



# Book of the Short Papers

**Editors: Francesco Maria Chelli, Mariateresa Ciommi, Salvatore Ingrassia, Francesca Mariani, Maria Cristina Recchioni**



UNIVERSITÀ  
POLITECNICA  
DELLE MARCHE



LIUC BUSINESS  
ANALYTICS AND  
DATA SCIENCE HUB



## CHAIRS

Salvatore Ingrassia (Chair of the Program Committee) - *Università degli Studi di Catania*

Maria Cristina Recchioni (Chair of the Local Organizing Committee) - *Università Politecnica delle Marche*

## PROGRAM COMMITTEE

Salvatore Ingrassia (Chair), Elena Ambrosetti, Antonio Balzanella, Matilde Bini, Annalisa Busetta, Fabio Centofanti, Francesco M. Chelli, Simone Di Zio, Sabrina Giordano, Rosaria Ignaccolo, Filomena Maggino, Stefania Mignani, Lucia Paci, Monica Palma, Emilia Rocco.

## LOCAL ORGANIZING COMMITTEE

Maria Cristina Recchioni (Chair), Chiara Capogrossi, Mariateresa Ciommi, Barbara Ermini, Chiara Gigliarano, Riccardo Lucchetti, Francesca Mariani, Gloria Polinesi, Giuseppe Ricciardo Lamonica, Barbara Zagaglia.

## ORGANIZERS OF INVITED SESSIONS

Pierfrancesco Alaimo Di Loro, Laura Anderlucci, Luigi Augugliaro, Iliaria Benedetti, Rossella Berni, Mario Bolzan, Silvia Cagnone, Michela Cameletti, Federico Camerlenghi, Gabriella Campolo, Christian Capezza, Carlo Cavicchia, Mariateresa Ciommi, Guido Consonni, Giuseppe Ricciardo Lamonica, Regina Liu, Daniela Marella, Francesca Mariani, Matteo Mazziotta, Stefano Mazzuco, Raya Muttarak, Livia Elisa Ortensi, Edoardo Otranto, Iliaria Prosdocimi, Pasquale Sarnacchiaro, Manuela Stranges, Claudia Tarantola, Isabella Sulis, Roberta Varriale, Rosanna Verde.

## FURTHER PEOPLE OF LOCAL ORGANIZING COMMITTEE

Elisa D'Adamo, Christian Ferretti, Giada Gabbianelli, Elvina Merkaj, Luca Pedini, Alessandro Pionati, Marco Tedeschi, Francesco Valentini, Rostand Arland Yebetchou Tchounkeu

Technical support: Matteo Mercuri, Maila Ragni, Daniele Ripanti

Copyright © 2023

PUBLISHED BY PEARSON

WWW.PEARSON.COM

ISBN 9788891935618AAVV

# Contents

<b>Preface</b>	<b>XXII</b>
<b>1 Plenary Sessions</b>	<b>1</b>
Inequality indices: accurate simulation-based inference Maria-Pia Victoria-Feser	2
Examples from the Interface of Neural Models and Spatio-Temporal Statistics in Environmental Applications Christopher K. Wikle, Likun Zhang, Myungsoo Yoo and Xiaoyu Ma	7
Demographic change and sustainability: novel approaches from digital and computational demography Emilio Zagheni	n.a.
<b>2 Invited Sessions</b>	<b>14</b>
<b>Machine learning in the design, analysis and integration of sample surveys</b>	
Causal Discovery for complex survey data Paola Vicard	15
Data Integration without conditional independence: a Bayesian Networks approach Pier Luigi Conti, Paola Vicard and Vincenzina Vitale	21
Mass imputation through Machine Learning techniques in presence of multi-source data Fabrizio De Fausti, Marco Di Zio, Romina Filippini and Simona Toti	27
<b>Machine learning: different uses and perspectives</b>	
Evaluation of pollution containment policies in the US and the role of machine learning algorithms Marco Di Cataldo, Margherita Gerolimetto, Stefano Magrini and Alessandro Spiganti	32

