cagliari, showing membership under 0.50. Overall, the contiguity constraint forces the contiguous provinces, generally located in the same region, in the same cluster. Few provinces violate the contiguity within the region: Arezzo with respect to contiguos provinces in Toscana; Rimini with respect to contiguos provinces in Emilia Romagna.

The contribution of the regions to the clusters is presented in Table 12. Nine regions contribute to cluster 1, all located in the North area of Italy except Toscana. Five regions

**Table 11** Membership and cluster of the provinces - contiguity

| Region | Province | Membership | Cluster | Region | Province | Membership | Cluster |
|---|---|---|---|---|---|---|---|
| Piemonte | Torino | 0.97 | 1 | Toscana | Lucca | 0.96 | 1 |
| Piemonte | Vercelli | 0.99 | 1 | Toscana | Pistoia | 0.96 | 1 |
| Piemonte | Novara | 0.99 | 1 | Toscana | Firenze | 0.94 | 1 |
| Piemonte | Cuneo | 0.98 | 1 | Toscana | Livorno | 0.50 | 1 |
| Piemonte | Asti | 0.99 | 1 | Toscana | Pisa | 0.79 | 1 |
| Piemonte | Alessandria | 0.97 | 1 | Toscana | Arezzo | 0.54 | 2 |
| Piemonte | Biella | 0.92 | 1 | Toscana | Siena | 0.52 | 1 |
| Piemonte | Verbano C.O. | 0.89 | 1 | Toscana | Grosseto | 0.38 | 1 |
| Valle d'Aosta | Aosta | 0.95 | 1 | Toscana | Prato | 0.90 | 1 |
| Liguria | Imperia | 0.58 | 1 | Umbria | Perugia | 0.91 | 2 |
| Liguria | Savona | 0.94 | 1 | Umbria | Terni | 0.46 | 2 |
| Liguria | Genova | 0.97 | 1 | Lazio | Viterbo | 0.79 | 3 |
| Liguria | La Spezia | 0.86 | 1 | Lazio | Rieti | 0.83 | 3 |
| Lombardia | Varese | 0.99 | 1 | Lazio | Roma | 0.80 | 3 |
| Lombardia | Como | 0.99 | 1 | Lazio | Latina | 0.99 | 3 |
| Lombardia | Sondrio | 0.98 | 1 | Lazio | Frosinone | 1.00 | 3 |
| Lombardia | Milano | 0.88 | 1 | Campania | Caserta | 0.99 | 3 |
| Lombardia | **Bergamo** | **1.00** | **1** | Campania | Benevento | 0.97 | 3 |
| Lombardia | Brescia | 1.00 | 1 | Campania | Napoli | 0.94 | 3 |
| Lombardia | Pavia | 0.99 | 1 | Campania | **Avellino** | **1.00** | **3** |
| Lombardia | Cremona | 1.00 | 1 | Campania | Salerno | 0.98 | 3 |
| Lombardia | Mantova | 0.99 | 1 | Abruzzo | L'Aquila | 0.99 | 3 |
| Lombardia | Lecco | 0.99 | 1 | Abruzzo | Teramo | 0.92 | 3 |
| Lombardia | Lodi | 0.98 | 1 | Abruzzo | Pescara | 0.90 | 3 |
| Lombardia | Monza Brianza | 1.00 | 1 | Abruzzo | Chieti | 0.97 | 3 |
| Trentino Alto Adige | Bolzano | 0.94 | 1 | Molise | Campobasso | 0.99 | 3 |
| Trentino Alto Adige | Trento | 0.98 | 1 | Molise | Isernia | 0.99 | 3 |

