

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



**STATISTICAL METHODS
FOR EVALUATION AND QUALITY:
TECHNIQUES, TECHNOLOGIES AND TRENDS (T³)**

**IES 2023 - Statistical Methods for Evaluation and Quality:
Techniques, Technologies and Trends (T³)**

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 (T³)

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'



Il Viandante - 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>

All rights reserved.

This work is protected by copyright law.

All rights, in particular those relating to translation, citation, reproduction in any form, to the use of illustrations, tables and the software material accompanying the radio or television broadcast, the analogue or digital recording, to publication and dissemination through the internet are reserved, even in the case of partial use. The reproduction of this work, even if partial or in digital copy, is admitted only and exclusively within the limits of the law and is subject with the authorization of the publisher. Violation of the rules involves the penalties provided for by the law.

Sponsored by



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 (T³)” 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	2
<i>Kenett R.S.</i>	
Solicited Session SS1 - <i>Statistical analysis and modeling of environmental pollution data</i>	3
Assessing environmental quality by clustering a structural equation model based index: An application to European cities air pollution	4
<i>Bottazzi Schenone M., Grimaccia E. and Vichi M.</i>	
Evaluating the nonlinear association between PM ₁₀ and emergency department visits	10
<i>Bucci A., Sanmarchi F., Santi L., Giostra F., Tubertini E., Rosa S., Nante N. and Golinelli D.</i>	
Estimating spatially varying Gaussian Graphical Models to unveil relationships among pollutants in the Red River Delta in Vietnam	16
<i>Pronello N., Cucco A., Ignaccolo R. and Ippoliti L.</i>	
Solicited Session SS2 - <i>Statistics in sports</i>	22
Clustering Athlete Performances in Track and Field Sports	23
<i>Argiento R., Colombi A., Modotti L. and Montagna S.</i>	
A Cross-Country Analysis of Engagement in Physical Activity and Sport Practice Learnt from Eurobarometer Survey Data	29
<i>Simone R.</i>	
Strong eras in male professional tennis	35
<i>Breznik K., Candila V., Milekhina A. and Restaino M.</i>	
NonParametric Combination method for data analytics in basketball matches	41
<i>Barzizza E., Biasetton N., Ceccato R., Disegna M. and Vezzosi G.</i>	
Solicited Session SS3 - <i>Statistical methods for the analysis of university student choices and academic performance</i>	47
The influence of labor market conditions on students' career disruption: first insights from Italy	48
<i>Usala C., Sulis I. and Porcu M.</i>	
Socio-economic aspects that may affect South-North students' mobility in Italy	53
<i>Genova V.G. and Boscaïno G.</i>	
An analysis of student's performance in bachelor's degree	59

<i>La Rocca M., Niglio M. and Restaino M.</i>	
An exploratory strategy for analyzing students' mobility data	65
<i>Primerano I. and Giordano G.</i>	
Solicited Session SS4 - <i>Statistics in football</i>	71
Community Detection in Sport Market Networks: The Case of Italian Professional Football	72
<i>Rondinelli R. and Ievoli R.</i>	
An Original Application to Football of PLS-SEM for the xG Model	78
<i>Cefis M. and Carpita M.</i>	
Performance Assessment of Football Players and Combined Permutation Tests with application to Home-Field Advantage	84
<i>Bonnini S.</i>	
A First Proposal of the Triad Census for Weighted Networks: an Application to Football	90
<i>Rondinelli R. and Palazzo L.</i>	
Solicited Session SS5 - <i>Advances in statistical learning from high-dimensional data</i>	96
PCA approaches for vector functional time series	97
<i>Aguilera A.M., Alonso F.J. and Acal C.</i>	
Conformal Prediction for Functional Kriging Models	102
<i>Diana A., Romano E. and Adzic J.</i>	
Measuring Public-Private Connectedness in Financial Markets	108
<i>Sánchez García J. and Cruz Rambaud S.</i>	
An original approach to anomalies in intertemporal choices through Functional Data Analysis: Theory and application for the study of Hikikomori syndrome	112
<i>Martino R., Ventre V., Cruz Rambaud S. and Maturo F.</i>	
Solicited Session SS6 - <i>Labour market: trends, perspectives and new challenges</i>	118
Enriching Job Vacancy Official Information with Online Job Advertisements: Chances and Limits	119
<i>Lucarelli A. and Righi A.</i>	
Innovation in Management: towards the Open Manager	126
<i>Bruttini P., Gallo M., Mariani P. and Menini T.</i>	
Solicited Session SS7 - <i>Data analysis for web sources</i>	132
Enhancing SMEs default prediction with web-scraped data	133
<i>Crosato L., Domenech J. and Liberati C.</i>	
Web data as enabler for informed decisions in Labour Market	137
<i>Maggioni G.</i>	
The metaverse & luxury fashion brands: strategic communication exercise	141
<i>Forciniti A. and Zavarrone E.</i>	
Increasing the Geographical Granularity of Economic Indicators with Google Trends	147