Machine Learning for Official Statistics: An Application on External Trade	n.a.
Mauro Bruno, Maria Serena Causo, Alessio Guandalini, Francesco Ortame and Silvia Russo	
Machine learning, data quality and official statistics: challenges and opportunities	n.a.
Stefano Menghinello	

### Statistical Machine Learning for environmental applications

Gaussian Processes and Deep Neural Networks for Spatial Prediction	38
Alex Cucco, Luigi Ippoliti, Nicola Pronello, Pasquale Valentini and Carlo Zaccardi	
How can we explain Random Forests in a spatial framework?	42
Natalia Golini, Luca Patelli and Xavier Barber	
Recent approaches in coupling deep learning methods with the statistical analysis of spatial point patterns	48
Jorge Mateu and Abdollah Jalilian	

### Statistical Process Monitoring for Complex Data in Industry 4.0

A Kernel-based Nonparametric Multivariate CUSUM for Location Shifts	53
Konstantinos Bourazas, Konstantinos Fokianos, Christos Panayiotou and Marios Polycarpou	
An Approach for Profile Monitoring via Mixture Regression Models	58
Davide Forcina, Antonio Lepore and Biagio Palumbo	
Anomaly Detection in Circular Data	63
Houyem Demni and Giovanni C. Porzio	

### Advances in Data Science and Statistical Learning [IMS Invited Session]

Empirical Bayes approximation of Bayesian learning: understanding a common practice	n.a.
Sonia Petrone	
Generalized Fiducial Inference on Differentiable Manifolds - a geometric perspective	n.a.
Jan Hannig	
Model-free bootstrap and conformal prediction in regression	n.a.
Dimitris Politis	

### ENBIS Session: System Maintenance, Boosting algorithms for regression, and Research Excellence

Boosting Diversity in Regression Ensembles	69
Mathias Bourel, Jairo Cugliari, Yannig Goude and Jean-Michel Poggi	
How ENBIS has contributed to the UK Universities Research Excellence Framework	71
Shirley Coleman	
Maintenance of degrading systems by dynamic programming or reinforcement learning	75
Antonio Pievatolo	

## Population Dynamics, Climate Change and Sustainability

- Climate change impacts on fertility in low- and middle-income countries: An analysis based on global sub-national data n.a.  
Côme Cheritel, Roman Hoffmann and Raya Muttarak
- Environmental Exposures and Under-5 Mortality in India: A Survival Analysis of DHS data 79  
Vinod Joseph Kannankeril Joseph
- The impact of temperature on expressed sentiment by migration status: Evidence from geo-located Twitter data 84  
Risto Conte Keivabu and Jisu Kim

## Statistical Learning for health research and omics data

- An alternative to the Dirichlet-multinomial regression model for microbiome data analysis 95  
Roberto Ascari, Sonia Migliorati and Andrea Ongaro
- Modelling ordinal response to treatment in a real-world cohort study 101  
Marco Alfò, Maria Francesca Marino and Silvia D'Elia
- On the application of the symmetric graphical lasso for paired data 105  
Saverio Ranciati and Alberto Roverato

## The Economic behaviour of Sustainability

- Airports performances and sustainable practices. An empirical study on Italian data 110  
Riccardo Gianluigi Serio, Maria Michela Dickson, Diego Giuliani and Giuseppe Espa
- Sustainability: still an undefined concept for Italians 116  
Raffaele Angelone and Andrea Marletta
- Quasi-experimental evidence on COVID-19 lockdown effects on Italian household food shopping basket composition and its sustainability 122  
Beatrice Biondi and Mario Mazzocchi

## Advances in statistical methods for complex problems

- Inferring multiple treatment effects from observational studies using confounder importance learning n.a.  
Omiros Papaspiliopoulos
- Path analysis in Ising models: an application to cyber-security risk assessment 127  
Monia Lupparelli and Giovanni M. Marchetti
- Causal Regularization n.a.  
Lucas Kania and Ernst Wit

