11th Scientific Meeting of the SIS Group
"Statistics for the Evaluation and Quality in Services"

BOOK OF SHORT PAPERS

Editors
Andrea Bucci
Alfredo Cartone
Adelia Evangelista
Andrea Marletta

IES PESCARA 2023

STATISTICAL METHODS FOR EVALUATION AND QUALITY: TECHNIQUES, TECHNOLOGIES AND TRENDS (T^3)

EDIZIONI Il Viandante

IES 2023 - Statistical Methods for Evaluation and Quality: Techniques, Technologies and Trends (T^3)

BOOK OF SHORT PAPERS

Editors: Andrea Bucci, Alfredo Cartone, Adelia Evangelista and Andrea Marletta

Book of Short papers
11th International Conference **IES 2023**
Statistical Methods for Evaluation and Quality: Techniques, Technologies and Trends (T^3)

University 'G. d'Annunzio' of Chieti-Pescara

Scientific Committee of the group of the Italian Statistical Society on Statistics for the Evaluation and Quality of Services - SVQS

Maurizio Carpita	University of Brescia
Pietro Amenta	University of Sannio
Matilde Bini	European University of Rome
Antonello D'Ambra	University of Campania 'L. Vanvitelli'
Luigi D'Ambra	University of Naples 'Federico II'
Paolo Mariani	University of Milan 'Bicocca'
Marica Manisera	University of Brescia
Monica Palma	University of Salento
Pasquale Sarnacchiaro	University of Naples 'Federico II'

Program Committee of the conference IES 2023

Chair: Paolo Mariani	University of Milan 'Bicocca'
Matilde Bini	European University of Rome
Mario Bolzan	University of Padova
Giuseppe Bove	University of Rome 3
Eugenio Brentari	University of Brescia
Ida Camminatiello	University of Campania 'L. Vanvitelli'
Maurizio Carpita	University of Brescia
Carlo Cavicchia	Erasmus University Rotterdam
Roy Cerqueti	University of Rome 'La Sapienza'
Enrico Ciavolino	University of Salento
Corrado Crocetta	University of Bari 'Aldo Moro'
Antonello D'Ambra	University of Campania 'L. Vanvitelli'
Pierpaolo D'Urso	University of Rome 'La Sapienza'
Tonio Di Battista	University 'G. d'Annunzio' of Chieti-Pescara
Simone di Zio	University 'G. d'Annunzio' of Chieti-Pescara
Mauro Ferrante	University of Palermo
Francesca Fortuna	University of Rome 3
Michele Gallo	University of Naples 'Orientale'
Claudiu Herteliu	Bucharest University of Economic Studies
Salvatore Ingrassia	University of Catania
Ron Kenett	Samuel Neaman Institute & KPA Group
Michele La Rocca	University of Salerno
Rosaria Lombardo	University of Campania 'L. Vanvitelli'
Antonio Lucadamo	University of Sannio
Marica Manisera	University of Brescia
Andrea Marletta	University of Milan 'Bicocca'
Lucio Masserini	University of Pisa
Fabrizio Maturo	University Mercatorum
Matteo Mazziotta	ISTAT
Rodolfo Metulini	University of Bergamo
Stefania Mignani	University of Bologna
Enrico Ripamonti	University of Brescia

Silvia Salini	University of Milano
Pasquale Sarnacchiaro	University of Naples 'Federico II'
Violetta Simonacci	University of Naples 'Federico II'
Maurizio Vichi	University of Rome 'La Sapienza'
Mariangela Zenga	University of Milan 'Bicocca'