Domenech J. and Marletta A.

Solicited Session SS8 - <i>Methodological and applicative contributions for evaluating sustainable development</i>	153
Evaluating sustainable development in EU countries through synthetic indicators	154
<i>Alaimo L.S. and Cucci M.</i>	
Naples and tourism sustainability: A survey of citizens' perceptions	160
<i>Aria M., Pagliara F., D'Aniello L. and Della Corte V.</i>	
Modelling inequalities for sustainable development in Italy countries	166
<i>Musella M., Borrata G., Camminatiello I. and Lombardo R.</i>	
Food Security and Sustainability: A Science Mapping Analysis	172
<i>Piscitelli A.</i>	
Solicited Session SS9 - <i>Inequalities in the labour market</i>	178
Skill similarities across Italian regions: an analysis based on the online job advertisements	179
<i>Kahlawi A., Buzzigoli L., Grassini L., Martelli C. and Giambona F.</i>	
Italian Labour Market reform and gender inequalities	185
<i>Marini C. and Nicolardi V.</i>	
Intergenerational transmission of disadvantages in the Italian labour market: evidence from AD-SILC data	191
<i>Busetta A., Fabrizi E., Ragozini G. and Sulis I.</i>	
Solicited Session SS10 - <i>Statistical methods and complexity for evaluation in finance</i>	197
Financial networks resilience and shocks propagation	198
<i>Cerqueti R., Cinelli M., Ferraro G. and Iovanella A.</i>	
How the choice of one parameter impacts the numerical stability of the efficient frontier	204
<i>Fassino C. and Uberti P.</i>	
Dynamic shrinkage for minimum variance combination of forecasts	210
<i>Mattera R.</i>	
Exploring the perception of the gender issue of Italian female entrepreneurs	217
<i>Castellano R., Riccioni J. and Rinaldi A.</i>	
Solicited Session SS11 - <i>Networks data analysis: new perspectives and applications</i>	223
Describing Italian mobility trajectories in higher education	224
<i>Genova V.G., Giordano G., Ragozini G. and Vitale M.P.</i>	
Collaboration networks: methodological issues and updated empirical evidence on Italian statisticians	230
<i>De Stefano D., Fabbrucci Barbagli A.G., Santelli F. and Zaccarin S.</i>	
Mapping Ashtma Complexity with Graph Theory: an Integrative Approach	236
<i>Cucco A., Simpson A., Murray C., Fontanella S. and Custovic A.</i>	
Investigating the patterns of Italian internal mobility: a network analysis at provincial level	242

Sarra A., D'Ingiullo D., Evangelista A., Nissi E., Quaglione D. and Di Battista T.

