Interval-Based Composite Indicators with a Triplex Representation: A Measure of the Potential Demand for the "Ristori" Decree in Italy.

Drago, Carlo

University “Niccolò Cusano”, NCI University, London

30 March 2021

Interval-Based Composite Indicators with a Triplex Representation: A Measure of the Potential Demand for the "Ristori" Decree in Italy.

Indicatori compositi basati su dati ad intervallo facendo uso di una rappresentazione Triplex: la misurazione della potenziale domanda del decreto "Ristori" in Italia

Carlo Drago[1]

Abstract In this work, we propose a new approach to constructing interval-based composite indicators based on the triplex representation. So, we measure the principal value of the indicator and simultaneously the value's uncertainty due to the different assumptions as different weightings associated how the indicator and their ranks can vary considering different assumptions or weights. The approach is useful not only on the construction of the composite indicators but also for a reliable interpretation of the results. The application shows the usefulness of the approach in detecting the regions higher the potential demand for economic support due to the Covid-19 emergency.

Abstract *In questo lavoro proponiamo un nuovo approccio alla costruzione di indicatori compositi basati su intervalli, basati sulla rappresentazione triplex. In questo caso siamo in grado di misurare non solo il valore principale dell'indicatore e l'incertezza del valore dovuta alla diversa assunzione come differenti ponderazioni associate ma anche come l'indicatore e il loro rango possono variare considerando differenti assunzioni o pesi. Quindi l'approccio è utile non solo sulla costruzione degli indicatori compositi, ma anche su un'interpretazione affidabile dei risultati.*

[1] Carlo Drago, University "Niccolò Cusano", Via Don Carlo Gnocchi 3, 00166, Rome and NCI University, London. Northern & Shell Tower, 4 Selsdon Way, Isle of Dogs, London E14 9GL, United Kingdom. We thank an anonymous referee for their helpful suggestions.

L'applicazione mostra l'utilità dell'approccio nell'analisi della domanda di sostegno economico ("ristori") dovuto all'emergenza Covid-19 in Italia.

Key words: interval data, symbolic data, composite indicators

1 The Statistical Problem

There are many situations where it is challenging to evaluate many complex phenomenon measures using a single value. In this case, we lose relevant information because we are aggregating the data in a unique measure. The use of interval-valued data can be an essential approach for retaining all the knowledge about the phenomenon under investigation and avoiding information loss (Billard and Diday 2003 Gioia 2009).

In this case, the complex information is related to the problematic measurement of a composite indicator. In this way, there can be a relevant issue on constructing the composite indicator, which contains some subjective choices. For instance, the weighting of the composite indicators can be differently identified. Following Greco et al. (2019) it is necessary to transform the subjective aspect of weighting the metrics more manageable and, most transparent, the most important thing to consider. After the composite indicator construction, it is necessary to evaluate the robustness and the sensitivity of the choices done on the final results of the composite indicator (Saisana et al. 2005).

In this respect, before considering any statistical analysis, it is crucial to passing through this stage of symbolic data analysis to define new formats for the data (Billard Diday 2003). These data should maintain all the complex information of the data. In this context, the use of composite indicators using interval data can be a possibility to represent the uncertainty accordingly on the data.

2 Interval-Based Composite Indicators Using a Triplex representation

To better represent a composite indicator based on a single value, it is possible simultaneously to consider different values obtained considering different initial weights or assumptions. The approach proposed by Drago (2017 and 2019 see also Gatto and Drago 2020) is to consider the possible different weighting schemes randomly as factors in the construction of the composite indicator. Using a Monte-Carlo simulation, obtain the different composite indicators associated with each assumption on the weighting scheme. Finally, the interval-based composite indicator can be constructed considering the different values obtained by the Monte-Carlo simulation and the center, the lower and the upper bound, representing extreme

scenarios from the construction of the possible composite indicators. Following Bertrand and Goupil (2000) and Billard (2010) given:

$$Y_u = [a_u, b_u], u = 1, \dots, n \tag{1}$$

Where a_u is the lower bound of the interval and b_u is the upper bound. We have the mean of the intervals:

$$\bar{Y} = \frac{1}{2n}\sum_{u\in E}(b_u + a_u) \tag{2}$$

And also variance:

$$S^2 = \frac{1}{3n}\sum_{u\in E}(b_u^2 + b_u a_u + a_u^2) - \frac{1}{4n^2}[\sum_{u\in E}(b_u + a_u)]^2 1, \dots, n \tag{3}$$

The use of the interval data is crucial because it retains the original data's relevant information, considering all the different weighting schemes.
In this respect, the data's triplex representation (Apostolatos et al. 1968, Nickel 1969) can be useful to consider the most relevant assumption of the different composite indicators constructed. The intervals and the triplex representation both have their arithmetic, allowing the statistical analysis of the different sets of composite indicators obtained (Williamson 1989 Gioia and Lauro 2005).
So we are explicitly considering in our interval-based composite indicator a value of the interval obtained using the classical approach in constructing the composite indicator. The advantage is twofold: to retain the information of the original composite indicator, and also to allow to evaluate the two radii, as sub-intervals constructed by considering the difference between the upper bound and the original composite indicator value, but also the difference between the most likely result of the composite indicator and the lower bound. These measures can be essential in interpreting the results because it allows measurement of the variability of the measures considering extreme scenarios.

