# Chapter 3
# A Non-compensatory Approach for the Measurement of the Quality of Life

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## 1 Introduction[1]

It has long been accepted that material well-being, as measured by GDP per capita, cannot alone explain the broader QoL in a geographical area. Several have been the attempts to construct alternative, non-monetary indices of social and economic well-being by combining in a single statistic a variety of different factors (dimensions) that are thought to influence (represent) QoL. The main problem in all these measures is arbitrariness in choosing the factors and the variables to assess QoL and, even more seriously, in normalizing, weighting and summarizing different indicators to come up with a single composite index.

The idea of summarizing complex phenomena into single numbers is not straightforward. It involves both theoretical and methodological assumptions which need to be assessed carefully to avoid producing results of dubious analytic rigour (Saisana et al. 2005). For example, additive methods assume a full substitutability among the different indicators (e.g. a good living standard may offset any environmental deficit and vice versa), but a complete compensability among the main dimensions of QoL is not desirable.

Therefore, it is necessary to consistently combine both the selection of variables representing the phenomenon and the choice of the 'best' aggregation function in order not to lose much statistical information.

In this chapter, we propose a non-compensatory composite index, denoted as MPI (Mazziotta-Pareto Index), which, starting from a linear aggregation, introduces penalties for the units with 'unbalanced' indicators' values.

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As an example of application, we consider the report on the QoL in the 107 Italian provinces, published by the Italian economic newspaper *Il Sole 24ore* in 2010. In particular, we use 36 indicators equally divided into six dimensions and present a comparison between *Il Sole 24ore* method and the proposed index.

The main aim of the work is not as much to 'assess' QoL, but rather to 'rank' the Italian provinces by QoL.

## 2 Measuring Quality of Life

### *2.1 General Aspects*

QoL is nowadays a priority issue for many countries since its measurement is very important for economic and social assessment, public policy, social legislation and community programmes.

In the scientific literature, there are many studies concerning the use of composite indices in order to measure QoL both from an objective and a subjective point of view.

In general, the steps for constructing a composite index can be summarized as follows:

(a) Defining the phenomenon to be measured. The definition of the concept should give a clear sense of what is being measured by the composite index. It should refer to a theoretical framework, linking various subgroups and underlying indicators.
(b) Selecting a group of individual indicators, usually expressed in different units of measurement. Ideally, indicators should be selected according to their relevance, analytical soundness, timeliness, accessibility, etc. (OECD 2008). The selection step is the result of a trade-off between possible redundancies caused by overlapping information and the risk of losing information.
(c) Normalizing individual indicators to make them comparable. Normalization is required prior to any data aggregation as the indicators in a data set often have different measurement units. Therefore, it is necessary to bring the indicators to the same standard, by transforming them into pure, dimensionless numbers. There are various methods of normalization, such as ranking, rescaling, standardization (or $Z$ scores) and 'distance to a reference'.
(d) Aggregating the normalized indicators by composite indices (mathematical functions). Different aggregation methods are possible. The most used are additive methods that range from summing up unit ranking in each indicator to aggregating weighted transformations of the original indicators. Multivariate techniques as principal component analysis (Dunteman 1989) are also often used.

For this approach, obviously, there are several problems such as finding data, losing information and researcher arbitrariness for (i) selection of indicators, (ii) normalization and (iii) aggregation and weighting. In spite of these problems, the advantages are clear, and they can be summarized in (a) unidimensional measurement of the phenomenon, (b) immediate availability and (c) simplification of the geographical data analysis.

Many works and analysis have won over the critics, and the scientific community concluded that it is impossible to obtain a 'perfect method' where the results are universally efficient. On the contrary, data and specific targets of the work must, time by time, individuate the 'best method' in terms of robustness, reliability and consistency of solutions.