Organizing Committee

Chair: Tonio Di Battista	University 'G. d'Annunzio' of Chieti-Pescara
Andrea Bucci	University 'G. d'Annunzio' of Chieti-Pescara
Alfredo Cartone	University 'G. d'Annunzio' of Chieti-Pescara
Marco Di Marzio	University 'G. d'Annunzio' of Chieti-Pescara
Marta Di Nicola	University 'G. d'Annunzio' of Chieti-Pescara
Simone Di Zio	University 'G. d'Annunzio' of Chieti-Pescara
Stefania Fensore	University 'G. d'Annunzio' of Chieti-Pescara
Lara Fontanella	University 'G. d'Annunzio' of Chieti-Pescara
Stefano Antonio Gattone	University 'G. d'Annunzio' of Chieti-Pescara
Luigi Ippoliti	University 'G. d'Annunzio' of Chieti-Pescara
Eugenia Nissi	University 'G. d'Annunzio' of Chieti-Pescara
Paolo Postiglione	University 'G. d'Annunzio' of Chieti-Pescara
Annalina Sarra	University 'G. d'Annunzio' of Chieti-Pescara
Pasquale Valentini	University 'G. d'Annunzio' of Chieti-Pescara
Adelia Evangelista (Secretariat)	University 'G. d'Annunzio' of Chieti-Pescara

Editors

Andrea Bucci	University of Macerata
Alfredo Cartone	University 'G. d'Annunzio' of Chieti-Pescara
Adelia Evangelista	University 'G. d'Annunzio' of Chieti-Pescara
Andrea Marletta	University of Milan 'Bicocca'

EDIZIONI IlViandante

IlViandante - Copyright © 2023 Edizioni BACME S.r.l.s.
Sede legale: Via Silvino Olivieri, 111 - 66100 Chieti (CH)

ISBN 979-12-803-3369-8
DOI 10.60984/978-88-94593-36-5-IES2023
https://doi.org/10.60984/978-88-94593-36-5-IES2023

Sponsored by

Farabella GLUTEN FREE

Preface

Statistical thinking, design and analysis play a crucial role in social life and are useful to society at large. Besides, promoting advanced methodological research is useful to facilitate the dissemination of ideas related to various fields of interest. For this purpose, experts in statistics, data analysis, data mining, statistical methods for decision making, machine learning and related methods come together to understand and analyse phenomena through data.

In line with this objective, the Statistics Group for the Evaluation and Quality of Services (SVQS; www.svqs.it) of the Italian Statistical Society (SIS) has been organizing the Innovation and Society (IeS) conference biennially since 2009, focusing on new developments and ideas in statistics applied to the evaluation and quality of public and private services, attracting national and international statisticians and data scientists. The meeting contributes to spot light on the main statistical approaches and methodologies for the evaluation of public services currently in use in different contexts, as well as to facilitate discussion on the impact of innovative statistical evaluation systems for these services, involving various economic and social policy actors.

The conference "Statistical Methods for Evaluation and Quality: Techniques, Technologies and Trends (T^3)" recorded valuable contributions that are reported in this volume. The papers underscore how the growing availability of data has tasked social and economic actors, organizations, and researchers with the management and analysis of large volumes of unstructured and heterogeneous data. In recent years, many tools for both qualitative and quantitative models have been developed to better describe and understand complex systems and their underlying behaviors, and the papers reported in this volume bear witness to this.

Techniques, technologies and trends: the study of data complexity presents the potential to provide analyses with increased frequency and timeliness, accuracy and objectivity, and to define sustainable models. Traditional quantitative methods for capturing socioeconomic data have often shown limitations in their ability to examine underlying systems, and with the three 'T' just mentioned, the outlines of future developments are starting to emerge.

The volume reports 127 contributions in the following areas:

- Advanced statistical methods for pattern recognition
- Advances in statistical learning from high-dimensional data
- Data analysis for web sources
- Distance and depth-based statistical learning methods for robust data analysis

- Economics and environment
- Education and labour
- Inequalities in the labour market
- Innovations and challenges in official statistics
- Labour market: trends, perspectives and new challenges
- Methodological and applicative contributions for evaluating sustainable development
- Methodological developments and applications for the assessment of student competencies
- Networks data analysis: new perspectives and applications
- New advanced statistical methods for data science
- Recent advances in statistical learning and data analysis
- Statistical analysis and modeling of environmental pollution data
- Statistical methods and complexity for evaluation in finance
- Statistical methods and composite indicators for healthcare
- Statistical methods and models for land monitoring with spatio-temporal data
- Statistical methods for environmental monitoring and sustainability
- Statistical methods for the analysis of university student choices and academic performance
- Statistical methods for the assessment of transport services and sustainable emissions
- Statistical methods for education and educational services
- Statistics in sports
- Tourism and territory.