Solicited Session SS12 - <i>Innovations and challenges in official statistics</i>	248
Formal and informal networks of care for the elderly: regional profiles compared	249
<i>Sicuro L., Tucci D. and Coniglio R.</i>	
Gender Gap: a multidimensional approach	255
<i>Acampora C., Fusco D., Liguori M.A. and Pagliuca M.M.</i>	
Using Whatsapp in Official Statistics: a New tool for managing the Agriculture Census	259
<i>Fabi C.</i>	
Solicited Session SS13 - <i>Statistical methods and composite indicators for healthcare</i>	265
Longitudinal composite indicators to measure the quality of health services	266
<i>Crocetta C., Antonucci L., Cataldo R. and Mazza R.</i>	
Past and Future of Doctor-Patient Communication	272
<i>Tedesco N., Zavarrone E. and Forciniti A.</i>	
Network Analysis approach to customer satisfaction and service quality detection: an application to health-care services	277
<i>Crocetta C., Grassia M.G., Marino M., Mazza R., Simonacci V. and Stavolo A.</i>	
A project evaluation study on multiset Likert scale data	283
<i>Simonacci V., Marino M., Grassia M.G. and Gallo M.</i>	
Solicited Session SS14 - <i>Distance and depth-based statistical learning methods for robust data analysis</i>	289
Robust distance-based predictive models	290
<i>Boj E., Grané A. and Parron D.</i>	
Data depth for mixed-type data through multidimensional scaling. An application to biological age imputation	294
<i>Cascos I., Grané A. and Qian J.</i>	
A compared protocol to improve clustering procedures	298
<i>Grané A., Riani M. and Salini S.</i>	
Robust diagnostics for Linear Mixed Models with the Forward Search . . .	304
<i>Corbellini A., Grossi L. and Laurini F.</i>	
Solicited Session SS15 - <i>Advanced statistical methods for pattern recognition</i>	310
Unsupervised classification of NPLs recovery curves	311
<i>Carleo A. and Rocci R.</i>	
Living alone in Italian municipalities	317
<i>Vellucci P., Benassi F., Naccarato A. and Gallo G.</i>	
Supervised learning from high-dimensional data through dynamic updating of functional classification rules	323

<i>Maturo F., Fortuna F. and Di Battista T.</i>	
Assessing the effectiveness of coordination among public authorities in cohesion expenditure	329
<i>Coco G., Monturano G. and Resce G.</i>	
Solicited Session SS16 - <i>Recent advances in statistical learning and data analysis</i>	335
A Predictive Functional Principal Component Analysis of Well-Being Data	336
<i>Marcis L., Pagliarella M.C. and Salvatore R.</i>	
Detecting the partition in the extended hierarchy of a dendrogram: an application on biomedical data	343
<i>PolICASTRO V., Palazzo L. and VISTOCO D.</i>	
Concordance measure for rankings	350
<i>Bissiri P.G. and Nai Ruscone, M.</i>	
Quadratic discriminant scoring for selecting clustering solutions	355
<i>Coraggio L. and Coretto P.</i>	
Solicited Session SS17 - <i>Statistical methods for education and educational services</i>	361
Association between INVALSI scores and students' mobility in Italy: a preliminary analysis	362
<i>Bacci S., Bertaccini B., Lombardi G. and Tocchioni V.</i>	
Modelling Responses and Response Times: an application to Mathematics INVALSI data	368
<i>Bungaro L., Desiderati R. and Mignani S.</i>	
Latent potential outcomes: An analysis of the effects of programs aimed at improving students' non-cognitive skills	374
<i>Pennoni F., Bartolucci F. and Vittadini G.</i>	
Cognitive Skills and Non Cognitive Skills to Analyze School and Students Performances	380
<i>Vittadini G.</i>	
Solicited Session SS18 - <i>Statistical methods for the assessment of transport services and sustainable emissions</i>	386
Sustainability assessment of urban transport by an LCA comparison on different technologies vehicles	387
<i>Della Ragione L. and Meccariello G.</i>	
Passenger comfort prediction via time-series classification	393
<i>Vanacore A., Pellegrino M.S. and Ciardiello A.</i>	
A statistical model to analyse driving behavior: a case study	399
<i>Rodia G., Sarnacchiaro P. and Acciarino V.</i>	
Aggregating judgments in non negotiable group decisions in transport system	403
<i>Amenta P. and Lucadamo A.</i>	
Solicited Session SS19 - <i>New advanced statistical methods for data science</i>	408