## Explainable machine learning models

- Enhancing Markowitz model: inspection of correlations and tail covariances 133  
Gloria Polinesi

Objective and subjective dimension of economic well-being: an approach based on statistical matching	139
Daniela Marella, Vincenzina Vitale and Pierpaolo D'Urso	
Sustainable, Accurate, Fair and Explainable Machine Learning Models	n.a.
Paolo Giudici and Emanuela Raffinetti	
<b>Flexible Learning for Environmental Sustainability</b>	
Comparison of traffic flow data sources for air pollution modelling	145
Theresa Smith and Nick McCullen	
Data analysis of photogrammetry-based mapping: the sea cucumbers in the Giglio Island as a case-study	150
Gianluca Mastrantonio, Daniele Ventura, Edoardo Casoli, Arnold Rakaj, Giovanna Jona Lasinio and Alessio Pollice	
Understanding forest damage in Germany: Finding key drivers to help with future forest conversion of climate sensitive	156
Nicole Augustin, Heike Puhlmann and Simon Trust	
<b>Inequalities in higher education outcomes: learning from data</b>	
Inequalities in international students mobility	163
Kristijan Breznik, Giancarlo Ragozini and Marialuisa Restaino	
Uncovering the interplay of territorial, socioeconomic, and demographic factors in high school to university transition	169
Vincenzo Giuseppe Genova, Andrea Priulla and Martina Vittorietti	
<b>Statistical Learning of demographic and health dynamics</b>	
Estimating the impact of a vaccine mandate: the case of measles in Italy	n.a.
Chiara Chiavenna	
Leveraging deep neural networks to estimate age-specific mortality from life expectancy at birth	n.a.
Andrea Nigri	
Nowcasting Daily Population Displacement in Ukraine through Social Media Advertising Data	n.a.
Claire Dooley, Ridhi Kashyap, Douglas Leasure and Francesco Rampazzo	
<b>Challenges towards Fairness and Transparency for Data Processes, Algorithms and Decision-Support Models</b>	
Challenges on Ethics, and Privacy in AI Applications to Fintech	175
Catarina Silva, Joana Matos Dias and Bernardete Ribeiro	
Uncertainty and fairness metrics	180
Anna Gottard	

## Educational Data mining: methods for complex data in students' assessment

Analysis of University Grades: An IRT Model for Responses and Response Times with Censoring 186  
Michela Battauz

Predicting high schools' students performances with registry's data: a machine learning approach 191  
Lidia Rossi, Marta Cannistrà and Tommaso Agasisti

Using response times to identify cheaters in CAT: A simulation study 195  
Luca Bungaro, Bernard P. Veldkamp and Mariagiulia Matteucci

## Spatial and Spatio-Temporal Modeling: Theory and Applications

A geostatistical investigation of the ammonia-livestock relationship in the Po Valley, Italy 200  
Paolo Maranzano, Kelly McConville, Philipp Otto and Felicetta Carillo

Bayesian multi-species N-mixture models for large scale spatial data in community ecology 206  
Michele Peruzzi

Minimum contrast for point processes' first-order intensity estimation 212  
Nicoletta D'Angelo and Giada Adelfio

## Statistical Framework for Measuring the Sustainability of Tourism

Data validity and statistical conformity with Benford's Law: the case of tourism in Sicily 217  
Roy Cerqueti and Davide Provenzano

Exploring the level of digitalization of the Italian museums through a multilevel ordered logit model 228  
Claudia Cappello, Sabrina Maggio and Sandra De Iaco

Functional Partial Least-Squares via Regression Splines. An application on Italian Sustainable Development Goals data 232  
Ida Camminatiello, Rosaria Lombardo, Jean-Francois Durand and Leonardo S. Alaimo