Table 11 continued

| Region | Province | Membership | Cluster | Region | Province | Membership | Cluster |
|---|---|---|---|---|---|---|---|
| Veneto | Verona | 1.00 | 1 | Puglia | Foggia | 0.99 | 3 |
| Veneto | Vicenza | 0.99 | 1 | Puglia | Bari | 0.96 | 3 |
| Veneto | Belluno | 1.00 | 1 | Puglia | Taranto | 0.97 | 3 |
| Veneto | Treviso | 1.00 | 1 | Puglia | Brindisi | 0.96 | 3 |
| Veneto | Venezia | 0.96 | 1 | Puglia | Lecce | 0.95 | 3 |
| Veneto | Padova | 0.99 | 1 | Puglia | Barletta A.T. | 0.96 | 3 |
| Veneto | Rovigo | 0.98 | 1 | Basilicata | Potenza | 0.99 | 3 |
| Friuli Venezia Giulia | Udine | 0.98 | 1 | Basilicata | Matera | 0.99 | 3 |
| Friuli Venezia Giulia | Gorizia | 0.82 | 1 | Calabria | Cosenza | 0.98 | 3 |
| Friuli Venezia Giulia | Trieste | 0.69 | 1 | Calabria | Catanzaro | 0.98 | 3 |
| Friuli Venezia Giulia | Pordenone | 0.98 | 1 | Calabria | Reggio Calabria | 0.92 | 3 |
| Emilia Romagna | Piacenza | 0.99 | 1 | Calabria | Crotone | 0.89 | 3 |
| Emilia Romagna | Parma | 0.98 | 1 | Calabria | Vibo Valentia | 0.93 | 3 |
| Emilia Romagna | Reggio Emilia | 0.99 | 1 | Sicilia | Trapani | 0.87 | 3 |
| Emilia Romagna | Modena | 0.99 | 1 | Sicilia | Palermo | 0.97 | 3 |
| Emilia Romagna | Bologna | 0.96 | 1 | Sicilia | Messina | 0.97 | 3 |
| Emilia Romagna | Ferrara | 0.95 | 1 | Sicilia | Agrigento | 0.94 | 3 |
| Emilia Romagna | Ravenna | 0.99 | 1 | Sicilia | Caltanissetta | 0.96 | 3 |
| Emilia Romagna | Forlì Cesena | 0.88 | 1 | Sicilia | Enna | 0.95 | 3 |
| Emilia Romagna | Rimini | 0.49 | 2 | Sicilia | Catania | 0.97 | 3 |
| Marche | Pesaro Urbino | 0.93 | 2 | Sicilia | Ragusa | 0.93 | 3 |
| Marche | Ancona | 0.94 | 2 | Sicilia | Siracusa | 0.91 | 3 |
| Marche | Macerata | 0.99 | 2 | Sardegna | Sassari | 0.85 | 3 |
| Marche | Ascoli Piceno | 0.86 | 2 | Sardegna | Nuoro | 0.84 | 3 |
| Marche | **Fermo** | **1.00** | **2** | Sardegna | Cagliari | 0.37 | 2 |
| Toscana | Massa Carrara | 0.87 | 1 | Sardegna | Oristano | 0.80 | 3 |
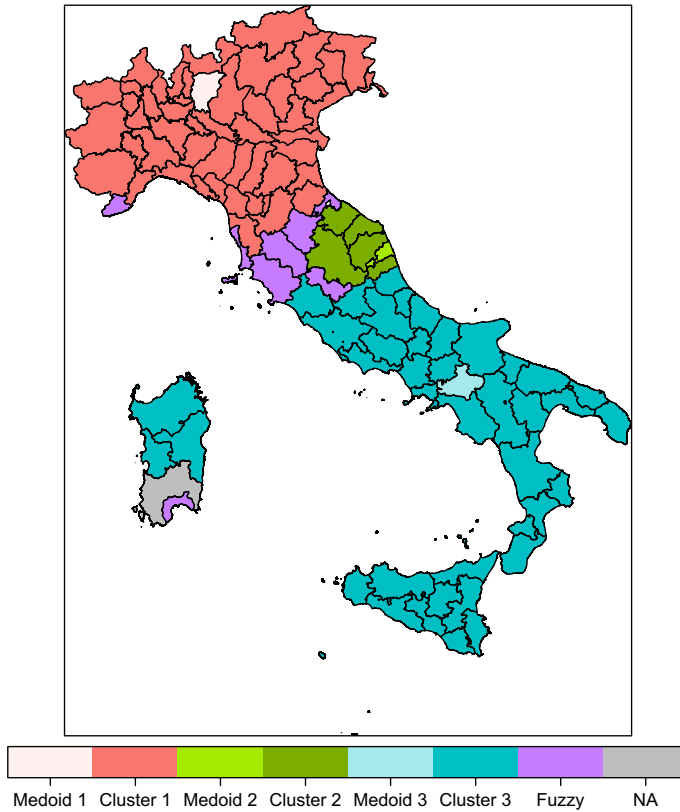
**Fig. 5** Cartogram cluster representation - contiguity constraint. Different colors for medoids, clusters and fuzzy provinces. (Color figure online)

contribute to cluster 2, all located in the Centre and South areas. Nine regions contribute to cluster 3, all located in the South area. As a general comment provinces in the same region are assigned to the same cluster.

The ternary plot of the memberships is presented in Fig. 6. It shows very few fuzzy provinces.

## 5 Conclusions

In this paper indicators of attractiveness at NUTS3 level in the framework of the EU Regional Competitiveness Index (RCI) are proposed. Then the Fuzzy C-Medoids Clustering model with multivariate data and *contiguity* constraints is applied for partitioning the Italian provinces (NUTS3). The novelty is the territorial level analized, and the identification of the indicators at the basis of the construction of the eleven composite competitiveness pillars. A *contiguity* constraint, based on the geographic contiguity of provinces, is also introduced in the model. With respect to the partitioning without spatial contraints in which there is one cluster with very good, one with medium and one with low competitiveness, the grouping of provinces in the same geographic area gives rise to one cluster with very good and two with low/very low competitiveness.

**Table 12** Region contribution to clusters

| Region | Cluster 1 | Cluster 2 | Cluster 3 | Total |
|---|---|---|---|---|
| Abruzzo | | | 4 | 4 |
| Basilicata | | | 2 | 2 |
| Calabria | | | 5 | 5 |
| Campania | | | 5 | 5 |
| Emilia Romagna | 8 | 1 | | 9 |
| Friuli Venezia Giulia | 4 | | | 4 |
| Lazio | | | 5 | 5 |
| Liguria | 4 | | | 4 |
| Lombardia | 12 | | | 12 |
| Marche | | 5 | | 5 |
| Molise | | | 2 | 2 |
| Piemonte | 8 | | | 8 |
| Puglia | | | 6 | 6 |
| Sardegna | | 1 | 3 | 4 |
| Sicilia | | | 9 | 9 |
| Toscana | 9 | 1 | | 10 |
| Trentino Alto Adige | 2 | | | 2 |
| Umbria | | 2 | | 2 |
| Valle d'Aosta | 1 | | | 1 |
| Veneto | 7 | | | 7 |
| total | 55 | 10 | 41 | 106 |

**Fig. 6** Ternary plot
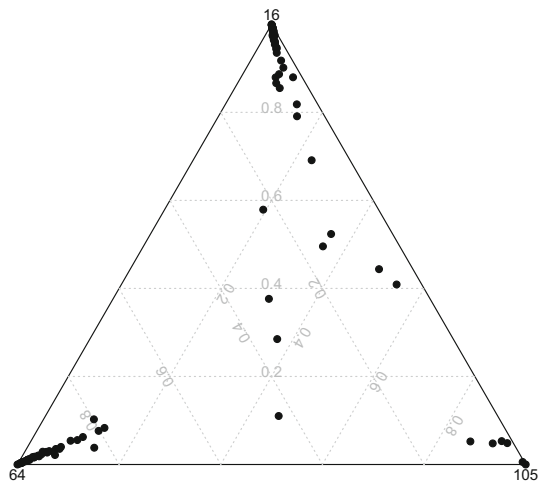


The first contribution of the paper is the territoral dimension of attractiveness. at NUTS3 level. The obtained provincial partitions based on the eleven dimensions - pillars - of attractiveness are not the end point of a statistical exercise in itself, but rather a starting point