## 2.2 *Source of Data*

In QoL research, we often distinguish between subjective and objective QoL. Subjective QoL is about feeling good and being satisfied with reference to different ambits and for life as a whole. Objective QoL is about fulfilling the societal and cultural demands for material wealth, social status and physical well-being (Susniene and Jurkauskas 2009). Accordingly, objective indicators exist in the society, and they can be monitored and assessed by their amount and frequency rate.

In *Il Sole 24ore* report, six dimensions of QoL are considered (living standard, job and business, environment and health, public order, population and free time), measured only by objective indicators.

The set of indicators selected to rank the 107 Italian provinces in 2010 is showed in Table 3.1. Each of the 36 indicators is interpreted as 'positive' or 'negative' with respect to QoL (polarity).[2] This classification is highly subjective and very difficult to judge. For instance, in the case of the variable 'Divorces/Separations' (negative polarity), it is arguable if a low value has to be considered 'good' or 'bad'. For the variable 'Population density' (negative polarity), one could even claim that both a high as well as a low value have to be regarded 'bad', whereas a value in the middle could be considered 'good' (Lun et al. 2006).

Dimensions have a descriptive meaning, beyond the final goal of generating a ranking: they guide the choice of the indicators and make easier the assessment of strengths and weaknesses of each province. However, the individual indicators have been selected through a logical rather than statistical choice, as it is independent from the values of the correlations among the variables. Besides, the selection of six indicators for each dimension seems to be due more to a kind of 'symmetry' criterion than to a thorough preliminary analysis of their real informative content (Gismondi and Russo 2008).

In this work, we do not go deeply into the delicate step of selection and interpretation of indicators. Nevertheless, let us note that it is not easy to determinate how many and what indicators should be taken into account to measure QoL.

[2]The polarity is 'positive' if increasing values of the indicator correspond to positive variations of QoL, and it is 'negative' if increasing values of the indicator correspond to negative variations of QoL.

**Table 3.1** Dimensions and individual indicators of QoL

| N. | Indicator | Polarity | N. | Indicator | Polarity |
|---|---|---|---|---|---|
| Living standard | | | Public order | | |
| 1 | Bank deposits (average per capita) | + | 19 | Housebreakings (per 100,000 people) | – |
| 2 | Monthly pension (average) | + | 20 | Car thefts (per 100,000 people) | – |
| 3 | Inflation ‘Foi’ index | – | 21 | Extortions (per 100,000 people) | – |
| 4 | Gross domestic product (trend) | + | 22 | Robberies (per 100,000 people) | – |
| 5 | House price (average per $m^2$) | – | 23 | Cheating cases (per 100,000 people) | – |
| 6 | Consumption (average per capita) | + | 24 | Murders (trend) | – |
| Job and business | | | Population | | |
| 7 | Defaulting firms (per 1,000 new firms) | – | 25 | Population density (people per $km^2$) | – |
| 8 | New economy firms (per 100 people) | + | 26 | Proportion of regular foreign citizens | + |
| 9 | New/dead companies | + | 27 | Graduates (per 1,000 people aged 25–30) | + |
| 10 | Protests (average per capita) | – | 28 | Birth rate | + |
| 11 | Aged 25–34 employment rate | + | 29 | Old-age dependency ratio | – |
| 12 | Female employment rate | + | 30 | Divorces/separations (per 10,000 families) | – |
| Environment and health | | | Free time | | |
| 13 | Public nursery schools | + | 31 | Index of sold books | + |
| 14 | ‘Tagliacarne’ infrastructure index | + | 32 | Bars and restaurants (per 100,000 people) | + |
| 15 | Hospital emigration | – | 33 | Concerts and shows (per 100,000 people) | + |
| 16 | Climate (thermal excursion) | – | 34 | Sporting index | + |
| 17 | ‘Legambiente’ urban ecosystem index | + | 35 | Voluntary associations (per 100,000 people) | + |
| 18 | Civil actions speed index | + | 36 | Cinemas (per 100,000 people) | + |

# 3 Methods for Constructing Composite Indices

In this section, we consider the methodological aspects related to the *Il Sole 24ore* and the non-compensatory approach.