## Statistical learning for well-being analysis

Assessing multidimensional poverty of the Italian provinces during Covid-19: a small area estimation approach 238  
Mariateresa Ciommi, Chiara Gigliarano, Francesca Mariani and Gloria Polinesi

The fuzzy set approach as statistical learning for the analysis of multidimensional well-being 244  
Gianni Betti, Federico Crescenzi, Antonella D'Agostino and Laura Neri

What Makes a Satisfying Life? Prediction and Interpretation with Machine-Learning Algorithms n.a.  
Conchita D'Ambrosio

## Bayesian contributions to Statistical Learning

A Bayesian framework for early cancer screening 249  
Sally Paganin and Jeff Miller

Imputing Synthetic Pseudo Data from Aggregate Data: Development and Validation for Precision Medicine n.a.  
Cecilia Balocchi

Linear models with assumptions-free residuals: a Bayesian Nonparametric approach 254  
Filippo Ascolani and Valentina Ghidini

## Data Visualization for Smart Insights and Advanced Predictive Analytics

Applications of data visualization for industry 259  
Martina Dossi, Stefano Sangaletti, Marilena Di Bari and Federica Bruschini

Some Notes on the Use of the Circular Boxplot n.a.  
Giovanni Camillo Porzio and Davide Buttarazzi

TERRA: a smart visualization tool for international trade in goods statistics 265  
Francesco Amato, Mauro Bruno and Maria Serena Causo

## Methods for the analysis of distributional data

Clustering of Distributional Data based on LDQ transformation 271  
Gianmarco Borrata and Rosanna Verde

Dynamic learning from data streams through the combined use of probability density functions and simplicial functional principal component analysis 276  
Francesca Fortuna, Fabrizio Maturo and Tonio Di Battista

Multivariate Parametric Analysis of Distributional Data n.a.  
Paula Brito

## Migrants and Refugees in Europe: social, economic and health-related issues

Labor Market Return to Refugees' Human Capital Investment: A Natural Experiment in Sweden n.a.  
Eleonora Mussino

Social networks and loneliness among older migrants in Italy 282  
Viviana Amati, Eralba Cela and Elisa Barbiano di Belgiojoso

The Italian Decree on Security: An Analysis of the Impact on Asylum Applications 287  
Giorgio Piccitto

## Modelling and Forecasting High-dimensional time series

Adaptive combinations of tail-risk forecasts 293  
Alessandra Amendola, Vincenzo Candila, Antonio Naimoli and Giuseppe Storti

Are Monetary Policy Announcements related to Volatility Jumps? 299  
Giampiero Gallo, Demetrio Lacava and Edoardo Otranto



Regularized Estimation and Prediction of the El Nino/Southern Oscillation Cycle	n.a.
Alessandro Giovannelli and Tommaso Proietti	
<b>3 Contributed Sessions</b>	<b>305</b>
<b>Bayesian nonparametric methods</b>	
Bayesian density estimation for modeling age-at-death distribution	306
Davide Agnoletto, Tommaso Rigon and Bruno Scarpa	
Bayesian mixing distribution estimation in the Gaussian-smoothed 1-Wasserstein distance	311
Catia Scricciolo	
Bayesian nonparametric estimation of heterogeneous intrinsic dimension via product partition models	316
Francesco Denti, Antonio Di Noia and Antonietta Mira	
Bayesian nonparametric multiple change point detection for time series of compositional data	322
Edoardo Marchionni and Riccardo Corradin	
Galton-Watson process: a non parametric prior for the offspring distribution	328
Massimo Cannas, Michele Guindani and Nicola Piras	
Hierarchical processes in survival analysis	333
Riccardo Cogo, Federico Camerlenghi and Tommaso Rigon	
<b>Economics and Statistics</b>	
A regression analysis for count data to investigate the effectiveness of incentives on the adoption of 4.0 technologies	339
Stefano Bonnini and Michela Borghesi	
Statistical analysis on SDGs indicators related to environmental sustainability	344
Najada Firza, Anisa Bakiu and Dante Mazzitelli	
Empowering futures adopting a spatial convergence of opinions: a Real-Time Spatial Delphi approach	349
Yuri Calleo, Simone Di Zio and Francesco Pilla	
Stocks price forecasts using Stochastic Differential Equations: an empirical assessment	355
Dario Frisardi and Matteo Spuri	
The Added-Worker Effect within Italian Households	361
Donata Favaro and Anna Giraldo	
<b>Health statistics 1</b>	
A model for the natural history of breast cancer: application to a Norwegian screening dataset	365
Laura Bondi, Marco Bonetti and Solveig Hofvind	

