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Abstract
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'Measuring competitiveness: a new composite indicator for Italian municipalities'

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1. Introduction

Competitiveness is a phenomenon of particular interest for territorial bodies, for both economic and social reasons. For instance, it strengthens nations' economy (Bhawsar and Chattopadhyay, 2015) and it is a tool which can improve living conditions and welfare (Competitiveness Advisory Group, 1995).

The concept of competitiveness is elusive and complex. Competitiveness is a multidimensional phenomenon which is studied at different levels, and several definitions are present in the literature based on the specific context of application.

The main objective of this thesis is measuring territorial competitiveness at local level in Italy, particularly competitiveness at municipal level, through the proposal of a composite indicator to be applied in the Italian context. The proposed indicator allows to get precise insights into territorial competitiveness in Italy, in terms of competitiveness scores and relative position of the municipalities in the rankings.

2. Objective

The main objective of this research is measuring the competitiveness at local level in Italy, particularly the competitiveness of Italian municipalities. In Italy, municipalities are basic public territorial entities having own autonomy in governing their territory (Istat, 2021). They belong to the system of Local Administrative Units (LAUs) (Eurostat, 2021), which identifies the municipalities and communes of EU member states. The focus on this detailed geographical level may allow to develop more targeted actions and policies to improve growth performance and well-being.

The main objective implies that a proper strategy to measure municipal competitiveness needs to be delineated. This is a challenging task, because competitiveness is a multidimensional phenomenon. Different methods to measure multidimensional phenomena are present in the literature. Among

them, building a composite indicator is a valid strategy, because it allows to take into account the dimensions and to aggregate them into a unique number, reducing dimensionality (Mazziotta and Pareto, 2017; 2013). While an individual indicator is a quantitative or a qualitative measure of a phenomenon, a composite indicator combines several individual indicators, following a framework established by the composite indicator builder (OECD and JRC, 2008; Freudenberg, 2003).

This research aims to introduce a composite indicator which is useful to measure competitiveness at municipal level in Italy. Such indicator should be able to effectively distinguish between different levels of competitiveness, and to compare competitiveness over time, since the objective is to allow a dynamic analysis on the competitiveness of Italian municipalities.

3. Methods

The objectives imply the definition of the methodology to build the proposed composite indicator and then to analyze it. The building process of a composite indicator is stepwise: it entails a sequence of connected phases (Mazziotta and Pareto, 2013; 2017; OECD and JRC, 2008; Freudenberg, 2003). Jointly considering these phases and the main objective of this thesis, the methodology used in this research may be summarized into the following main steps: 1) Definition of municipal competitiveness and of its dimensions, 2) Selection of the data sources and the individual indicators, 3) Normalization, weighting and aggregation of the indicators, 4) Analysis of the scores and the rankings, and influence analysis, 5) Study of two specific groups of municipalities. These phases are described in detail in the following.

1) Definition of municipal competitiveness and of its dimensions

The main objective of this thesis implies, first of all, that the phenomenon of interest needs to be clearly identified. The economic literature does not provide neither a specific definition nor a theoretical framework related to competitiveness at municipal level, which could be used in the proposed indicator. However, regions and municipalities share some features: for instance, the adjustment mechanisms which operate at national level do not similarly apply neither at the regional nor at the municipal level. The underlying theoretical framework and definition of municipal competitiveness were based on the literature on regional competitiveness.

The proposed composite indicator is based on a definition of regional competitiveness which belongs to the context of official statistics: the definition adopted by the Regional Competitiveness Index (RCI) (Dijkstra et al., 2011; Annoni and Kozovska, 2010), the first composite index which measures regional competitiveness in the EU at NUTS 2 level. Hence, based on the literature review, in this thesis municipal competitiveness was defined as the ability of a municipality to offer an attractive and sustainable environment for firms and residents to live and work.

The RCI was also used as the main reference to identify the dimensions of competitiveness and to select the individual indicators. The proposed composite indicator entails seven dimensions: Education, Job, Economic wellbeing, Territory and environment, Entrepreneurship, Innovation, and Infrastructures and mobility. They were identified based on the theoretical framework of the RCI and the extensive literature review, including for instance Bhawsar and Chattopadhyay (2015), and OECD (2016).

2) Selection of the data sources and the individual indicators

The individual indicators were selected according to two criteria: first, their assumed relevance for competitiveness based on the theoretical framework; second, their time availability for the same periods. Given the dynamic analysis objective, the aim is to analyze at least one comparison over time for the composite indicator.