## 3.1 The Il Sole 24ore Approach

The steps in the construction of the composite index used by the Italian economic newspaper *Il Sole 24ore* are the following: (i) normalization of the individual indicators through 'distance to a reference' approach[3] and (ii) aggregation of the normalized indicators by arithmetic mean.

(i) *Normalization*
Let $X=\{x_{ij}\}$ be the matrix with $n=107$ rows (Italian provinces) and $m=36$ columns (QoL indicators). The normalized matrix $Y=\{y_{ij}\}$ is computed as follows:

$$y_{ij} = \frac{x_{ij}}{\max_i(x_{ij})}1000 \quad \text{if the } j\text{-th indicator is 'positive';}$$

$$y_{ij} = \frac{\min_i(x_{ij})}{x_{ij}}1000 \quad \text{if the } j\text{-th indicator is 'negative';}$$

where $\min_i(x_{ij})$ and $\max_i(x_{ij})$ are the minimum and the maximum values for the $j$-th indicator.

(ii) *Aggregation*
The partial composite index, for the $h$-th dimension, is given by:

$$\overline{y}_{ih} = \frac{\sum_{j=1}^{6} y_{i,6(h-1)+j}}{6}, \quad (h = 1,\ldots,6)$$

and the composite index of QoL is expressed as:

$$\mathrm{M}_{\overline{y}_i} = \frac{\sum_{h=1}^{6} \overline{y}_{ih}}{6}.$$

[3]Normalization consists in transforming the original indicators so that they are compatible and comparable with each other. The 'distance to a reference' criterion measures the relative position of a given indicator to a reference point. In this case, the 'distance from the best performer, is used, and the reference is the maximum value if the individual indicator is considered 'positive' for the QoL and the minimum otherwise.

The main characteristic of this approach lies in the use of a linear transformation for ‘positive’ indicators and a nonlinear transformation for ‘negative’ indicators (Bernardi et al. 2004). However, the second transformation is not ‘dual’ compared to the first one, i.e. given two provinces, the difference between transformed values by the first formula is different than the difference between transformed values by the second one. Moreover, normalizing by ‘distance from the best performer’ can lead to a bias if minimum and maximum are quite different from the other values (*outliers*).

Finally, as regards the aggregation function, we note that the composite index of QoL can be written as a simple arithmetic mean of 36 individual indicators.

### 3.2 A Non-compensatory Approach

The method proposed by the authors for constructing a composite index of QoL is based on the assumption of ‘non-substitutability’ of the dimensions, i.e. they have all the same importance and a compensation among them is not allowed (Munda and Nardo 2005). Therefore, we can aggregate the indicators of each dimension by arithmetic mean and summarize the partial composite indices by MPI.

The steps in the construction of the MPI are the following: (i) normalization of the individual indicators by ‘standardization’ and (ii) aggregation of the standardized indicators by arithmetic mean with penalty function based on ‘horizontal variability’ (variability of standardized values for each unit).

In case of *Il Sole 24ore* data, we have an intermediate step aimed at aggregating the indicators inside each dimension using the simple arithmetic mean.

(i) *Normalization*

Being $X=\{x_{ij}\}$ the original data matrix, we compute the standardized matrix $Z=\{z_{ij}\}$ as follows:

$$z_{ij} = 100 + \frac{(x_{ij} - \mathrm{M}_{x_j})}{\mathrm{S}_{x_j}} 10 \quad \text{if the } j\text{-th indicator is ‘positive’;}$$

$$z_{ij} = 100 - \frac{(x_{ij} - \mathrm{M}_{x_j})}{\mathrm{S}_{x_j}} 10 \quad \text{if the } j\text{-th indicator is ‘negative’;}$$

where:

$$M_{x_j} = \frac{\sum_{i=1}^{n} x_{ij}}{n}; \quad S_{x_j} = \sqrt{\frac{\sum_{i=1}^{n} (x_{ij} - M_{x_j})^2}{n}}.$$