**Table 13** Pillars by province

| Region | Province | Pillar I | Pillar II | Pillar III | Pillar IV | Pillar V | Pillar VI | Pillar VII | Pillar VIII | Pillar IX | Pillar X | Pillar XI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Piemonte | Torino | 0.76 | 0.35 | 0.66 | 0.04 | 0.49 | 0.72 | 0.76 | 0.38 | 0.42 | 0.49 | 1.35 |
| Piemonte | Vercelli | 0.67 | − 0.30 | − 0.66 | − 0.08 | 0.35 | 0.06 | 0.21 | − 0.54 | − 0.42 | 0.29 | − 0.69 |
| Piemonte | Novara | 0.61 | 0.02 | − 0.26 | − 0.63 | 0.51 | 0.03 | 0.83 | − 0.25 | − 0.08 | 0.57 | 0.12 |
| Piemonte | Cuneo | 0.86 | − 0.40 | − 0.36 | 0.26 | 1.16 | − 0.14 | 0.54 | − 0.05 | − 0.32 | 0.08 | − 0.16 |
| Piemonte | Asti | 0.70 | − 0.01 | − 0.41 | 0.09 | 0.92 | − 0.13 | 0.24 | − 0.29 | − 0.46 | − 0.15 | − 0.45 |
| Piemonte | Alessandria | 0.54 | − 0.43 | − 0.38 | − 1.20 | 0.09 | 0.29 | 0.33 | − 0.44 | − 0.39 | 0.10 | − 0.45 |
| Piemonte | Biella | 0.75 | − 0.18 | − 0.62 | − 0.69 | 0.35 | 0.57 | 0.66 | − 0.46 | − 0.65 | 0.50 | − 0.65 |
| Piemonte | Verbano C.O. | 0.80 | − 0.87 | − 0.49 | − 0.64 | 0.83 | − 0.24 | 0.28 | − 0.42 | − 0.99 | − 0.36 | − 0.51 |
| Valle d'Aosta | Aosta | 1.04 | 0.65 | − 0.87 | − 0.37 | 0.93 | − 0.55 | 0.41 | − 0.12 | − 0.10 | − 0.20 | 0.41 |
| Liguria | Imperia | 0.12 | 0.21 | − 0.51 | 0.03 | 0.04 | − 0.46 | − 0.37 | − 0.63 | − 0.98 | − 0.94 | − 0.58 |
| Liguria | Savona | 0.45 | − 0.11 | − 0.02 | − 0.01 | 0.16 | 0.78 | 0.18 | − 0.57 | − 0.32 | − 0.18 | − 0.38 |
| Liguria | Genova | 0.39 | − 0.51 | 0.59 | − 0.08 | 0.21 | 0.64 | 0.38 | 0.08 | 0.03 | − 0.05 | − 0.24 |
| Liguria | La Spezia | 0.34 | − 0.63 | 0.18 | − 0.48 | 0.00 | 0.32 | 0.07 | − 0.28 | − 0.20 | − 0.19 | − 0.42 |
| Lombardia | Varese | 0.45 | 0.03 | − 0.38 | 0.88 | 0.88 | − 0.06 | 0.69 | − 0.15 | 0.29 | 0.61 | − 0.02 |
| Lombardia | Como | 0.50 | − 0.01 | − 0.46 | 0.86 | 1.24 | − 0.17 | 0.48 | − 0.27 | − 0.11 | 0.39 | 0.09 |
| Lombardia | Sondrio | 0.43 | 0.17 | − 1.54 | − 0.49 | 1.59 | 0.19 | 0.43 | − 0.35 | − 0.42 | − 0.29 | − 0.70 |
| Lombardia | Milano | 0.66 | 0.38 | 2.42 | 0.53 | 0.69 | 0.83 | 1.32 | 2.56 | 1.68 | 1.09 | 3.14 |
| Lombardia | Bergamo | 0.45 | 0.01 | − 0.35 | 0.18 | 1.14 | 0.25 | 0.37 | 0.11 | − 0.02 | 0.52 | − 0.23 |
| Lombardia | Brescia | 0.49 | − 0.34 | − 0.12 | 0.67 | 1.22 | − 0.25 | 0.51 | 0.18 | − 0.28 | 0.61 | − 0.10 |
| Lombardia | Pavia | 0.53 | 0.19 | − 0.12 | − 0.31 | 0.62 | 0.42 | 0.97 | − 0.28 | − 0.25 | 0.20 | − 0.49 |
| Lombardia | Cremona | 0.58 | − 0.01 | − 0.41 | − 0.11 | 0.91 | − 0.19 | 0.69 | − 0.30 | − 0.28 | 0.54 | − 0.34 |
| Lombardia | Mantova | 0.66 | − 0.72 | − 0.21 | − 0.38 | 0.83 | − 0.67 | 0.51 | − 0.25 | − 0.74 | 0.52 | − 0.28 |
| Lombardia | Lecco | 0.64 | 0.40 | − 0.56 | 0.97 | 1.42 | 0.35 | 0.67 | − 0.44 | − 0.43 | 0.87 | − 0.01 |
| Lombardia | Lodi | 0.56 | 0.27 | − 0.34 | − 0.24 | 0.73 | − 0.08 | 0.51 | − 0.67 | − 0.48 | 0.42 | − 0.65 |
| Lombardia | Monza Brianza | 0.51 | 0.48 | − 0.31 | 0.56 | 1.21 | 0.28 | 0.78 | 0.12 | 0.44 | 0.66 | 0.04 |
| Trentino Alto Adige | Bolzano | 0.72 | 0.37 | − 0.72 | 0.74 | 0.27 | − 0.34 | 1.06 | 0.70 | 0.68 | − 0.01 | − 0.12 |
| Trentino Alto Adige | Trento | 0.96 | 1.06 | − 0.54 | 0.78 | 1.32 | 0.82 | 0.47 | 0.03 | 0.97 | 0.12 | 0.01 |