The Conference event attracted many contributions as well as numerous Authors, not just from Italy but also from abroad. Over the three-day meeting, the Community has the opportunity to witness some of the state-of-the arts, new trajectories, and methodological challenges in 24 solicited sessions, 7 sessions of free contributes, two round tables - organized by Maurizio Vichi and Matilde Bini respectively - and three keynotes sessions with Ron S. Kennet of Samuel Neaman Institute of Israel, Luigi D'Ambra of Federico II University of Naples, and the former Minister Enrico Giovannini from University of Tor Vergata.

Organizers

Paolo Mariani
Chair of the Program Committee
Tonio Di Battista
Chair of Local Organizing Committee
Maurizio Carpita
Coordinator of the SVQS Group

Contents

Plenary Session

1. *Befitting Cross Validation with Three Case Studies* (Kenett R.S.)

Statistical analysis of COVID19 impact on Italian mortality

Analisi statistica dell'impatto del COVID19 sulla mortalità italiana

Girolamo Franchetti and Massimiliano Politano

Abstract This study proposes an alternative approach to measuring excess mortality due to COVID19 pandemics compared to the CEMC method. It investigates changes in biometric dynamics since the COVID-19 outbreak in 2019 by comparing empirical data from Italian mortality tables between 2011 and 2021 to counterfactual death probabilities derived from two commonly used statistical models, Lee-Carter and Renshaw-Haberman. Estimates are provided for 2019, 2020, and 2021, with an additional estimate for 2020 to 2021. The findings are presented to observe the dynamics of expected deaths over time.

Abstract *Questo studio propone un approccio alternativo rispetto a quello del CEMC per misurare l'eccesso di mortalità dovuto alla pandemia COVID19, indagando i cambiamenti nelle dinamiche biometriche dall'inizio della pandemia di COVID-19 nel 2019. I dati empirici delle tavole di mortalità italiane tra il 2011 e il 2021 vengono confrontati con le probabilità di morte controfattuali derivate da due modelli statistici comunemente utilizzati, Lee-Carter e Renshaw-Haberman. Vengono fornite stime per il 2019, il 2020 e il 2021, con un'ulteriore stima per il 2020 rispetto al 2021. I risultati sono presentati per osservare la dinamica del numero atteso di morti nel tempo.*

1 Introduction

Our colleagues at CEMC, COVID-19 Excess Mortality Collaborators, have conducted interesting research on their framework [4], which employs a combination

Girolamo Franchetti
University of Naples "Federico II", Economics and Statistics Science Department
e-mail: girolamo.franchetti@unina.it

Massimiliano Politano
University of Naples "Federico II", Economics and Statistics Science Department
e-mail: massimiliano.politano@unina.it

of six models to estimate excess deaths. The specific result in Italy is estimated to be 259,000 (with a confidence interval of 242,000 to 276,000).

However, we have concerns regarding the combination of these six models. The approach involves assigning reliability weights to each model, which is estimated based on pre-pandemic historical data. We believe that it may not be appropriate to assign weights to different models in this manner, as these subjective weights could introduce excessive increases in the estimate of deaths.

While the rationale for assigning more weight to the model with a more accurate estimate is understandable, we are concerned that this approach may introduce bias into the estimation, making it less reliable. As a result, we have opted to use classical actuarial models to estimate the probability of death and have conducted simulations to infer the estimates for each model.

This section of the study examines excess deaths through actuarial models based on mortality tables [1]. This approach allows for a direct observation of the impact of COVID-19 on the probability of death [5]. The results show an increase in excess deaths with age, peaking around age 80 before decreasing. The study uses the Lee-Carter and Renshaw-Haberman models with the R software package *StMoMo*[1], and the dataset is obtained from the I.Stat platform[2]. However, the dataset has a limitation in that the maximum age is an age class for those 100 years and older, so the weighted average of q_x is computed with the weight $l_x/\sum_{x=1}^{199} l_x$. All data and scripts are available on the OSF.io storage[3]. The framework involves using biometric panel data to determine the probability of death by age and year, converting this probability into mortality rates, and obtaining the matrix of death rates from 2011 to 2021 for each age. The estimated deaths are then compared with those based on mortality estimation models. The study also conducts simulations of death probabilities for the subsequent year in each part of the framework and shows significant results on confidence intervals through inference analysis.