(ii) *Aggregation*

The partial composite index, for the $h$-th dimension, is given by:

$$\overline{z}_{ih} = \frac{\sum_{j=1}^{6} z_{i,6(h-1)+j}}{6} \qquad (h = 1,\ldots,6)$$

and the MPI of QoL is obtained as:

$$\mathrm{MPI}_i = \mathrm{M}_{\overline{z}_i} - \mathrm{S}_{\overline{z}_i}\mathrm{cv}_{\overline{z}_i}$$

where

$$M_{\overline{z}_i} = \frac{\sum_{h=1}^{6} \overline{z}_{ih}}{6}; \quad S_{\overline{z}_i} = \sqrt{\frac{\sum_{h=1}^{6} (\overline{z}_{ih} - \mathrm{M}_{\overline{z}_i})^2}{6}}; \quad \mathrm{cv}_{\overline{z}_i} = \frac{S_{\overline{z}_i}}{M_{\overline{z}_i}}.$$

The proposed approach is characterized by the use of a function (the product $S_{\overline{z}_i}, \mathrm{cv}_{\overline{z}_i}$) to penalize the units with 'unbalanced' values of the partial composite indices. The penalty is based on the coefficient of variation and is zero if all the values are equal.[4] The purpose is to favour the provinces that, mean being equal, have a greater balance among the different dimensions of QoL.

Moreover, the 'standardization' rule is 'dual' and converts all indicators to a common scale where the mean is 100 and the standard deviation is 10 (Aiello and Attanasio 2004).

## 3.3 Comparisons and Differences

In this section, we present the main differences between the two methods. Table 3.2 provides an example of normalizing indicators by 'distance from the best performer' (*Y* scores) and 'standardization' (*Z* scores). The table provides also the mean of *Y* scores, the mean of *Z* scores and the MPI. With reference to indicators' polarity, *X*1 and *X*3 are considered 'positive', whereas *X*2 is 'negative'.

There are a number of points of interest in Table 3.2. First, a difference can be pointed out in the coefficient of variation (CV) between *X*2 and *Y*2, mainly due to the nonlinear transformation used by *Il Sole 24ore* method for 'negative' indicators (if *X*2 was a 'positive' indicator, the CV did not change). Moreover, *Y* scores show different ranges between the two approaches, since, while the maximum is always fixed to 1,000, the minimum is not defined (e.g. 750–1,000 for *Y*2 vs. 200–1,000 for *Y*3).

[4] Note that the penalty can be added or subtracted depending on the nature of the index (De Muro et al. 2010).

**Table 3.2** A comparison of normalization rules and aggregation schemes

| | Indicators | | | *Y* scores | | | | *Z* scores | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Unit | *X1* | *X2* | *X3* | *Y1* | *Y2* | *Y3* | Mean | *Z1* | *Z2* | *Z3* | Mean | MPI |
| 1 | 3 | 80 | 1,000 | 272.7 | 750.0 | 1,000.0 | 674.2 | 85.9 | 84.2 | 114.1 | 94.7 | 92.7 |
| 2 | 5 | 70 | 800 | 454.5 | 857.1 | 800.0 | 703.9 | 92.9 | 100.0 | 107.1 | 100.0 | 99.7 |
| 3 | 7 | 70 | 600 | 636.4 | 857.1 | 600.0 | 697.8 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| 4 | 9 | 70 | 400 | 818.2 | 857.1 | 400.0 | 691.8 | 107.1 | 100.0 | 92.9 | 100.0 | 99.7 |
| 5 | 11 | 60 | 200 | 1,000.0 | 1,000.0 | 200.0 | 733.3 | 114.1 | 115.8 | 85.9 | 105.3 | 103.5 |
| Mean | 7.0 | 70.0 | 600.0 | 636.4 | 864.3 | 600.0 | | 100.0 | 100.0 | 100.0 | | |
| Std. dev. | 2.8 | 6.3 | 282.8 | 257.1 | 79.5 | 282.8 | | 10.0 | 10.0 | 10.0 | | |
| CV (%) | 40.4 | 9.0 | 47.1 | 40.4 | 9.2 | 47.1 | | 10.0 | 10.0 | 10.0 | | |