**Table 13** continued

| Region | Province | Pillar I | Pillar II | Pillar III | Pillar IV | Pillar V | Pillar VI | Pillar VII | Pillar VIII | Pillar IX | Pillar X | Pillar XI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Veneto | Verona | 0.44 | − 0.15 | − 0.01 | 0.53 | 1.08 | 0.19 | 0.48 | 0.21 | 0.03 | 0.46 | 0.19 |
| Veneto | Vicenza | 0.14 | 0.14 | − 0.11 | 0.76 | 1.41 | 0.08 | 0.62 | 0.07 | 0.24 | 1.23 | 0.23 |
| Veneto | Belluno | 0.29 | − 0.13 | − 0.52 | 0.73 | 1.44 | − 0.08 | 0.69 | − 0.13 | − 0.24 | 0.44 | − 0.54 |
| Veneto | Treviso | 0.53 | 0.10 | − 0.04 | 0.98 | 1.47 | 0.31 | 0.54 | − 0.11 | 0.04 | 0.65 | 0.11 |
| Veneto | Venezia | 0.58 | 0.12 | 1.53 | 0.56 | 0.76 | 0.50 | 0.38 | 0.16 | − 0.01 | − 0.02 | − 0.09 |
| Veneto | Padova | 0.42 | − 0.32 | 0.12 | 0.80 | 1.39 | 0.68 | 0.41 | 0.31 | 0.22 | 0.57 | 0.26 |
| Veneto | Rovigo | 0.42 | − 0.44 | − 0.36 | − 0.03 | 1.04 | 0.63 | 0.17 | − 0.54 | − 0.82 | − 0.08 | − 0.75 |
| Friuli Venezia Giulia | Udine | 1.14 | − 0.33 | − 0.26 | 0.62 | 1.17 | 0.91 | 0.43 | − 0.10 | − 0.39 | 0.24 | 0.43 |
| Friuli Venezia Giulia | Gorizia | 0.89 | − 0.66 | 0.10 | 0.02 | 0.47 | − 0.76 | 0.30 | − 0.33 | 0.23 | 0.41 | − 0.50 |
| Friuli Venezia Giulia | Trieste | 0.93 | − 0.27 | 0.71 | − 0.15 | 0.50 | 1.49 | 1.07 | − 0.21 | 1.18 | 0.27 | 0.03 |
| Friuli Venezia Giulia | Pordenone | 1.00 | − 0.88 | 0.00 | 0.45 | 1.06 | 0.00 | 0.41 | − 0.12 | 0.29 | 0.59 | 0.35 |
| Emilia Romagna | Piacenza | 0.55 | − 0.13 | − 0.38 | − 0.63 | 0.62 | 1.01 | 0.51 | − 0.39 | − 0.07 | 0.47 | − 0.31 |
| Emilia Romagna | Parma | 0.43 | − 0.81 | − 0.07 | 0.15 | 0.60 | 1.36 | 0.72 | 0.04 | 0.07 | 0.72 | 0.51 |
| Emilia Romagna | Reggio Emilia | 0.84 | 0.45 | − 0.08 | 0.39 | 0.56 | 0.22 | 0.33 | − 0.15 | − 0.31 | 0.91 | 0.18 |
| Emilia Romagna | Modena | 0.59 | − 0.10 | − 0.37 | 0.37 | 0.48 | 0.64 | 0.76 | 0.04 | 0.42 | 0.90 | 0.75 |
| Emilia Romagna | Bologna | 0.89 | 0.34 | 0.30 | 0.80 | 0.61 | 1.41 | 0.87 | 0.20 | 0.63 | 0.77 | 1.37 |
| Emilia Romagna | Ferrara | 0.91 | − 0.77 | − 0.35 | − 0.33 | − 0.02 | 1.15 | 0.52 | − 0.39 | − 0.13 | − 0.09 | 0.07 |
| Emilia Romagna | Ravenna | 0.86 | − 0.02 | − 0.15 | 0.59 | 0.91 | − 0.09 | 0.43 | − 0.12 | 0.13 | 0.14 | 0.07 |
| Emilia Romagna | Forlì Cesena | 0.69 | − 0.21 | − 0.51 | 1.01 | 0.90 | 0.28 | 0.25 | − 0.24 | − 0.11 | 0.11 | − 0.03 |
| Emilia Romagna | Rimini | 0.69 | − 1.17 | 0.06 | 0.74 | 0.78 | − 0.30 | − 0.15 | − 0.37 | 0.83 | 0.18 | − 0.09 |
| Marche | Pesaro Urbino | 0.25 | − 1.07 | − 0.43 | 0.48 | 0.20 | 0.46 | − 0.03 | − 0.48 | − 0.04 | 0.36 | − 0.35 |
| Marche | Ancona | 0.46 | − 0.02 | − 0.01 | 0.27 | 0.33 | 0.25 | 0.37 | − 0.31 | 0.48 | 0.46 | 0.23 |
| Marche | Macerata | 0.00 | 0.28 | − 0.54 | 0.47 | 0.46 | 0.28 | − 0.08 | − 0.46 | − 0.63 | 0.19 | − 0.30 |
| Marche | Ascoli Piceno | 0.06 | 0.20 | − 0.45 | 0.22 | 0.25 | 0.98 | − 0.32 | − 0.68 | − 0.16 | 0.26 | − 0.33 |
| Marche | Fermo | 0.03 | − 0.25 | − 0.50 | 0.20 | 0.40 | 0.32 | 0.00 | − 0.74 | − 0.30 | 0.53 | − 0.42 |
| Toscana | Massa Carrara | 0.29 | − 0.57 | − 0.44 | − 0.06 | − 0.47 | 0.06 | 0.07 | − 0.32 | − 0.53 | − 0.16 | − 0.42 |
| Toscana | Lucca | 0.35 | − 0.73 | − 0.39 | 0.51 | − 0.18 | 0.04 | 0.07 | − 0.34 | − 0.41 | 0.27 | − 0.20 |