A unified framework for two-dimensional clustering on preference-approvals: an analysis of Eurobarometer data	409
<i>Albano A., Sciandra M. and Plaia A.</i>	
Pandemic Data Quality Modelling: A Bayesian Approach	415
<i>Ferrari L., Manzi G., Micheletti A., Nicolussi F. and Salini S.</i>	
Explainable AI for Peer-to-Peer Credit Risk Management	421
<i>Babaei G., Pagnottoni P. and Do T. T.</i>	
Tackling misclassification in surveys about undeclared work via the EM algorithm	427
<i>Arezzo M.F., Guagnano G. and Vitale D.</i>	
Solicited Session SS20 - <i>Tourism, territory and data analysis</i>	432
Tourism, sustainability, and territorial impact: an input-output analysis . .	433
<i>Garau G. and El Meligi A.K.</i>	
The Impact of Big Data in Tourism	439
<i>Ciuffreda R., Choedon C. and Simonetti B.</i>	
Neural network-based prediction of domestic tourists' length of stay in Italy	443
<i>Antolini F. and Cesarini S.</i>	
The management of cultural heritage in contexts of undertourism: a model for assessing the economic sustainability of public-private partnerships	450
<i>Calabrò F.</i>	
Solicited Session SS21 - <i>Statistical methods and models for land monitoring with spatio-temporal data</i>	457
Geo-referenced data and complex networks for measuring road accident risk	458
<i>Cantaluppi G., Clemente C., Della Corte F. and Zappa D.</i>	
A comparison of geospatial models for car crash risk	464
<i>Cantaluppi G., Giardino G. and Zappa D.</i>	
Geostatistical modelling of livestock-related PM _{2.5} pollution and scenario analysis for policymakers - Work in progress	470
<i>Fassò A., Rodeschini J., Fusta Moro A. and Finazzi F.</i>	
Functional clustering methods for space-time big data from mobile phone networks	476
<i>Perazzini S., Metulini R. and Carpita M.</i>	
Solicited Session SS22 - <i>Methodological developments and applica- tions for the assessment of student competencies</i>	483
Modeling the main drivers of mathematical literacy of school-leaving stu- dents. Some evidence from the Invalsi tests	484
<i>Davino C., Palumbo F., Romano R. and Vistocco D.</i>	
Educational Data Mining: clustering students' performance over time . . .	490
<i>Taraborrelli G. and Farnè M.</i>	
The nexus of cultural capital with participation in early childhood education	496
<i>Ripamonti E.</i>	
High- and Low-Performing students and future career: a gender and social issue	502
<i>Falzetti P. and Ricci R.</i>	