Data were mainly retrieved from A misura di Comune (Istat, 2016) for the periods 2014 and 2015. A misura di Comune is an Italian statistical multi-source system gathering data from different sources, mainly administrative ones, for Italy. An univariate analysis was performed to understand the main features of these data.

The final dataset includes data for 7159 municipalities and 17 individual indicators, for 2014 and 2015. A multivariate analysis was carried out to explore the data structure and the suitability of the individual indicators to measure competitiveness.

3) Normalization, weighting and aggregation of the indicators

The individual indicators were normalized to achieve comparability. The choice of the normalization method considered that the objective is carrying out a dynamic analysis of the competitiveness of Italian municipalities, hence the chosen method should allow comparisons of absolute changes over time. The chosen normalization method is the rescaling (or min-max) (Mazziotta and Pareto, 2017).

As each dimension includes at least two individual indicators, for each year, the individual indicators were aggregated using a two-step procedure: first, a sub-index for each dimension was computed, then these were aggregated in the final composite indicator. In both steps, a system of equal weights was adopted, because it is not possible to find a clear indication in the literature about the most appropriate differential weights for the individual indicators and for the dimensions. The proposed municipal-level indicator is positive: higher scores indicate improvements of municipal competitiveness.

The sub-indexes were created using the COMposite Indices Creator (COMIC) software (Massoli and Pareto, 2017). Three versions of the sub-indexes were obtained applying three aggregation techniques: the mean of 0-1 indices, the geometric mean, and the Adjusted Mazziotta-Pareto Index (AMPI) (Massoli and Pareto, 2017; Mazziotta and Pareto, 2017). In the formulation adopted in COMIC, these methods include a rescaling step to normalize the data.

Adopting a consistent approach, the sub-indexes were combined into the final composite indicator using the same aggregation methods used for the individual indicators. A code written using the software R was implemented for the final aggregation. COMIC was not used at this step, to avoid normalizing the data twice.

The two-step aggregation resulted in six composite indicators: three versions, namely the mean, the geometric mean and the AMPI, for each year.

4) Analysis of the scores and the rankings, and influence analysis

To study the ability of the proposed indicator to measure municipal competitiveness, a detailed analysis was carried out, comparing the scores and the related rankings, and identifying the most influential dimensions for competitiveness. The results were compared between the three aggregation methods, and over time.

The scores were analyzed using maps to study the geographical distribution, scatter plots to examine heterogeneity of the scores, and velocity-acceleration score plots. The rankings were analyzed computing Spearman's rank correlation and summary statistics of the absolute differences of rank.

Besides, an influence analysis was carried out to identify the most relevant dimension for municipal competitiveness. In each of seven simulations, one dimension was removed and the absolute differences of rank were computed between the original ranking and the new ranking. This process was repeated for the three versions of the composite indicator and for the two periods. The most influent dimension is the removed one which is associated to the highest coefficient of variation of the absolute differences of rank.

5) Study of two specific groups of municipalities.

Finally, the study of two specific groups of municipalities further explored the properties of the composite indicator. It also showed the usefulness of disaggregating the composite indicator into its dimensions, which can highlight specific strengths and weaknesses of the municipalities. This final analysis provided additional interesting insights which completed the detailed picture of territorial competitiveness in Italy provided by the proposed composite indicator.

4. Results

In order to reach the desired objectives, a composite indicator of municipal competitiveness was built following the methodology described above in Section 3. The aim was creating a composite indicator which is able to properly measure municipal competitiveness by distinguishing between different levels of competitiveness, and to compare competitiveness over time. To evaluate such ability, the composite indicator was applied to a dataset of 7159 municipalities and 17 individual indicators for two periods, 2014 and 2015. As described in Section 3, three aggregation methods, namely the mean, the geometric mean and the AMPI, were applied and their results compared.

The 2016 edition of the RCI (Annoni et al., 2017) shows that NUTS 2 Italian regions have either a low or medium level of competitiveness. The proposed composite indicator gives a geographically detailed picture at municipal level, providing further insights about territorial competitiveness in Italy.

Figure 1 shows the geographical distribution of municipal competitiveness scores in 2014: it was similar for the three aggregation methods. Municipal competitiveness scores were heterogeneous within each NUTS 2 region, with particularly high coefficients of variation in the regions of the South and the Islands. Every NUTS 2 region hold some municipalities with high competitiveness scores, but their concentration was more variable: on a general basis, it was higher in Northern Italy than in

Southern Italy. The geographical distribution of the scores showed few differences between 2014 and 2015. In terms of competitiveness scores, most of the municipalities did not notably change between 2014 and 2015, independently of their level of competitiveness in 2014, their geographical position in terms of NUTS 1 regions, and the aggregation technique which was applied. However, the interpretation of these results should take into account that the two periods considered are very close in time.