**Table 13** continued

| Region | Province | Pillar I | Pillar II | Pillar III | Pillar IV | Pillar V | Pillar VI | Pillar VII | Pillar VIII | Pillar IX | Pillar X | Pillar XI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Toscana | Pistoia | 0.45 | − 0.13 | − 0.22 | 0.54 | 0.33 | 0.10 | − 0.12 | − 0.60 | − 0.23 | − 0.45 | − 0.35 |
| Toscana | Firenze | 0.76 | 0.52 | 0.84 | 0.86 | − 0.37 | 1.16 | 0.68 | 0.12 | 0.50 | 0.62 | 0.54 |
| Toscana | Livorno | 0.69 | 0.71 | − 1.30 | 0.25 | − 0.41 | − 0.14 | − 0.20 | − 0.22 | 0.04 | 0.01 | − 0.44 |
| Toscana | Pisa | 0.57 | 0.33 | − 0.10 | 0.72 | − 0.15 | 0.95 | 0.56 | − 0.26 | − 0.06 | 0.19 | 0.39 |
| Toscana | Arezzo | 0.66 | − 0.16 | − 0.50 | 0.67 | 0.23 | − 0.30 | − 0.03 | − 0.37 | − 0.49 | 0.50 | − 0.35 |
| Toscana | Siena | 0.66 | 0.92 | − 0.38 | 0.02 | 0.33 | 0.38 | 0.35 | − 0.18 | 0.49 | − 0.08 | − 0.20 |
| Toscana | Grosseto | 0.32 | 0.24 | − 0.90 | 0.35 | − 0.23 | − 0.38 | − 0.06 | − 0.52 | − 0.76 | − 0.86 | − 0.56 |
| Toscana | Prato | 0.75 | 0.72 | − 0.15 | 0.91 | − 0.04 | 0.33 | 0.33 | − 0.26 | − 0.73 | 0.75 | − 0.43 |
| Umbria | Perugia | 0.03 | − 0.42 | − 0.58 | 0.88 | 0.19 | 0.56 | 0.13 | − 0.60 | − 0.27 | − 0.06 | − 0.37 |
| Umbria | Terni | − 0.14 | − 0.85 | − 0.51 | − 0.17 | − 0.03 | 0.08 | − 0.01 | − 0.67 | − 0.55 | − 0.19 | − 0.57 |
| Lazio | Viterbo | − 0.59 | − 0.11 | − 0.50 | − 1.53 | − 0.27 | 0.05 | − 0.28 | − 0.62 | − 0.74 | − 0.94 | − 0.58 |
| Lazio | Rieti | − 0.65 | − 0.93 | − 0.55 | − 0.11 | − 0.54 | 0.24 | − 0.59 | − 0.85 | − 1.63 | − 0.94 | − 0.54 |
| Lazio | Roma | − 0.67 | − 0.57 | 1.08 | 0.18 | − 0.59 | 0.42 | 0.77 | 0.97 | 0.45 | 1.04 | 1.04 |
| Lazio | Latina | − 0.98 | − 0.31 | − 0.56 | − 0.23 | − 0.51 | − 0.03 | − 0.43 | − 0.50 | − 0.20 | − 0.28 | − 0.78 |
| Lazio | Frosinone | − 0.89 | − 0.70 | − 0.40 | − 0.46 | − 0.51 | − 0.38 | − 0.57 | − 0.52 | − 1.20 | 0.09 | − 0.75 |
| Campania | Caserta | − 1.11 | − 0.42 | − 0.29 | − 1.63 | − 1.24 | − 0.92 | − 1.12 | − 0.58 | − 0.91 | − 0.99 | − 0.82 |
| Campania | Benevento | − 0.86 | − 2.18 | − 0.50 | − 1.30 | − 0.60 | 0.00 | − 0.91 | − 0.76 | − 0.13 | − 0.97 | − 0.81 |
| Campania | Napoli | − 0.84 | 1.05 | − 0.06 | − 1.31 | − 1.15 | − 1.23 | − 0.98 | 0.04 | 0.19 | − 0.58 | − 0.68 |
| Campania | Avellino | − 0.99 | − 0.42 | − 0.29 | − 0.47 | − 0.73 | 0.05 | − 0.62 | − 0.54 | − 0.80 | − 0.50 | − 0.87 |
| Campania | Salerno | − 1.11 | − 1.21 | − 0.59 | − 0.83 | − 0.90 | − 0.54 | − 1.03 | − 0.45 | − 0.18 | − 0.68 | − 0.71 |
| Abruzzo | L'Aquila | − 0.61 | 0.31 | − 0.37 | − 0.44 | − 0.84 | 0.94 | − 0.35 | − 0.53 | − 0.94 | − 0.76 | − 0.58 |
| Abruzzo | Teramo | − 0.82 | − 1.31 | − 0.39 | − 0.58 | − 0.42 | 0.35 | − 0.37 | − 0.55 | − 0.78 | − 0.23 | − 0.61 |
| Abruzzo | Pescara | − 0.76 | − 1.68 | − 0.36 | 0.17 | − 0.21 | 0.39 | − 0.28 | − 0.69 | 0.05 | − 0.26 | − 0.37 |
| Abruzzo | Chieti | − 0.79 | − 1.17 | − 0.49 | 0.26 | − 0.19 | 0.27 | − 0.66 | − 0.24 | − 0.74 | 0.16 | − 0.82 |
| Molise | Campobasso | − 0.37 | 0.28 | − 0.73 | − 1.07 | − 0.17 | − 0.20 | − 0.58 | − 0.83 | − 1.01 | − 0.73 | − 0.75 |
| Molise | Isernia | − 0.64 | 0.63 | − 0.65 | − 1.05 | − 0.69 | 0.65 | − 0.54 | − 0.62 | − 1.33 | − 0.85 | − 0.82 |
| Puglia | Foggia | − 1.75 | − 0.42 | − 0.56 | − 0.52 | − 0.93 | − 0.99 | − 1.30 | − 0.50 | − 0.59 | − 1.17 | − 1.10 |