The main difference between *Y* and *Z* scores is that the *Y* scores computation makes indicators independent of the unit of measurement, but not of their variability. The higher the CV, the greater the weight, in terms of normalized values, on the mean. Therefore, using *Y* scores, *X*3 has a greater weight than *X*1 in the computation of the mean, and unit 2 obtains a greater score than unit 4 (703.9 vs. 691.8), whereas with regard to *Z* scores, the two units have the same score (100).

Then, in order to assign the same 'importance' to each variable, it is possible to apply a transformation rule that makes the indicators independent of both unit of measurement and variability.

Finally, let us consider the effect on indicators aggregation through the two approaches (simple arithmetic mean and arithmetic mean with penalty, MPI).

Units 2, 3 and 4 have the same mean of *Z* scores, but units 2 and 4 have an unbalanced distribution of the values, so they rank lower according to the MPI (the rank changes from the second to the third position). This is justified in the case of non-substitutability of the indicators, as a low value of an indicator cannot be compensated by a high value of another indicator. So, if the mean is the same, the units with unbalanced values assume a lower final score.

## 4 An Application to Italian Provinces

Many analyses were performed on the basis of available data in order to compare the different approaches. First, let us consider the partial rankings based on *Y* scores and *Z* scores on the six QoL dimensions. Figure 3.1 shows the distributions of absolute ranking differences. Note that such differences are due to the normalization criterion since, in this case, the aggregation function (mean) is the same.

For each dimension (except 'Free time'), the mean absolute difference of rank is relevant; in particular, for 'Population', the mean is 16.5, and this result is combined with a high standard deviation value (13.7). In this dimension, there is a province that moves by 59 positions changing normalization rule! Also in the 'Living standard' dimension, a high value of the mean (10.0) corresponds to a high value of standard deviation (8.9). In these two dimensions, the Spearman's rank correlation coefficient is lower than the other groups. On the contrary, in the 'Free time' dimension, the absolute differences of rank are very low (mean of 1.4 and standard deviation of 1.5) and the Spearman's coefficient is close to one.

Table 3.3 shows the comparison of final rankings derived from different aggregation methods. The mean absolute difference of rank between *Z* bar ( $M_{\bar{z}_i}$ ) and MPI is very small (1.1), and it is due to the penalty function. This closeness is confirmed by the value produced by Spearman's coefficient ($\rho = 0.998$). On the contrary, the 'distance' between *Z* bar and *Il Sole 24ore* ( $M_{\bar{y}_i}$ ) is greater (6.1) and depends on the normalization criterion ($\rho = 0.759$). Finally, the mean absolute difference of rank between *Il Sole 24ore* and MPI is 6.8, i.e. the rank of each province changes, on average, by 6.8 positions between the two methods. This result is due to both normalization criterion and aggregation function.