The competitiveness scores were used to create rankings of the municipalities. In each period, the Spearman's rank correlation between each pair of methods was higher than 0.98, while the mean of the absolute differences of rank was high: on average, a municipality shifted by at least 130 positions when two methods are compared. Table 1 shows the summary statistics of the absolute differences of rank for 2014 data, the results for 2015 are similar. To sum up, the rankings for different methods were not perfectly equal, suggesting that it is important to be cautious in the interpretation of the relative position in the rankings.

The most influential dimension for municipal competitiveness did not coincide in the two time periods considered. The influence analysis showed that the most influential dimension for municipal competitiveness is Innovation in 2014, and Entrepreneurship in 2015, regardless of the aggregation method applied. Though, Innovation and Entrepreneurship are the two most influential dimensions in both years. Table 2 shows the summary statistics of the absolute differences of rank for the 2014 influence analysis, for the arithmetic mean composite indicator.

Furthermore, two specific groups of municipalities were studied: the ten least competitive municipalities in Northern Italy and the ten most competitive municipalities in Southern Italy. The analysis of these specific cases, also involving the disaggregation of the composite indicator into its dimensions, gave further interesting insights into municipal competitiveness. Particularly, the disaggregation can be used to identify the dimensions which represent specific strengths and weaknesses of the municipalities. This concluded the geographical analysis and contributed to create a detailed picture of territorial competitiveness in Italy.

In addition, the analysis of these groups of municipalities highlighted specific issues arising from using administrative data sources. It was not possible to properly measure some features of the residents, for instance of those who live in municipalities in Northern Italy but work in Switzerland. This issue may have partially impacted the scores and the rankings. However, the advantage of administrative data sources is that they allow to carry out analyses even at a very disaggregated level of analysis. The building of a composite indicator at municipal level could not be achieved without using administrative data sources.

The initially set objectives were essentially met. The results showed that building a composite indicator to measure territorial competitiveness at municipal level, which is a very disaggregated level of analysis, is actually feasible. The research carried out in this thesis resulted in the proposal of a composite indicator which is useful for providing detailed insights into competitiveness in Italy, by measuring municipal competitiveness over all Italian municipalities.

5. Contributions

The contribution of this thesis can be summarized into two main points.

First, it proposes a measure of competitiveness at a very disaggregated geographical level: a composite indicator which is useful to analyze municipal competitiveness in Italy. A similar measure is not available in the Italian literature on competitiveness. Besides, an original feature of the proposed indicator is that it uses individual indicators resulting from an experimental program. A misura di Comune is a multi-source system which integrates data from both traditional and experimental sources, the latter being particularly valorised. This corresponds to an integration between traditional and more innovative data production methods. The experimental program provides data at highly disaggregated territorial level.

Second, the proposed indicator allows the comparison of competitiveness of all Italian municipalities: it is not built for a subgroup of municipalities or for one specific municipality, but it is created to provide a comprehensive picture of municipal competitiveness in Italy. The proposed indicator has a detailed geographical focus which lead to detailed insights into territorial competitiveness in Italy, in terms of scores, rankings, and strengths and weakness of the municipalities. Its insights add to the one provided by the RCI, helping in capturing the heterogeneity which characterizes the competitiveness in the Italian NUTS 2 regions.

The proposed composite indicator of municipal competitiveness is based on data retrieved from experimental data sources, mainly administrative ones, which allow to gather data at the desired geographical level. This composite indicator represents a valid example of use of such data sources, which contribute to analyze phenomena that it should be not otherwise possible to measure. Due to the data availability issues which typically characterize the municipal context, data were retrieved only for 2014 and 2015, and the composite indicator was applied for those periods. The proposed composite indicator may be seen as a first prototype, the eventual update of new data would allow its computation for other periods.

In this research, the proposed composite indicator is applied in the Italian context. Actually, its applicability may be extended beyond Italian borders. It is recalled that, according to the NUTS classification, Italian municipalities are LAUs, a group which include all municipalities and communes of EU member states. The proposed indicator may be applied to other LAUs in the EU. Though, this potential extension would require further research, to understand the degree of data availability at LAU level in other EU countries and, for the available data, the extent to which they are comparable.

Figure 1: Maps showing the level of competitiveness of Italian municipalities in 2014. They refer to the composite indicators computed with the arithmetic mean, the geometric mean and the AMPI, respectively. Darker colours represent lower scores of the competitiveness indexes while warm colours refer to higher scores of competitiveness.