**Table 13** continued

| Region | Province | Pillar I | Pillar II | Pillar III | Pillar IV | Pillar V | Pillar VI | Pillar VII | Pillar VIII | Pillar IX | Pillar X | Pillar XI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Puglia | Bari | − 1.46 | 0.49 | 0.03 | 0.56 | − 0.32 | − 0.36 | − 0.64 | − 0.10 | 0.30 | − 0.45 | − 0.55 |
| Puglia | Taranto | − 1.32 | 0.22 | − 0.14 | − 0.19 | − 0.68 | − 1.06 | − 1.10 | − 0.42 | − 0.01 | − 0.52 | − 1.11 |
| Puglia | Brindisi | − 1.08 | − 0.25 | − 0.34 | 0.30 | − 0.64 | − 1.37 | − 0.61 | − 0.48 | − 0.62 | − 0.73 | − 1.02 |
| Puglia | Lecce | − 1.19 | − 0.74 | − 1.12 | − 0.02 | − 0.20 | − 0.44 | − 1.19 | − 0.46 | − 0.35 | − 0.81 | − 0.77 |
| Puglia | Barletta Andria Trani | − 1.42 | − 0.33 | − 1.19 | − 0.61 | − 0.35 | − 1.15 | − 1.30 | − 0.36 | − 1.29 | − 0.80 | − 0.95 |
| Basilicata | Potenza | − 0.70 | 0.08 | − 0.88 | − 0.82 | − 0.54 | − 0.24 | − 1.36 | − 0.26 | − 0.16 | 0.07 | − 1.00 |
| Basilicata | Matera | − 0.75 | − 0.47 | − 0.89 | − 0.55 | − 0.26 | − 0.28 | − 0.68 | − 0.51 | − 0.20 | − 1.01 | − 0.93 |
| Calabria | Cosenza | − 0.59 | − 0.33 | − 0.74 | − 1.24 | − 1.44 | − 0.47 | − 1.30 | − 0.75 | − 0.33 | − 1.07 | − 0.89 |
| Calabria | Catanzaro | − 0.79 | − 1.39 | − 0.56 | − 0.80 | − 0.85 | − 0.20 | − 0.76 | − 0.32 | 0.02 | − 1.03 | − 0.92 |
| Calabria | Reggio Calabria | − 0.55 | 0.35 | − 0.61 | − 1.22 | − 1.38 | − 0.85 | − 1.61 | − 0.65 | − 0.38 | − 1.16 | − 1.12 |
| Calabria | Crotone | − 0.58 | − 0.99 | − 1.34 | − 0.67 | − 1.66 | − 1.45 | − 1.25 | − 1.02 | − 0.44 | − 1.14 | − 1.32 |
| Calabria | Vibo Valentia | − 0.95 | − 0.38 | − 0.58 | − 0.04 | − 1.51 | − 1.08 | − 1.27 | − 0.66 | 0.07 | − 1.18 | − 1.03 |
| Sicilia | Trapani | − 0.44 | 1.14 | − 0.51 | − 1.57 | − 1.30 | − 1.25 | − 1.21 | − 0.83 | − 0.76 | − 1.04 | − 0.98 |
| Sicilia | Palermo | − 0.52 | 0.64 | − 0.18 | − 0.58 | − 1.36 | − 1.00 | − 0.94 | − 0.54 | − 0.27 | − 0.81 | − 0.56 |
| Sicilia | Messina | − 0.91 | 0.27 | − 0.57 | − 1.18 | − 0.96 | − 0.64 | − 1.40 | − 0.69 | − 0.50 | − 0.74 | − 0.92 |
| Sicilia | Agrigento | − 0.59 | 0.50 | − 0.83 | − 1.01 | − 1.62 | − 0.91 | − 1.23 | − 0.91 | − 1.46 | − 1.23 | − 1.07 |
| Sicilia | Caltanissetta | − 0.54 | − 0.18 | − 0.72 | − 0.90 | − 1.29 | − 1.70 | − 1.53 | − 1.31 | − 1.00 | − 1.44 | − 1.30 |
| Sicilia | Enna | − 0.59 | 0.20 | − 0.61 | 0.49 | − 2.04 | − 1.09 | − 1.30 | − 0.96 | − 1.24 | − 1.15 | − 1.21 |
| Sicilia | Catania | − 0.94 | 0.26 | − 0.14 | − 0.38 | − 1.18 | − 1.41 | − 0.92 | − 0.65 | − 0.09 | − 0.82 | − 0.85 |
| Sicilia | Ragusa | − 0.86 | 0.48 | − 0.87 | − 0.32 | − 0.66 | − 1.36 | − 1.18 | − 0.79 | − 0.10 | − 1.05 | − 0.84 |
| Sicilia | Siracusa | − 0.90 | − 0.04 | − 0.60 | − 0.71 | − 1.34 | − 1.73 | − 1.17 | − 0.61 | − 0.52 | − 0.11 | − 0.97 |
| Sardegna | Sassari | − 0.22 | 0.90 | − 0.61 | − 0.20 | − 1.49 | − 0.88 | − 0.39 | − 0.46 | − 0.73 | − 0.87 | − 0.70 |
| Sardegna | Nuoro | − 0.40 | 1.23 | − 1.16 | − 0.65 | − 1.47 | − 0.85 | − 0.68 | − 0.68 | − 0.86 | − 1.21 | − 0.93 |
| Sardegna | Cagliari | − 0.33 | 2.74 | − 0.45 | 0.51 | − 1.27 | 0.24 | 0.11 | − 0.18 | − 0.48 | 0.10 | 0.51 |
| Sardegna | Oristano | − 0.45 | 1.60 | − 0.92 | 0.36 | − 1.63 | 0.10 | − 0.70 | − 0.63 | − 1.30 | − 1.11 | − 0.72 |