2 Investigation

2.1 Probabilities

The Lee-Carter [2] and Renshaw-Haberman [3] models are regression models that provide average values of death probability and estimates of death rates conditioned by age. The term ”expectation” is used to refer to the probabilities estimated by these models. The study compares observed and estimated probabilities by age and observation period to assess how well the observations met the relative expectation.

[1] CRAN Manual available at `https://cran.r-project.org/web/packages/StMoMo/StMoMo.pdf`

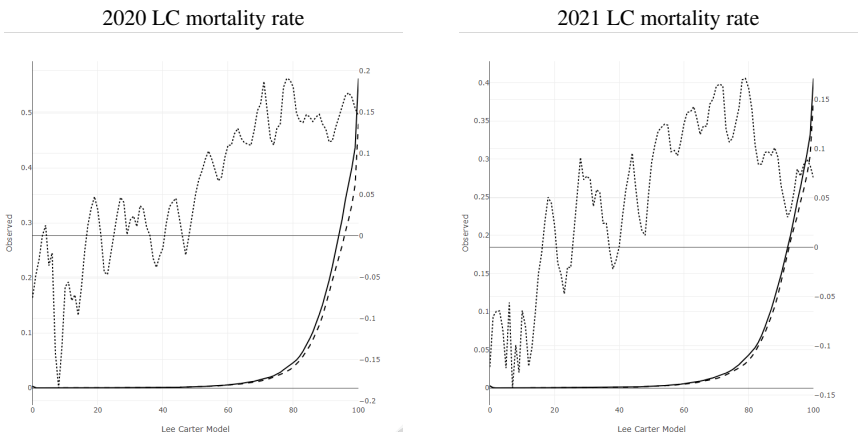
[2] ISTAT database available at `http://dati.istat.it/`

[3] Data storage available at `https://osf.io/9cqbm/`

From 2019 to 2020

Let's consider the first model, the Lee-Carter one. Here there is an interesting result.

Fig. 1



A graph (1) comparing mortality rates from 2019 to 2021 shows a cyclical pattern, with the mortality gap peaking at age 80 and decreasing at later ages. The smooth dynamics of the pattern are surprising, as is the reduction in mortality rates for younger age groups. We can then observe the death probabilities according to the Renshaw-Haberman Model:

The probability dynamics show a distinctive pattern, with a peak at ages 45-65 and a decline after age 85. Mortality rates for 2021 are generally as expected, except for a slightly lower rate at age 30 and unexpected events impacting mortality rates in certain age groups.

From 2020 to 2021

This constitutes a pivotal point of our study. While the findings may not be unexpected, they are of great significance in terms of their implications for predicting future outcomes.

The graphs show a negative trend in the gap due to newer data. COVID-19 had a less severe impact on mortality than expected, resulting in less observed mortality than estimated. The model predicts a wider negative gap in older ages and shows fluctuation in the mismatch, with higher mismatch in the first 20 years and widening mismatch in older ages. Therefore, it is expected that there were more deaths in 2020 than realized.