Solicited Session SS23 - <i>Statistical methods for environmental monitoring and sustainability</i>	508
Clustering spatial data through optimal transports	509
<i>Balzanella A. and Verde R.</i>	
New interpretative insights for environmental air quality by means of FDA	514
<i>Terzi S., Naccarato A. and Fortuna F.</i>	
A Bayesian State-Space Model to Mitigate Unmeasured Confounding . . .	520
<i>Zaccardi C., Valentini P. and Ippoliti L.</i>	
Mining social media data for damage assessment in environmental disasters	526
<i>del Gobbo E., Cafarelli B., Ippoliti L. and Fontanella L.</i>	
Solicited Session SS24 - <i>Satisfaction and behavior in tourism</i>	531
The evaluation of the hotel stay through a new development of correspondence analysis coping with ordinal variables	532
<i>D'Ambra A. and Amenta P.</i>	
Assessing the role of knowledge and authenticity in the formation of attendee loyalty at cultural festivals	536
<i>Rivetti F., Lucadamo A. and Rossi C.</i>	
Residents' Opinions and Perceptions of Tourism Development in the Historic City of Matera	542
<i>Sarnacchiaro P., Di Gennaro R. and Di Taranto E.</i>	
Exploring tourism at religious sites: The case of Assisi	547
<i>Rivetti F., Dini M. and Splendiani S.</i>	
Session of free contributes SFC1 - <i>Education and labour</i>	552
Local concordance among the items of questionnaires on student's opinion (OPIS)	553
<i>Terzi S. and Petrarca F.</i>	
High School Proficiency of Future University Students: An Analysis based on INVALSI Data	560
<i>Santelli F., Di Credico G. and Di Caterina C.</i>	
Employment vulnerability of immigrants in the labour market – Does origin matter?	566
<i>Bittaye M.</i>	
The effect of pricing policies on students' use of university canteens	572
<i>Masserini L., Bini M. and Lorenzoni V.</i>	
Gig workers' identikit	576
<i>Zavarrone E. and Forciniti A.</i>	
Session of free contributes SFC2 - <i>Tourism and territory</i>	582
Multi-source approach for statistics in tourism sector	583
<i>Bianchino A., Fusco D., Giordano P., Liguori M.A. and Summa D.</i>	
Statistical analysis of tourism sustainability in Campania: post Covid-19 review	589
<i>Giacalone M., Basile V. and Bellucci M.</i>	
Investigating recent changes in dietary behavior	596
<i>D'Uggento A., d'Ovidio F.D., Toma E. and Onorati M.G.</i>	

Depopulation in the Abruzzo municipalities	603
<i>Carulli A.L., Di Spalatro D. and Valentini A.</i>	
The Productions System of Inland Areas	607
<i>Madia Carucci A.M. and Regano A.</i>	
Session of free contributes SFC3 - <i>Social issues</i>	613
Modelling the gender gap in youth mortality with an Age-Period-Cohort analysis	614
<i>Lanfiuti Baldi G. and Nigri A.</i>	
Random forest for classifying odor emission sources	620
<i>Distefano V., Palma M., De Iaco S. and Mazuruse G.</i>	
An Experimental Annotation Task Investigating Annotator Agreement Within a Misogynistic Dictionary and Corpus	626
<i>Tontodimamma A., Ignazzi E., Anzani S., Fontanella L. and Di Zio S.</i>	
Statistical analysis of COVID19 impact on Italian mortality	632
<i>Franchetti G. and Politano M.</i>	
Measuring multidimensional deprivation using objective and subjective data: an application of the Voronoi ranking method	638
<i>Ciommi M., Mariani F., Polinesi G. and Recchioni M.C.</i>	
Session of free contributes SFC4 - <i>Trends</i>	644
The role of big data analytics in circular supply chains: A bibliometric analysis	645
<i>Khan F. and Rapposelli A.</i>	
Estimation of the ranking of incentive policies for the adoption of 4.0 tech- nologies	652
<i>Bonnini S. and Borghesi M.</i>	
Risk Management and Future Scenarios. A proposal based on a mixed- method approach	658
<i>Di Zio S., Bolzan M., Marozzi M. and Scioni M.</i>	
Explainable artificial intelligence (XAI) through artificial intelligence from a human in the loop (HITL) perspective: an interview with ChatGPT	664
<i>Santarcangelo V., Lamacchia A., Vitullo S., Di Lecce M. and Giacalone M.</i>	
Relevance in official statistics: information needs, satisfaction with data quality, some results and future perspectives	670
<i>Loporcaro M.F.</i>	
Session of free contributes SFC5 - <i>Economic issues</i>	676
Evolutionary trends of start-ups in Italy: a case study	677
<i>Dutillo P., Caruso G., Iannone B. and Gattone S.A.</i>	
Permanent establishments and efficiency analysis with global enterprises .	682
<i>Frenda A. and Sepe E.</i>	
Techniques and constructs in some recent market and organizational research	685
<i>Sciascia I.A.</i>	
The value of buildings in the Italian general government balance sheet . . .	689
<i>Santoro P. and Regano A.</i>	