for an exhaustive reading of our territories. Each composite pillar enables to carry out a precise anamnesis of the territory through the "components" of the pillar, and then to define the "cure" with the formulation of policy proposals tailored to each territory. The added value of the measurement approach adopted lies in its biunivocity: it is possible to move from indicators to pillars and vice versa. In this rewind activity, it is possible to identify the elementary indicator(s) whose value has been decisive in generating a given performance in a particular pillar, that is in a dimension of attractivity.

The second contribution of the paper is the relevance of policies based on contiguity of territories. The analysis has shown that contiguous provinces may be assigned to different clusters, even in the presence of contiguity constraints in the clustering model, showing the relevance of policies based on a NUTS3 level, a route already considered by the Italian government.

The analysis developed and the related set of indicators at NUTS3 level constitute an information base that could be effectively used for the implementation of the National Recovery and Resilience Plan (NRRP). The proposed indicators enrich the information framework at disposal of the policy makers constituted by the BES of the territories (BES-Istat) and can guide the allocation of European resources according to the extent of the territorial gap.

## Appendix

*Pillar I - Institutions* The indicators selected for the analysis are:

- PENDING TRIALS (reversed). Pending trials of more than three years - civil justice - percentage values of total proceedings. The incidence of proceedings that have not been resolved within the time limits provided by law and that have been in "storage" for more than three years measure the degree of inefficiency of the judicial system, which has a strong impact on the operating costs of the public apparatus. In fact, the parties involved could claim compensation from the State for unreasonable duration and this waste of resources, taken away from strategic investments for the area, explains the negative sign with respect to attractiveness.

- TRIAL DURATION (reversed). Effective average duration in days of civil proceedings - civil justice. The duration of civil proceedings has historically been a major obstacle to the attraction of foreign direct investment (FDI) of the greenfield type where the company builds new facilities ("green") such as sales office, production plant that have a strong impact on the territory because of the creation of new jobs, in particular for the cumbersome nature of the resolution of labor disputes between the employer and the employee.

- VOTE PARTICIPATION. European elections, as a percentage of total eligible voters, average, 2004, 2009, 2014, 2019.

- FEMALE MUNICIPAL ADMINISTRATORS OUT OF TOTAL LOCAL ADMINISTRATORS. Gender equity in terms of "representation" is a proxy for the status and role of women in society.

- SOCIAL RELATIONS INTENSITY. Non profit organizations, per 10000 inhabitants. The solidarity networks of associationism are a strength of a territory that makes up for the shortcomings of public services provided at the local level.

- ADMINISTRATIVE CAPACITY (NUTS3 level). Rating classes: "excellent" score 90-100; "very good" 80-89; "good" 60-79; "satisfactory" 50-59; "weak" 40-49; "poor" 20-39;

"fallible" 0–19, (Fondazione Etica on data from Amministrazione Trasparente). The Public Rating evaluates not the policies but the administrative machine that those policies produce. It analyzes, from an ESG (Enviromental, Social, Governance) sustainability perspective, six areas related to the administrative capacity of Public Administrations: Budget, Governance, Personnel Management, Services and relationship with citizens, Procurement and relationship with suppliers, Environment[3]

- CORRUPTION IN THE LAST 3 YEARS (reversed). Proportion of persons who had at least one contact with a public official and who paid a bribe to a public official, or were asked for a bribe by those public officials, during the last three years before the survey.

- BRIBE HEALTH (reversed). Percentage of persons who know someone (friends, relatives, colleagues) who has been asked for money, favors, gifts in exchange for goods or services in the Health/Care sector when applying for welfare benefits, such as grants, subsidies, social or public housing, disability pensions, or other benefits.

- BRIBE ASSISTANCE (reversed). Percentage of people who know someone (friends, relatives, colleagues) who has been asked for money, favors, gifts in exchange for goods or services in the care sector when applying for welfare benefits, such as grants, subsidies, social or public housing, disability pensions, or other benefits.

- BRIBE EDUCATION (reversed). Percentage of people who know someone (friends, relatives, colleagues) who have been asked for money, favors, or gifts in exchange for goods or services in the Education sector.

- BRIBE JOB (reversed). Percentage of people who know someone (friends, relatives, colleagues) who have been asked for money, favors, or gifts in exchange for goods or services in employment when looking for a job, participating in a contest, or starting a job.

- BRIBE BRIBE ADMINISTRATION (reversed). Percentage of people who know someone (friends, relatives, colleagues) who have been asked for money, favors, gifts in exchange for goods or services by a public official.[4]

*Pillar II. Macroeconomic stability*

The indicators selected for the analysis are:

- SURPLUS (DEFICIT) OF ADMINISTRATION IN RELATION TO CURRENT REVENUES. With local government revenues steadily exceeding expenditures, a virtuous cycle is triggered whereby a virtuous local PA with a financial margin is able to intervene in the local economy by injecting new resources that raise the attractiveness potential through a positive migration balance and a net flow of new productive settlements.

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[3] The six areas are:

1. Budget - weighted score 15 out of 100.
2. Governance - weighted score 25 out of 100.
3. Personnel management - weighted score 15 out of 100.
4. Services and relations with citizens - weighted score 20 out of 100.
5. Contracts and relationship with suppliers - weighted score 15 out of 100.
6. Environmental impact - weighted score 10 out of 100.