Fig. 2

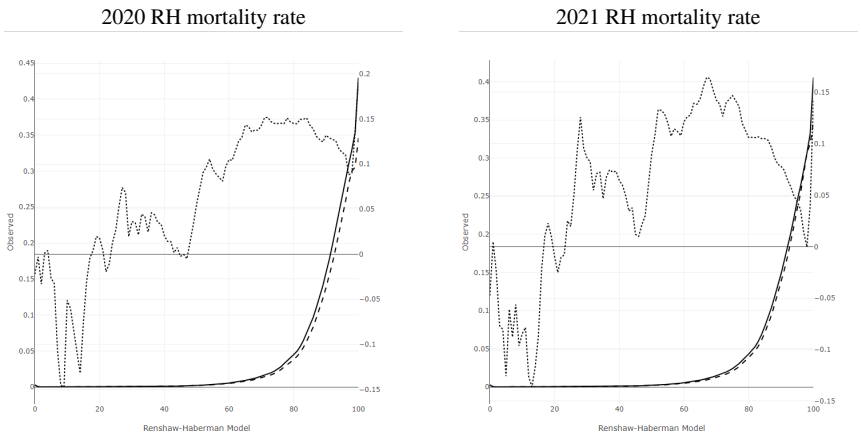
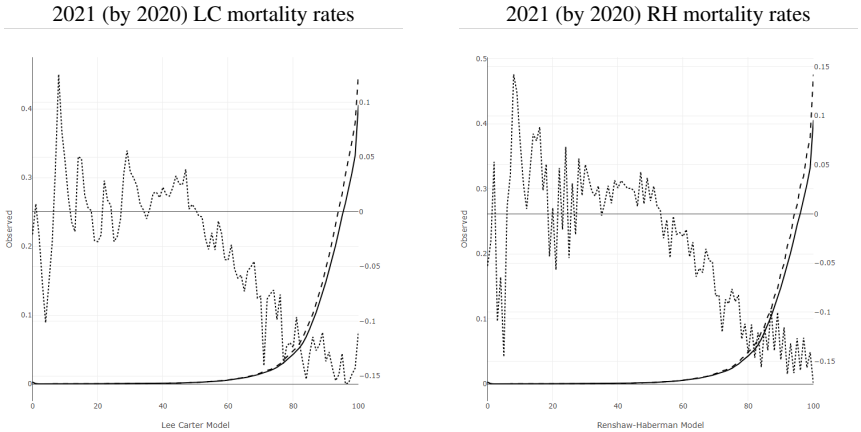


Fig. 3



2.2 Death Excess

Estimating the expected deaths $\mathbb{E}[\frown] = Pop \cdot q_x$ for 2020 and 2021 based on the 2019 population and mortality rates, it is evident that the actual numbers exceeded the predicted figures, particularly for the 65+ age group. However, the change in impact from 2020 to 2021 must also be taken into account. The following graphs exhibit the excess deaths across age and time periods for the Lee-Carter and Renshaw-Haberman models, with numerical results presented in the table in Section 3:

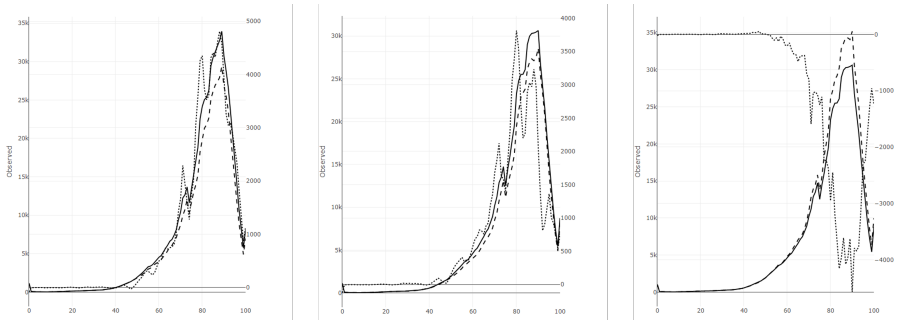


Fig. 4: LC excesses of deaths (left to right) 2020, 2021 (from 2019) and 2021 (from 2020)

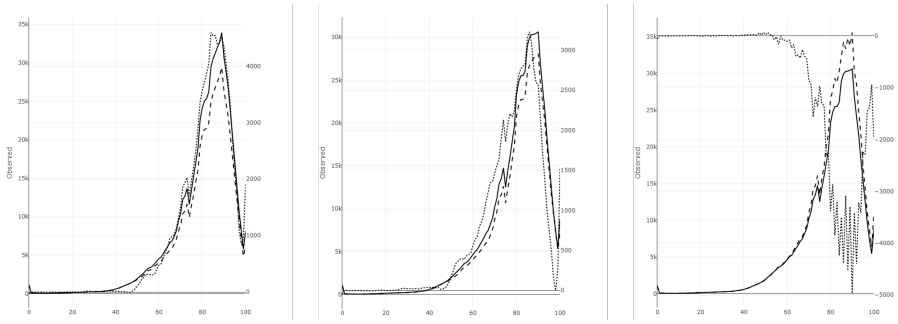


Fig. 5: RH excesses of deaths (left to right) 2020, 2021 (from 2019) and 2021 (from 2020)