Generalized Bayesian Ensemble Survival Trees: an extension to categorical variables to apply it to real data Elena Ballante	370
Joint modelling of hospitalizations and survival in Heart Failure patients: a discrete non parametric frailty approach Chiara Masci, Marta Spreafico and Francesca Ieva	375
Mobility trends in Italy during the first wave of Covid-19 pandemic: analysis on Google data Ilaria Bombelli and Daniele De Rocchi	381
Tracking attitudes towards COVID vaccines: A text mining analysis Leonardo Scarso, Marco Novelli and Francesco Saverio Violante	387
Treatment effect assessment in observational studies with multi-level treatment and outcome Federica Cugnata, Paola Vicard, Paola M.V. Rancoita, Fulvia Mecatti, Clelia Di Serio and Pier Luigi Conti	393
 <b>Indicators: composition, uses and limitations</b>	
Are European consumers willing to pay the true price for sustainable food? Luca Secondi and Mengting Yu	399
Can the reliability of composite indexes be impacted by uncertainty of individual indicators? Caterina Giusti, Stefano Marchetti and Vincenzo Mauro	406
Initial Coin Offerings and ESG: allies or enemies? Alessandro Bitetto and Paola Cerchiello	411
On the impact of intraclass correlation in the ANVUR evaluation of academic departments Giorgio Edoardo Montanari and Marco Doretti	417
Small area estimation of monetary poverty indicators with poverty lines adjusted using local price indexes Luigi Biggeri, Stefano Marchetti, Caterina Giusti, Monica Pratesi, Francesco Schirripa Spagnolo and Gaia Bertarelli	422
Smart Composite Indicators Measuring Corporate Sustainability: A Sensitivity Analysis Camilla Salvatore, Annamaria Bianchi and Silvia Biffignandi	428
 <b>Multivariate data analysis 1</b>	
A note on most powerful tests for right censored survival data Maria Veronica Vinattieri and Marco Bonetti	434
Enhancing Principal Components by a Linear Predictor: an Application to Well-Being Italian Data Laura Marcis, Maria Chiara Pagliarella and Renato Salvatore	439

Proper Bayesian Bootstrap for Bagging tree model in survival analysis with correlated data	445
Farah Naz and Elena Ballante	
ROBOUT: a multi-step methodology for conditional outlier detection	450
Matteo Farnè and Angelos Vouldis	
Robustness of the Efficient Covariate-Adaptive Design for balancing covariates in comparative experiments	456
Rosamarie Frieri, Alessandro Baldi Antognini, Maroussa Zagoraiou, and Marco Novelli	
Separation scores: a new statistical tool for scoring and ranking partially ordered data	462
Marco Fattore	
<b>Statistics in Society 1</b>	
Community detection analysis with robin on hashtag network	468
Valeria Policastro, Francesco Santelli and Giancarlo Ragozini	
Film Tourism Motivation through the lens of Trip Advisor data	474
Nicolò Biasetton, Marta Disegna, Girish Prayag and Elena Barzizza	
Life satisfaction and social activities in later life in Italy: a focus on the Internet use	480
Claudia Furlan and Silvia Meggiolaro	
Social capital endowment's role in the intergenerational transmission of education	485
Alessandra Trimarchi, Maria Gabriella Campolo and Antonino Di Pino Incognito	
Streaming Data from Social Networks to Track Political Trends	490
Emiliano del Gobbo and Barbara Cafarelli	
The scientific production on gender dysphoria: a bibliometric analysis	495
Maria Gabriella Grassia, Marina Marino, Massimo Aria, Rocco Mazza, Luca D'Aniello and Agostino Stavo	
<b>Assessment and Education</b>	
A hierarchical modelling approach to explain differential functioning of mathematics items by student's gender	500
Clelia Cascella	
A latent variable approach to Millennials' knowledge of green finance	506
Maria Iannario, Alessandra Tanda and Claudia Tarantola	
Archetypal analysis and latent Markov models: A step-wise approach	512
Lucio Palazzo, Rosa Fabbriatore and Francesco Palumbo	
From high school to university: academic intentions and enrolment of foreign students in Italy	518
Francesca Di Patrizio, Eleonora Trappolini and Cristina Giudici	
Growth models for the progress test in Italian dentistry degree program	523
Giulio Biscardi, Leonardo Grilli, Carla Rampichini, Laura Antonucci and Corrado Crocetta	