[4] At an international level, the Bribe cases fall within the concept of "corruption" in the extended sense. On the contrary, in the Italian legal definition they do not constitute offences of real corruption, but are representative of situations in which in order to receive a service theoretically publicly available one is induced to "pay".

- COLLECTION CAPACITY. Percentage ratio of accrued collections to total collected amount. It measures the ability of the local government to collect assessed revenues and is calculated through the percentage ratio of accrued collections to total collections.

- INTEREST EXPENSES IN RELATION TO CURRENT REVENUES (reversed). These are current expenses linked to debts previously contracted by local government, which explains the negative sign with respect to attractiveness.

*Pillar III - Infrastructure*

The indicators selected for the analysis are:

- ACCESSIBILITY (TRAVEL TIMES) INDEX TOWARDS URBAN AND LOGISTIC NODES (reversed). The index is based on matrices of distances in km and average travel times, calculated with GIS instruments. This is because it is not enough to know the actual level of physical infrastructure of a given area, but it is also important to have information regarding its degree of use, its accessibility, its usefulness and the service actually provided.

- SEATS KM OFFERED BY ALL MODES OF TRANSPORT PER INHABITANT. The availability of a local public transport offer (Tpl) adequate to the needs of the population is an essential aspect for the quality of life in cities. A widespread and deficient service reduces traffic congestion and consequently travel time, contains the economic costs incurred by families and businesses and ensures better air quality by reducing the use of private vehicles.

- ANNUAL PASSENGER DENSITY IN LOCAL PUBLIC TRANSPORT AND AIRPORTS PER INHABITANT. Ratio of number of passengers in local public transport and airports to population.

- CAR-SHARING: AVAILABILITY OF VEHICLES PER 100 THOUSAND INHABITANTS. Considering that more than 30 million residents move every day in Italy to reach their place of study or work, new forms of travel are developing that involve sharing a car with study or work colleagues.

*Pillar IV - Health*

The indicators selected for the analysis are:

- LIFE EXPECTANCY AT BIRTH, AVERAGE NUMBER OF YEARS. The increase in life expectancy of the population, together with the decrease in the birth rate have strongly characterized Italy in recent decades, with a significant impact on the age structure of the population. Estimates made by Istat (2021) on life expectancy for 2020 indicate that "following the COVID-19 pandemic that has significantly affected Italy, characterized by a demographic structure much older than other countries, a significant reversal in the process of steady improvement in longevity observed in recent years, especially in some areas of the country particularly affected by the spread of the virus. In terms of life expectancy at birth, compared with an estimate of about 0.9 years lost overall at the national level (from 83.2 to 82.3 years), a strong heterogeneity emerges among the various territories, with an emptying, in terms of years lived, more marked in the northern regions (from 83.6 to 82.1 years expected), compared with the center (from 83.6 to 83.1) and the south (from 82.5 to 82.2).

- INFANT MORTALITY PER 1000 LIVE BIRTHS (reversed). Ratio of the number of deaths in the first year of life per 10000 live births. The first year of life accounts for 85% of deaths under 5 years of age. Today the mortality rate of children under 5 in Italy is lower than

the European average and lower than that of the United States: it has gone from 347 deaths per thousand live births in 1887 to about 4 per thousand today.

- CANCER MORTALITY (20–64 YEARS). Standardized rates per 10000 residents (reversed).

- HOSPITAL OUTMIGRATION TO OTHER REGIONS FOR ORDINARY ACUTE HOSPITALIZATIONS. Proportion of total hospitalized persons residing in the region (reversed). Mobility for health reasons is inversely related to the quality of services offered by the territory of residence, which explains the negative sign of the link with attractiveness.

*Pillar V - Basic Education*

The indicators selected for the analysis are:

- VOCATIONAL (VOCATIONAL) GRADUATES. Technical and vocational graduates (proportion of total graduates in the province). Vocational education programmes are designed to provide learners with the knowledge and the set of skills specific to a particular occupation or trade. Such programmes may have work-based components (e.g. apprenticeships, dual-system education programmes). Successful completion of such programmes leads to labour market-relevant, vocational qualifications acknowledged as occupationally oriented by the relevant national authorities and/or the labour market (Eurostat 2020)

- STUDENTS' READING PROFICIENCY LEVEL - MEAN SCORE. Reading proficiency is essential for a wide variety of human activities—from following instructions in a manual; to figuring out the who, what, when, where and why of a situation; to the many ways of communicating with others for a specific purpose or transaction (OECD - PISA 2018). Proficiency in literacy is closely related to proficiency in numeracy.

- STUDENTS' NUMERACY PROFICIENCY LEVEL—mean score. Mathematical performance measures the mathematical literacy of a 15 year-old to formulate, employ and interpret mathematics in a variety of contexts to describe, predict and explain phenomena, recognising the role that mathematics plays in the world. The mean score is the measure. A mathematically literate student recognises the role that mathematics plays in the world in order to make well-founded judgments and decisions needed by constructive, engaged and reflective citizens.

- UNDERACHIEVEMENT RATE IN READING. Percentage of students in grades II of the upper secondary school who do not achieve Level II on (5 levels) in literacy (BES Istat) (reversed). Level 2 is considered the baseline of proficiency, thus the pupils performing under this baseline are considered underachievers (the OECD refers to them as low achievers). This is not only a worrying social issue, but also a drag on Italy future economic competitiveness. Education systems can pursue excellence and equity at the same time: provinces with small proportions of underachievers tend to have also high proportions of top performers.

- UNDERACHIEVEMENT RATE IN NUMERACY. Percentage of students in grades II of the upper secondary school who do not achieve Level II on (5 levels) in numeracy (BES Istat) (reversed). Inadequate mathematical proficiency concerns a larger collective of boys (37.8% on average in Italy) than alphabetical proficiency with gender differences: in mathematics, girls did not reach sufficient levels in 42.2% of cases while boys did in 33.5%.