Linear and nonlinear factors affecting default risk in the peer-to-peer lending market	695
<i>Giordano F., Milito S. and Parrella M.L.</i>	
Session of free contributes SFC6 - <i>Methodological issues</i>	701
Macroeconomic Time Series Classification by Nonparametric Trend Estimation	702
<i>Feo G., Giordano F., Niglio M. and Parrella M.L.</i>	
A Normalization Method for Space-time Analysis of Evaluation and Quality Indicators	709
<i>Mazziotta M. and Pareto A.</i>	
Unveiling Latent Structures: exploring Multidimensional IRT Models using Dirichlet Process Mixtures	713
<i>Valentini P., Fontanella S. and Fontanella L.</i>	
On a technique to detect accounting data manipulation	718
<i>Passamonti C.</i>	
Session of free contributes SFC7 - <i>Economics and environment</i>	724
Determinants of Water Conservation Behaviour and Spatial Heterogeneity in their Coefficients	725
<i>Mammadli R. and Gigliarano C.</i>	
Modeling the economic burden of grass pollen allergoid immunotherapy . .	731
<i>Bilancia M. and Di Bona D.</i>	
Swine fever in Liguria: who does pay for economic losses? A causal analysis	735
<i>Baggetta C., Cavalletti B. and Corsi M.</i>	
Measuring Multidimensional Poverty of the Italian Regions in the era of COVID-19	741
<i>Chelli F.M.C., Ciommi M., Gigliarano C. and Polinesi G.</i>	
Drivers of inflation: relationships changing over time	747
<i>Sokolenko O., Palumbo A., Fortuna F., Naccarato A. and Marie J.</i>	
Environmental accounting and sustainable cities: an explorative bibliometric-based literature analysis	753
<i>Kaur A., Javed A., D'Andreamatteo A. and Rapposelli A.</i>	

The effect of pricing policies on students' use of university canteens

L'effetto delle politiche di prezzo sull'uso delle mense universitarie da parte degli studenti

Lucio Masserini, Matilde Bini and Valentina Lorenzoni

Abstract University canteens play an important role in academic life; they not only allow students to benefit from subsidised food services and meals at lower prices than those commonly available at other local eateries but also affect other aspects, such as students' health, social relationships and academic achievement. Using a quasi-experimental design and a difference-in-differences approach, this study aims to evaluate the impact of an income-based pricing policy on students' frequency of using university canteens and their meal choices. Using data from an Italian university, this study shows that users who experienced a meal price increase significantly reduced their use of university canteens.

Abstract *Utilizzando un disegno quasi sperimentale e un approccio basato sulla differenza nelle differenze, questo studio si propone di valutare l'impatto di una politica dei prezzi basata sul reddito sulla frequenza di utilizzo delle mense universitarie da parte degli studenti e sulle loro scelte di pasto. Utilizzando i dati di un'università italiana, questo studio dimostra che gli utenti che hanno subito un aumento del prezzo dei pasti hanno ridotto significativamente l'uso delle mense universitarie.*

Key words: difference-in-differences, food choice, price change, pricing policies, university canteen meals, university finance

Lucio Masserini

Department of Economics and Management, University of Pisa, Pisa, Italy; e-mail: lucio.masserini@unipi.it

Matilde Bini

Department of Human Sciences, European University of Rome, Rome, Italy; e-mail: matilde.bini@unier.it

Valentina Lorenzoni

Institute of Management, Sant'Anna School of Advanced Studies, Pisa, Italy; e-mail: valentina.lorenzoni@santannapisa.it

1 Introduction

Universities and related facilities play a strategic role in the promotion of students' well-being by ensuring their academic achievement and enhancing their social life, overall health status and human dignity [3].