The COVID-19 pandemic and academic E-learning: Italian students and instructors' perceptions	527
Francesco Santelli, Teresa Gentile, Davide Bizjak and Lorenzo Fattori	
Working Students and job market outcomes: Insights from the University of Florence	532
Gabriele Lombardi, Valentina Tocchioni and Alessandra Petrucci	
<b>Bayesian methods and applications 1</b>	
Analyzing RNA data with scVelo: identifiability issues and a Bayesian implementation	538
Elena Sabbioni, Enrico Bibbona, Gianluca Mastrantonio and Guido Sanguinetti	
Approximate Bayesian Computation for Probabilistic Damage Identification	544
Cecilia Viscardi, Silvia Monchetti, Luisa Collodi, Gianni Bartoli, Michele Betti, Michele Boreale and Fabio Corradi	
Estimation of scientific productivity with a hierarchical Bayesian model	550
Maura Mezzetti and Ilia Negri	
Heat waves and free-knots splines	555
Gioia Di Credico and Francesco Pauli	
The Hierarchical Beta-Bernoulli Process as Out-of-Scope Query Detector	560
Marco Dalla Pria and Silvia Montagna	
<b>Health and mortality</b>	
A novel definition of comorbidity based on the Global Burden of Diseases project weights	566
Angela Andreella, Lorenzo Monasta and Stefano Campostrini	
An Age-Period-Cohort model of gender gap in youth mortality	572
Giacomo Lanfiuti Baldi and Andrea Nigri	
Kinlessness in adult and old age across Europe	578
Marta Pittavino, Bruno Arpino and Elena Pirani	
Parameter orthogonalization for Siler mortality model	584
Claudia Di Caterina and Lucia Zanotto	
Pseudo-observations in survival analysis	590
Marta Cipriani, Alfonso Piciocchi, Valentina Arena and Marco Alfò	
Sex Gap in Cancer-Free Life Expectancy: The Association with Smoking, Obesity and Physical Inactivity	595
Alessandro Feraldi, Cristina Giudici and Nicolas Brouard	
Women's Exposure to HIV in Africa: the Role of Intimate Partner Violence	599
Micaela Arcaio and Anna Maria Parroco	

## Mixture Models

An extension of finite mixtures of latent trait analyzers for biclustering bipartite networks	605
Dalila Failli, Maria Francesca Marino and Francesca Martella	
Constrained Mixtures of Generalized Normal Distributions	611
Pierdomenico Dutillo, Alfred Kume and Stefano Antonio Gattone	
Mixture-based clustering with covariates for ordinal responses	617
Kemawadee Preedalikit, Daniel Fernández, Ivy Liuc, Louise McMillan, Marta Nai Ruscone and Roy Costilla	
Partial membership models for soft clustering of multivariate count data	623
Emiliano Seri, Thomas Brendan Murphy and Roberto Rocci	
Regression for mixture models for extremes	629
Viviana Carcaiso, Ilaria Prodocimi and Isadora Antoniano-Villalobos	
Robust matrix-variate mixtures of regressions	635
Salvatore Daniele Tomarchio and Michael P. B. Gallagher	