3 Application Results

To analyze the proposed approach, we consider an application based on the analysis of the interest and potential demand for "Decreto Ristori" as a policy measure to

sustain the Italian Economy from the Covid-19 Emergency. In this sense, the policy measure was the DL 28 October 2020, n. 137, containing "Additional urgent measures in the field of health protection, support to workers and businesses, justice and safety, connected to the epidemiological emergency from Covid-19" (V.A. 2021 MEF 2021). This decree was very relevant because it was significant for many businesses in Italy, so the potential demand or interest measured as google queries on the period 2020-10-25- 2021-2-28 (essential to consider also the additional renewals of the decree, which identify different measure and different policies). The interest measured in this sense is absorbing because it allows identifying relevant Italian zones special in need of economic sustain.

More specifically, we collected the queries by using Google Trends (see Google Trends 2021). The different queries are: “decreto ristori”, “decreto ristori bis”, “decreto ristori ter”, “decreto ristori quater”, “decreto ristori quinquies”, “fondo perduto decreto ristori”, “decreto ristori codici ateco” and “finally bonus decreto ristori”. The queries are performed for the Italian territory. Obtained the different values for the regions, we consider the Monte-Carlo simulation using different weights schemes. So we obtain the visual representation of the simulation as a heat map in figure 1. We can then compute the different intervals for the region, considering the lower bound, the equal weights scenario, and the upper bound. Using the triplex representation, we can compute the two radii. The two radii (lower radius L.R. and upper radius U.R.) are useful for obtaining a measure of uncertainty related to the composite indicator's computation. Finally, we compute the prototype as the "interval average," considering all the different intervals computed for each region. The mean computation is obtained using the triplex arithmetic (Williamson 1989 and Gioia and Lauro 2005). The final results are shown in Table 1. The result clearly shows some regions in Italy in which it is higher the potential demand and interest for the decree "Ristori." In particular, these regions are Calabria, Campania, and Apulia (Puglia). In these regions, it is higher the measured level of poverty (see Drago 2020). The remarkable difference is the Sicily which does not show a higher the potential demand and interest for the decree "Ristori." This result can suggest that the zones in more severe economic difficulty tend to demand high for economic sustain. It is possible using this indicator to identify them. The results can also be interpreted considering the radii of the difference between the main scenario and the upper and the radii. These differences can have a relevant applicative result because it shows in the apposite ranking how different from the main scenario, the potential demand in some query (related to a single topic). It could be essential to consider the main scenario (or the center of the interval in a different context considering the data as a genuine interval representation) and how can be different the lower and the upper bounds.

Table 1: Interest and the Potential Demand for the Decree "Ristori" over the period 2020-10-25 and the period 2021-2-28

Region	LB	EW	UB	L.R. (1)	U.R. (2)	rank (1)	rank (2)
Calabria	0.85	1.21	1.52	0.36	0.31	1	1

Campania	0.92	1.15	1.44	0.23	0.29	6	4
Apulia	0.71	0.92	1.18	0.21	0.26	8	6
Tuscany	0.48	0.65	0.86	0.17	0.21	11	9
Lombardy	0.25	0.49	0.77	0.24	0.28	5	5
Sicily	0.37	0.49	0.61	0.12	0.12	15	15
Piedmont	0.09	0.31	0.55	0.22	0.24	7	7
Umbria	-0.12	0.14	0.38	0.25	0.24	3	8
Basilicata	-0.24	0.01	0.31	0.25	0.30	4	3
Abruzzo	-0.24	-0.06	0.11	0.19	0.16	9	12
Lazio	-0.20	-0.09	0.02	0.12	0.10	16	18
Marche	-0.33	-0.15	0.03	0.18	0.19	10	11
Emilia-Romagna	-0.34	-0.20	-0.01	0.15	0.19	12	10
Veneto	-0.56	-0.44	-0.31	0.12	0.13	14	13
Molise	-0.85	-0.55	-0.24	0.30	0.31	2	2
Liguria	-0.70	-0.58	-0.47	0.11	0.11	17	17
Sardinia	-0.69	-0.60	-0.53	0.08	0.08	20	20
Friuli-Venezia Giulia	-0.76	-0.66	-0.56	0.10	0.10	19	19
Trentino-Alto Adige/South Tyrol	-1.11	-1.00	-0.88	0.11	0.12	18	16
Aosta	-1.19	-1.05	-0.93	0.15	0.12	13	14
Prototype computed	-0.18	0	0.19	0.18	0.19		