Although the literature in the field of university facilities is sparse [1], some studies have revealed that easy access to high-quality food is an important aspect of students' well-being with relevant short- and mid-term consequences. Research has shown that adequate access to food has an impact on students' performance and retention, potentially contributing to their general health and having considerable implications for long-term health preservation and the reduction of the collective health care burden [4,5]. University canteens are generally able to offer low-cost meals and play an important role in the promotion of students' university careers and general well-being from a public health perspective, since they allow students to benefit from subsidised food services and meals at lower prices than those commonly found among their competitors. Using a difference-in-differences (DID) approach, this study aims to evaluate the effect of introducing an income-based pricing system on students' use of university canteens and their meal choices at these canteens. DID is a statistical technique used for policy evaluation in quasi-experimental designs with panel data. Two aspects were analysed as outcome variables to evaluate the impact of the new pricing system on students' eating habits: 1) the frequency of university canteen use and 2) the proportion of light and large meals consumed. The study was carried out in a university in Central Italy that has three university canteens administered by the Financial Aid and Scholarship Office.

2 Method

Given that this study used panel data and involved a natural experiment, where the treatment consisted of the introduction of a new income-based pricing system, a DID approach [2,6] was employed. The DID estimator is a popular tool in quasi-experimental designs for evaluating the impact of a treatment or intervention using a repeated cross-sectional or panel design. In our setting, the same students belonging to the treated and control groups were observed for two periods, before and after treatment, in such a way that the students were made into their own controls. The basic idea behind the DID technique is that in the absence of treatment, the change in the treated outcome would have been the same as the change in the non-treated outcome. Thus, although the outcome levels may differ between the treated and control groups even in the pre-treatment period, the impact of the treatment could be measured by the DID estimator as the difference in average outcomes in the treatment group before and after treatment minus the difference in average outcomes in the control group before and after treatment [6]. The DID estimator can be easily implemented using a regression approach, which can obtain the estimates and corresponding standard errors in one step:

$$y_{it} = \beta_0 + \beta_1 t_{it} + \beta_2 T_{it} + \beta_3 (t_{it} \times T_{it}) + X_{it} \delta + \varepsilon_{it}$$

where y_{it} represents the relevant outcome variable (the frequency of canteen use and the proportions of FM, LM1 and LM2); t_{it} is a binary variable for the period of observation, where $t_{it} = 0$ stands for the period before April 1, 2018, and $t_{it} = 1$ stands for the period from April 1, 2018, onwards; T_{it} is a binary treatment variable, where $T_{it} = 0$ indicates students in the control group (those with unchanged meal prices) and $T_{it} = 1$ stands for students in the treatment group (those whose meal prices increased or decreased); X_{it} is a vector of covariates, entered in the model as control variables; and ε_{it} is the error term. β_3 is the coefficient of interest and represents the DID estimator. It results from the interaction term obtained by multiplying the treatment indicator and the period of observation; it takes a value of 1 for students whose meal prices changed after the treatment. For the frequency of canteen use, the regression equation was estimated with the ordinary least squares technique; for the proportions of meal types, a beta regression approach was carried out (for more details, see [7]). In both cases, robust clustered standard errors were used to control for heteroskedasticity and clustered data.

3 Results

Two outcome variables were used to assess the impact of the new pricing system on the students' eating habits: 1) the frequency of university canteen use and 2) the proportion of meal types (large and light meals) consumed.

Taking the number of accesses as a dependent variable, the effect of price variation was evaluated using two DID models: one for students whose meal prices increased and the other for those whose meal prices were reduced. Taking the proportion of meal types consumed (FM, LM1 and LM2) as a dependent variable and the two intervention groups, additional DID models were also estimated. In both cases, analyses were carried out separately for all students, as well as for frequent and non-frequent users. The general DID model used in our analysis allows for the inclusion of both fixed and time-varying covariates. For each model, we present only the DID estimates summarised as β_3 , which represents the main parameter of interest and measures the magnitude and direction of the effect of the price variation.