## Sampling methods and analysis of survey data

On the use of auxiliary information to define the sampling design for large-scale geospatial data	641
Chiara Bocci and Emilia Rocco	
Optimal joint inclusion probabilities for spatial sampling	n.a.
Giuseppe Arbia, Piero Demetrio Falorsi and Vincenzo Nardelli	
Robustness and Balance of Sampling or Experimental Designs and Mixture of Designs	647
Yves Tillé and Ejub Talovic	
Robustness Bounds for Sampling and Experimental Designs	654
Ejub Talovic and Yves Tillé	
Statistical Matching: Hotdeck or Propensity Score?	661
Elena Dalla Chiara, Marcello D’Orazio and Federico Perali	
The Italian experience on register-based statistics considering measurement, coverage and sampling errors	667
Marco Di Zio, Romina Filippini and Simona Toti	

## Space-time statistics

A Hierarchical Spatio-Temporal Model for Time-Frequency Data: An application in bioacoustic analysis	673
Hiu Ching Yip, Gianluca Mastrantonio, Enrico Bibbona, Daria Valente and Marco Gamba	
An approach to cluster time series extremes with spatial constraints	679
Alessia Benevento, Fabrizio Durante and Roberta Pappadà	
An integrated space-time model to evaluate the innovation drivers in Italy	685
Emma Bruno, Rosalia Castellano and Gennaro Punzo	

Revealing the dynamic relations between traffic and crowding using big data from mobile phone network	691
Selene Perazzini, Rodolfo Metulini and Maurizio Carpita	
SMaC: Spatial Matrix Completion method	697
Giulio Grossi, Alessandra Mattei and Georgia Papadogeorgou	
The impact of traffic flow and road signs on road accidents: an approach based on spatiotemporal point pattern analysis on linear networks	702
Andrea Gilardi and Riccardo Borgoni	
<b>Clustering and classification 1</b>	
A clustering model for flow data: an application to international student mobility	708
Cinzia Di Nuzzo and Donatella Vicari	
Contingency tables with structural zeros and discrete copulas	713
Roberto Fontana, Elisa Perrone and Fabio Rapallo	
Levels Merging in the Latent Class Model	719
Christophe Biernacki	
Model-based clustering of count processes with multiple change	725
Shuchismita Sarkar and Xuwen Zhu	
Similarity Measures and Internal Evaluation Criteria in Hierarchical Clustering of Categorical Data	729
Jana Cibulková, Zdeněk Šulc, Hana Řezanková and Jaroslav Horníček	
Spectral clustering of mixed data via association-based distance	735
Alfonso Iodice D'Enza, Francesco Palumbo and Cristina Tortora	
<b>Dynamic models and time series</b>	
A graph based convolution Neural Network approach for forecast reconciliation	741
Andrea Marcocchia and Pierpaolo Brutti	
A multivariate hidden semi-Markov model for the analysis of multiple air pollutants	747
Marco Mingione, Pierfrancesco Alaimo Di Loro, Francesco Lagona and Antonello Maruotti	
A smooth transition autoregressive model for matrix-variate time series	753
Andrea Bucci	
Dynamic network models with time-varying nodes	759
Luca Gherardini, Mauro Bernardi and Monia Lupparelli	
Time lapse analysis of nuclear calcium spiking in plant cells during symbiotic signaling	765
Ivan Sciascia, Andrea Crosino and Andrea Genre	
Two-stage weighted least squares estimator of multivariate conditional mean observation-driven time series models	770
Mirko Armillotta	