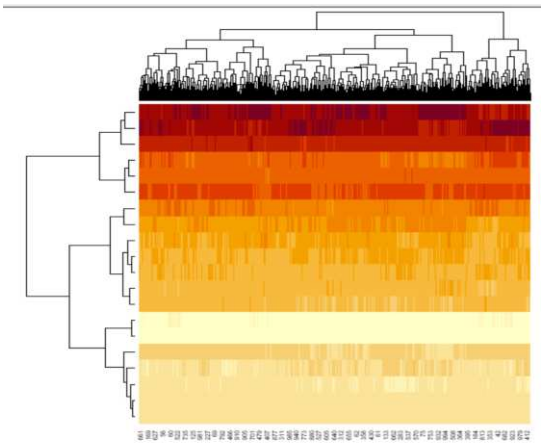

Figure 1: Heat map of the different simulations performed (in the columns) for each ranked region (in the row)

4 Conclusions

The results in this work show the possibility of using the triplex representation in the interval to interpret the different intervals in a useful way to economic policy. The main scenario (or the center of the interval) can analyze the potential demand or the interest in the topic. The obtained relevant result is the identification of the relevant zones with a higher potential demand for economic support. There are relevant advantages to using the triplex representation to interpret the result of the analysis. First of all, we are explicitly taking into account the main scenario (in this sense, the equal weight scenario includes the main result of a classical composite indicator outcome).
Secondarily, this representation allows the computing of the lower and the upper radii to represent the limitations of the classical approach identifying where there is stronger the request and interest for some queries or in the application for different economic supports.

References

1. Apostolatos, N., Kulisch, U. Krawczyk, R. Lortz, B. Nickel K. -Wipperman, W. (1968) The Algorithmic Language Triplex-Algol 60. Numerische Mathematik 11 (1968)
2. Billard L. (2010) Symbolic Data Analysis: Basic Statistics. Compstat August 2010.
3. Billard, L., & Diday, E. (2003). From the statistics of data to the statistics of knowledge: symbolic data analysis. Journal of the American Statistical Association, 98(462), 470-487.
4. Drago, C. (2017) Interval Based Composite Indicators. FEEM Working Paper No. 42.2017
5. Drago, C. (2019) Decomposition of the Interval Based Composite Indicators by Means of Biclustering. CLADAG 2019 12-th Scientific Meeting Classification and Data Analysis Group Cassino, September 11 – 13, 2019 Book of Short Papers/Abstracts
6. Drago, C. (2020) The Analysis and the Measurement of Poverty: An Interval Based Composite Indicator Approach. Preprints 2020, 2020120695 (doi: 10.20944/preprints202012.0695.v1).
7. Gatto, A., & Drago, C. (2020). Measuring and modeling energy resilience. Ecological Economics, 172, 106527.
8. Gioia F. (2009) Portfolio Selection Models with Interval Data. Statistica Applicata Vol. 21, n. 1, 2009 43
9. Gioia, F., & Lauro, C. N. (2005). Basic statistical methods for interval data. Statistica applicata, 17(1), 75-104.
10. Google Trends (2021) Data source: Google Trends (https://www.google.com/trends) page accessed the 28/2/2021
11. Greco, S., Ishizaka, A., Tasiou, M., & Torrisi, G. (2019). On the methodological framework of composite indices: A review of the issues of weighting, aggregation, and robustness. Social Indicators Research, 141(1), 61-94.
12. MEF (2021) Decreto ristori: le misure a favore di chi è in difficoltà https://www.mef.gov.it/covid-19/Decreti-ristori-le-misure-a-favore-di-chi-e-in-difficolta/ Page accessed the 28/2/2021
13. Nickel K. (1969) Triplex-Algol and its Applications, in Topics in Interval Analysis, E. Hansen, ed., Oxford University Press, Oxford.
14. Saisana, M., Saltelli, A., & Tarantola, S. (2005). Uncertainty and sensitivity analysis techniques as tools for the quality assessment of composite indicators. Journal of the Royal Statistical Society: Series A (Statistics in Society), 168(2), 307-323.
15. V. A. (2021) Decreto Ristori https://www.pmi.it/tag/decreto-ristori#:~:text=Il%20cosiddetto%20Decreto%20Ristori%2C%20ovvero,ottobre%20e%20pubblicato%20in%20Gazzetta page accessed the 28/2/2021
16. Williamson, R. C. (1989). Probabilistic arithmetic (Doctoral dissertation, University of Queensland).