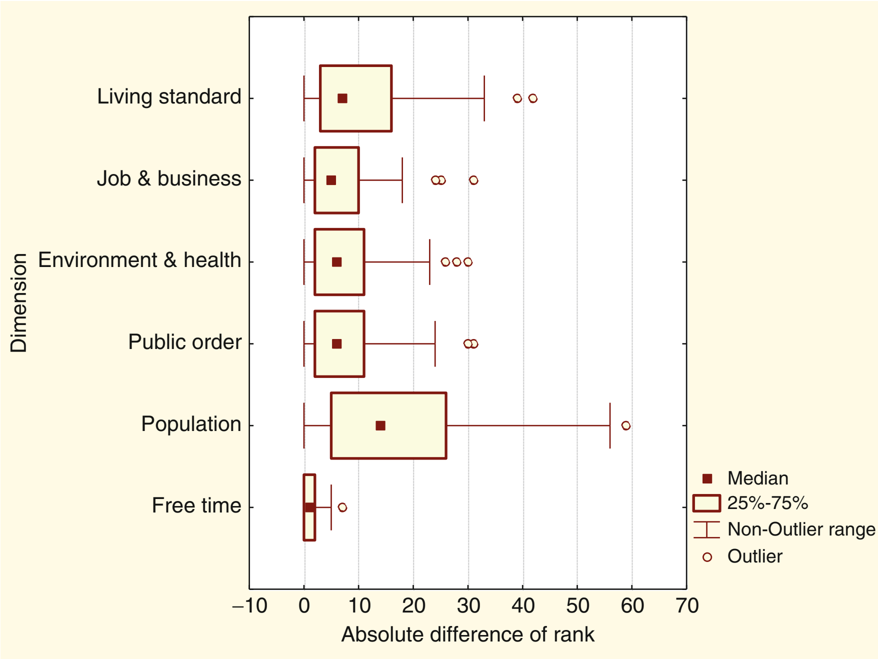


**Fig. 3.1** Comparing partial rankings based on *Y* scores and *Z* scores

**Table 3.3** A comparison of final rankings by different aggregation methods

| Statistics | Sole 24ore – *Z* bar | *Z* bar – MPI | MPI – Sole 24ore |
|---|---|---|---|
| Absolute difference of rank | | | |
| Mean | 6.1 | 1.1 | 6.8 |
| Std. dev. | 7.3 | 1.3 | 7.9 |
| Minimum | 0.0 | 0.0 | 0.0 |
| Maximum | 51.0 | 6.0 | 55.0 |
| Median | 5.0 | 1.0 | 5.0 |
| Rank correlation | | | |
| Spearman's rho | 0.759 | 0.998 | 0.944 |

Figure 3.2 shows a multiple scatter plot representing the relations between *Il Sole 24ore* ranking (horizontal axis) and *Z* bar/MPI ranking (vertical axis). The coordinates determining the location of each province correspond to its specific ranks on the composite indices. Final rankings are reported in Table 3.4, where the provinces are ordered according to *Il Sole 24ore* method.

The divergence between *Il Sole 24ore* and *Z* bar is due to the different normalization rule and, as explained before, some cases are evident (see, in particular, Oristano and Milano). The difference between *Z* bar and MPI is very small and lies in the