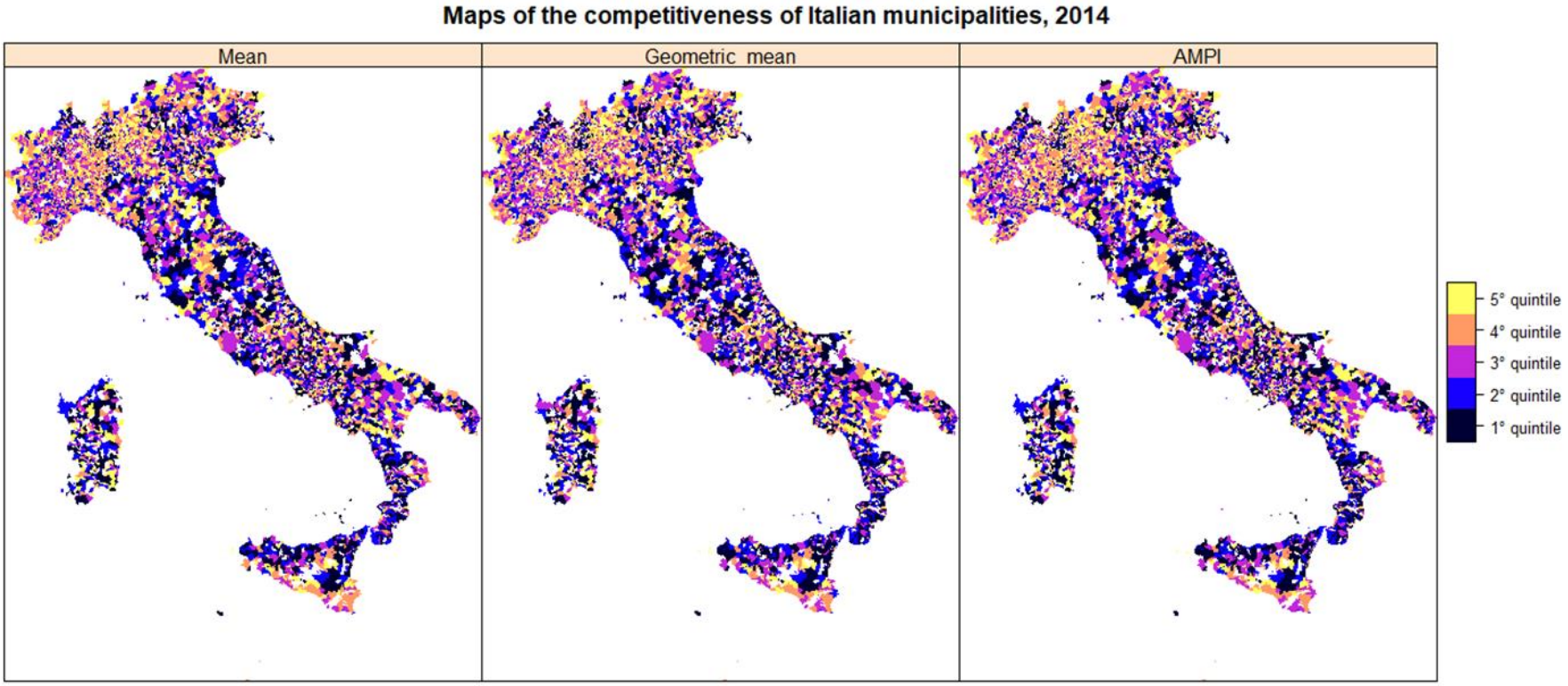

Table 1: Summary statistics of the absolute differences of rank, 2014

Absolute differences of rank	Mean	Variance	Standard deviation	Coefficient of variation
Mean-geometric mean	251.675	74074.98	272.167	1.081
Mean-AMPI	137.128	19445.92	139.449	1.017
Geometric mean-AMPI	150.739	33553.25	183.175	1.215

Values are rounded to three digits.

Table 2: 2014 influence analysis, summary statistics of the absolute differences of rank. Composite indicator: arithmetic mean.

Removed pillar	Mean	Variance	Standard deviation	Coefficient of variation
6.Innovation	439.442	326884.347	571.738	1.301
5.Entrepreneurship	127.791	24133.749	155.35	1.216
3.Economic wellbeing	383.987	165125.933	406.357	1.058
2.Job	206.319	44192.517	210.22	1.019
7.Infrastructures and mobility	302.814	82465.545	287.168	0.948
1.Education	282.699	67379.351	259.575	0.918
4.Territory and environment	698.681	386441.13	621.644	0.89

The removed pillars are arranged according to the size of the coefficient of variation, from the highest to the lowest.

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