Table 1 shows the results of the DID linear regression models that were estimated using the frequency of university canteen use as a dependent variable. With regard to the students whose meal prices increased (Table 1), the DID estimate (β_3) indicates a significant decrease in the total number of accesses; this effect was also observed among both frequent and non-frequent users. Given the logarithmic scale of the dependent variable, results can be interpreted more effectively in terms of percentage change. On average, the price increase produced a 29.9% (95% CI: 23.2%–36.0%) reduction in the number of accesses. The magnitude of the effect produced by the price variation is higher among frequent users, whose canteen use was reduced by 36.3% (95% CI: 25.2%–45.7%) as compared to the 20.2% (95% CI: 7.0%–31.5%) decrease among non-frequent users. No effect was detected among the students whose meal prices were reduced.

Table 1 DID estimates on the number of accesses according to the type of price change

	Overall	Non-frequent users	Frequent users
Price increase	-0.356 (0.046)***	-0.225 (0.078)**	-0.450 (0.081)***
Price reduction	0.043 (0.041)	0.071 (0.075)	0.096 (0.065)

The dependent variable is the log-transformed frequency of canteen use. Models also include the individual-level covariates (age, gender, course year and faculty). Robust standard errors are in parentheses. * $p < .05$. ** $p < .01$. *** $p < .001$.

Other results we obtained show the effect on FM consumption. DID estimates show significant effects only for students whose meal prices increased. Among these students, the probability of always choosing and never choosing FM increased by 40.9% and 87.8%, respectively. This effect was not observed when the sub-groups of frequent and non-frequent users were evaluated. Among frequent users, the price increase was associated with a 12.9% reduction, on average, in choosing FM.

Among the students whose meal prices increased, results show a rise in the proportion of those who chose LM1, both overall (+15.8%) and in the two-subgroups of frequent (+21.9%) and non-frequent users (+29.3%). On the other hand, the probabilities of never and always choosing LM1 were not affected by the price variation. When the effect of price reduction on LM1 selection was analysed, the only significant effect observed was a threefold increase in the probability of always choosing LM1 among non-frequent users.

With regard to the proportion of LM2 consumed, the analysis of students whose meal prices increased shows that the intervention produced a higher probability of not choosing LM2 both overall (+42.2%) and among non-frequent users (+42.8%). Conversely, the probability of always choosing LM2 decreased significantly in the same groups. Overall and among non-frequent users, price reduction had a significant negative effect on the probability of always choosing LM2. No other significant effect was associated with price reduction.

References

1. Blichfeldt, B.D., Gram, M.: Lost in transition? Student food consumption. *Higher Education*, 65, pp. 277-289 (2013)
2. Card, D., Krueger, A.: Minimum wages and employment: a case of the fast food industry in New Jersey and Pennsylvania. *American Economic Review*, 84, pp. 772-784 (1994)
3. Gallegos, D., Ramsey, R., Ong, K.W.: Food insecurity: is it an issue among tertiary students? *Higher Education*, 67, pp. 497-510 (2014)
4. Hughes, R., Serebryanikova, I., Donaldson, K., Leveritt, M.: Student food insecurity: the skeleton in the university closet. *Nutrition & Dietetics*, 68(1), pp. 27-32 (2011)
5. Kirkpatrick, S.I., Tarasuk, V.: Food insecurity is associated with nutrient inadequacies among Canadian adults and adolescents. *Journal of Nutrition*, 138, pp. 604-612 (2008)
6. Meyer, B.: Natural and quasi-experiments in economics. *Journal of Business & Economic Statistics*, 13, pp. 151-161 (1995)
7. Puhani, P.A.: The treatment effect, the cross difference, and the interaction term in nonlinear “difference-in-differences” models. *Economics Letters*, 115(1), pp. 85-87 (2012)