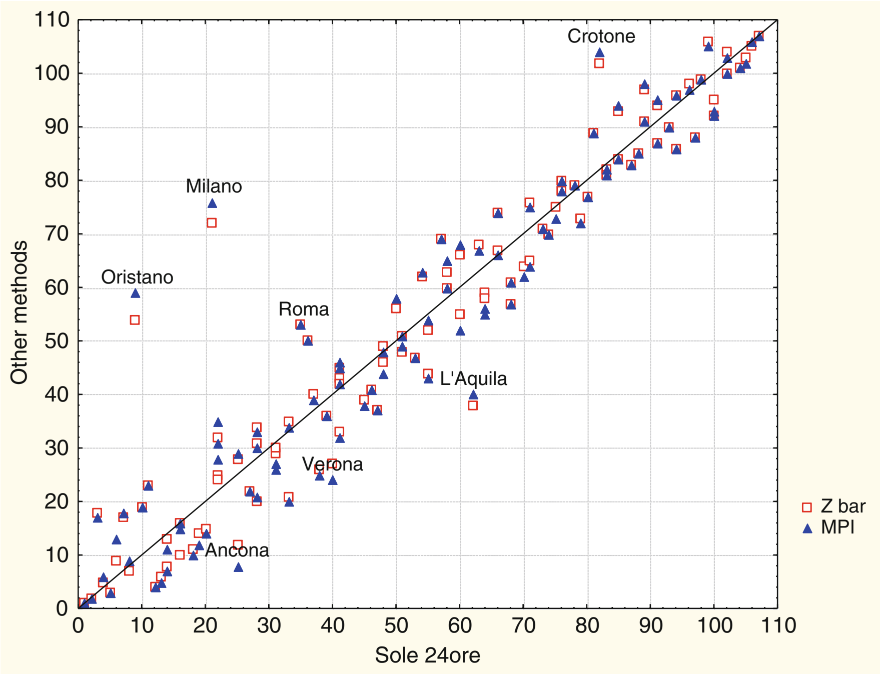


**Fig. 3.2** Comparing final rankings of QoL

**Table 3.4** Final ranking of QoL by aggregation method

| Province | Sole 24ore | *Z* bar | MPI | Province | Sole 24ore | *Z* bar | MPI |
|---|---|---|---|---|---|---|---|
| Bolzano | 1 | 1 | 1 | Savona | 55 | 52 | 54 |
| Trento | 2 | 2 | 2 | Terni | 55 | 44 | 43 |
| Sondrio | 3 | 18 | 17 | La Spezia | 57 | 69 | 69 |
| Trieste | 4 | 5 | 6 | Asti | 58 | 63 | 65 |
| Siena | 5 | 3 | 3 | Rovigo | 58 | 60 | 60 |
| Aosta | 6 | 9 | 13 | Cagliari | 60 | 55 | 52 |
| Gorizia | 7 | 17 | 18 | Lucca | 60 | 66 | 68 |
| Bologna | 8 | 7 | 9 | L'Aquila | 62 | 38 | 40 |
| Oristano | 9 | 54 | 59 | Rieti | 63 | 68 | 67 |
| Belluno | 10 | 19 | 19 | Lodi | 64 | 59 | 56 |
| Cuneo | 11 | 23 | 23 | Massa Carrara | 64 | 58 | 55 |
| Macerata | 12 | 4 | 4 | Matera | 66 | 74 | 74 |
| Parma | 13 | 6 | 5 | Viterbo | 66 | 67 | 66 |
| Ravenna | 14 | 13 | 11 | Imperia | 68 | 57 | 57 |
| Udine | 14 | 8 | 7 | Prato | 68 | 61 | 61 |
| Firenze | 16 | 16 | 15 | Pavia | 70 | 64 | 62 |
| Rimini | 16 | 10 | 16 | Alessandria | 71 | 76 | 75 |

(continued)