3 Conclusion

In conclusion, based on the results obtained from the analysis of excess deaths and probability measures, it appears that there is a stronger excess of deaths particularly in the older age groups, as well as a weakening trend over time, suggesting a temporary effect of this shock on mortality [6, 7, 8]. Confidence intervals are computed based on the Normal-like shaped distribution of the death excesses to make estimations, and the tables below provide numerical results. Additionally, we found that the expected amount of deaths is significantly lower than CEMC estimations. The table above presents the relevant numerical results.

	LC		RH	
	Observed	Estimated	Observed	Estimated
2020	745856	643328	745856	643556
2021	712527	637963	712527	639137
2021 (from 2019)	712527	795983	712527	795451

Table 1: Total deaths counted for both models in each observation year

	Min	Mean	Max
2020	68578	68723	68868
2021	73266	73470	73674
2021 (by 2020)	-88874	-88336	-87798

Table 2: LC Model

	Min	Mean	Max
2020	67897	68070	68243
2021	71681	71924	72167
2021 (by 2020)	-88379	-87833	-87287

Table 3: RH Model

In contrast to the CEMC framework, we utilized the classical actuarial model to estimate the probability of death, and conducted simulations to derive estimates for each model. The results consistently show a lower probability of death, and highlight the maximum impact of events in 2019 on mortality. Although COVID-19 has resulted in increased mortality, our findings suggest that mortality may eventually revert to pre-pandemic levels. Nonetheless, further research is necessary to validate these findings and consider the potential influence of other factors on mortality rates.

References

1. Zhang, Y.: The negative impact of COVID-19 on life insurers. Geneva Papers on Risk and Insurance-Issues and Practice, 46(2), 209-232 (2021)
2. Lee, R. D. and Carter, L. R.: Modeling and Forecasting US Mortality. Journal of the American Statistical Association, 87(419), 659-671 (1992)
3. Haberman, S. and Renshaw, A.: Modelling and projecting mortality improvement rates using a cohort perspective. Insurance: Mathematics and Economics, 53, 150-168 (2013)
4. COVID-19 Excess Mortality Collaborators: Estimating excess mortality due to the COVID-19 pandemic: a systematic analysis of COVID-19-related mortality, 2020-21. The Lancet, 399(10304), 1907-1918 (2022)
5. Friedman, J., Liu, P., Troeger, C. E., et al.: Predictive performance of international COVID-19 mortality forecasting models. Nature Communications, 12, 2609 (2021)
6. Levy, C. and Cohen, R.: Infectious diseases in the COVID-19 era: gaps between countries. The Lancet Global Health, 10(2), e85-e86 (2022)
7. Tenforde, M. W. and Link-Gelles, R.: Reduction in COVID-19-related mortality over time but disparities across population subgroups. The Lancet Microbe, 4(5), e195-e196 (2023)
8. Johns Hopkins University: Mortality Analysis. Available via URL: `https://coronavirus.jhu.edu/data/mortality`. Cited on 14 May 2023.

This book collects the papers presented at the 11th Scientific Meeting of the SIS Group "Statistics for the Evaluation and Quality in Services" *Statistical Methods for Evaluation and Quality: Techniques, Technologies and Trends (T^3)*, which took place at the University of Chieti-Pescara, on 30th August-1st September, 2023.
The papers, which had been selected through a refereeing process, contain topics on statistical approaches and methodologies for the evaluation of public services in different contexts, and cover the areas of digital transition, e-commerce and digital marketing, enterprises, environment and territory, healthcare and wellness, finance, bank and FinTech, justice system, labour market, official statistics, public administration, food and wine, school, education and training, social, sports, sustainability, tourism, transport, university and research, well-being and welfare.

ISBN: 979-12-803-3369-8
DOI: 10.60984/978-88-94593-36-5-IES2023

ISBN 9791280333698