**Table 3.4** (continued)

| Province | Sole 24ore | *Z* bar | MPI | Province | Sole 24ore | *Z* bar | MPI |
|---|---|---|---|---|---|---|---|
| Piacenza | 18 | 11 | 10 | Pistoia | 71 | 65 | 64 |
| Forlì | 19 | 14 | 12 | Teramo | 73 | 71 | 71 |
| Livorno | 20 | 15 | 14 | Ascoli P. | 74 | 70 | 70 |
| Milano | 21 | 72 | 76 | Chieti | 75 | 75 | 73 |
| Genova | 22 | 25 | 31 | Carbonia-Iglesias | 76 | 78 | 78 |
| Grosseto | 22 | 24 | 28 | Potenza | 76 | 80 | 80 |
| Verbano-Cusio-Oss. | 22 | 32 | 35 | Medio Campidano | 78 | 79 | 79 |
| Ancona | 25 | 12 | 8 | Pescara | 79 | 73 | 72 |
| Ogliastra | 25 | 28 | 29 | Campobasso | 80 | 77 | 77 |
| Ferrara | 27 | 22 | 22 | Isernia | 81 | 89 | 89 |
| Nuoro | 28 | 20 | 21 | Crotone | 82 | 102 | 104 |
| Olbia-Tempio | 28 | 34 | 33 | Frosinone | 83 | 82 | 81 |
| Pesaro Urbino | 28 | 31 | 30 | Lecce | 83 | 81 | 82 |
| Modena | 31 | 29 | 26 | Brindisi | 85 | 84 | 84 |
| Reggio E. | 31 | 30 | 27 | Enna | 85 | 93 | 94 |
| Mantova | 33 | 35 | 34 | Latina | 87 | 83 | 83 |
| Padova | 33 | 21 | 20 | Cosenza | 88 | 85 | 85 |
| Roma | 35 | 53 | 53 | Catanzaro | 89 | 97 | 98 |
| Bergamo | 36 | 50 | 50 | Ragusa | 89 | 91 | 91 |
| Cremona | 37 | 40 | 39 | Avellino | 91 | 87 | 87 |
| Treviso | 38 | 26 | 25 | Vibo Valentia | 91 | 94 | 95 |
| Como | 39 | 36 | 36 | Bari | 93 | 90 | 90 |
| Verona | 40 | 27 | 24 | Benevento | 94 | 86 | 86 |
| Brescia | 41 | 43 | 42 | Salerno | 94 | 96 | 96 |
| Pisa | 41 | 42 | 46 | Siracusa | 96 | 98 | 97 |
| Pordenone | 41 | 45 | 45 | Messina | 97 | 88 | 88 |
| Sassari | 41 | 33 | 32 | Agrigento | 98 | 99 | 99 |
| Arezzo | 45 | 39 | 38 | Catania | 99 | 106 | 105 |
| Venezia | 46 | 41 | 41 | Palermo | 100 | 95 | 93 |
| Vicenza | 47 | 37 | 37 | Taranto | 100 | 92 | 92 |
| Novara | 48 | 49 | 48 | Caltanissetta | 102 | 104 | 103 |
| Perugia | 48 | 46 | 44 | Reggio Calabria | 102 | 100 | 100 |
| Biella | 50 | 56 | 58 | Trapani | 104 | 101 | 101 |
| Lecco | 51 | 51 | 51 | Caserta | 105 | 103 | 102 |
| Vercelli | 51 | 48 | 49 | Foggia | 106 | 105 | 106 |
| Varese | 53 | 47 | 47 | Napoli | 107 | 107 | 107 |
| Torino | 54 | 62 | 63 | | | | |

penalty function: the provinces that have the greatest penalization are Rimini and Genova, which loose six positions. The comparison between *Il Sole 24ore* and MPI shows large differences in many provinces, especially, on the top of the ranking (the province of Milano, e.g. drop from position 21 down to position 76). On the other hand, the provinces showing low values of normalized indicators seem to be more stable (no large differences between the two approaches).

On the whole, the greater differences among the methods are in the high part of the ranking where, probably, the provinces have high values of normalized indicators and high 'horizontal variability' too.

## 5 Concluding Remarks

The study of appropriate indicators to measure the QoL is in continuous evolution. The composite index used by *Il Sole 24ore* is based on a simple arithmetic mean of 36 normalized indicators related to six main dimensions and assumes a full substitutability among the various indicators. However, as asserted by the literature, a complete compensability among the principal dimensions of QoL is not desirable. For this reason, an alternative composite index (MPI) that penalizes the provinces with 'unbalanced' values of the partial indices is proposed.

A comparison between the two methods shows that the main factor affecting the results is the normalization criterion: in fact, the 'standardization' entails an equal weighting of the indicators while the 'distance from the best performer' implies different weights. As a consequence of this, the provinces with high values in indicators with greater weights obtain higher scores with *Il Sole 24ore* method as compared to MPI. Moreover, if we consider two provinces with equal mean of normalized values, but different 'horizontal variability', they obtain different scores using the MPI.

Therefore, the use of a 'penalty' for 'unbalanced' values of the indicators allows us to distinguish the provinces with uneven achievement across different dimensions of QoL.

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