## Environmental learning and indicators

- Assessing the performance of nuclear norm-based matrix completion methods on CO<sub>2</sub> emissions data 776  
Rodolfo Metulini, Francesco Biancalani, Giorgio Gnecco and Massimo Riccaboni
- Deep Learning for smart and sustainable agriculture 782  
Amalia Vanacore, Armando Ciardiello, Annalisa Izzo, Pierdomenico Zaffino, Carolina Vecchio, Gennaro Pio Auricchio and Luigi Uccelli
- Do green transition, environmental taxes and renew-able energy promote ecological sustainability in G7 countries? Evidence from panel quantile regression 788  
Aamir Javed, Agnese Rapposelli and Asif Javed
- Doubly Robust DID for National Parks evaluation: “just” environmental benefits, or socioeconomics impacts as well? 795  
Riccardo D’Alberto, Francesco Pagliacci and Matteo Zavalloni
- On the gap between emitted and absorbed carbon dioxide. Are trees enough to save us? 801  
Lorenzo Mori and Maria Rosaria Ferrante
- Small scale analysis of energy vulnerability in the municipality of Palermo 806  
Giuliana La Mantia

## Health statistics 2

- A test for non-differential misclassification error in database epidemiological studies 812  
Giorgio Limoncella, Leonardo Grilli, Emanuela Dreassi, Carla Rampichini, Robert Platt and Rosa Gini
- Is the COVID-19 ‘color code’ of Italian regions subjected to political manipulation? 816  
Giovanni Busetta and Fabio Fiorillo
- Modelling multilevel ordinal response under endogeneity: application to DTC patients’ outcome 822  
Silvia D’Elia
- Monitoring drugs-based diagnostic therapeutic paths in heart failure patients using state-sequence analysis techniques 827  
Nicole Fontana, Laura Savaré and Francesca Ieva
- Optimal two-stage design based on error rates under a Bayesian perspective 833  
Susanna Gentile and Valeria Sambucini

## Migrants in Italy and return migration

- Comparing migrant and “native” Italian adolescents in risky behaviours from FSS and SHARE Corona surveys n.a.  
Daniela Foresta
- EU-Border crisis on Twitter: sentiments and misinformation analysis 839  
Elena Ambrosetti, Cecilia Fortunato and Sara Miccoli

Graduates' interregional migration in times of crisis: the Italian case Thaís García-Pereiro, Ivano Dileo and Anna Paterno	843
Intentions to stay: The experience of return migrants in Albania Maria Carella, Thaís García-Pereiro, Roberta Pace and Anna Paterno	848
Return migration to home country: a systematic literature review with text mining and topic modelling Cecilia Fortunato, Andrea Iacobucci and Elena Ambrosetti	853
The allocation of time within native and foreign couples living in Italy Giovanni Busetta, Maria Gabriella Campolo and Antonino Di Pino Incognito	860
Ειλεΐθυια comes from afar: The foreigners' contribution to fertility by Italian provinces Eleonora Miaci, Cristina Giudici, Eleonora Trappolini, Marina Attili, Cinzia Castagnaro and Antonella Guarneri	866
<b>Sustainability assessment</b>	
ESG, sustainability and stock market risk Michele Costa	871
Exploring the effect of consumer motivation and perception of sustainability on food choices with a Discrete Choice Experiment Gloria Solano-Hermosilla, Jesus Barreiro-Hurle and Iliaria Amerise	875
Sustainability explained by ChatGPT artificial intelligence in a HITL perspective: innovative approaches Vito Santarcangelo, Angelo Lamacchia, Emilio Massa, Saverio Gianluca Crisafulli, Massimiliano Giacalone and Vincenzo Basile	881
Measuring economic and ecological efficiency of urban waste systems in Italy: a comparison of SFA and DEA techniques Massimo Gastaldi, Ginevra Virginia Lombardi, Agnese Rapposelli and Giulia Romano	887
Profile based latent distance association analysis for sparse tables. Application to the attitude of EU citizens towards sustainable tourism Francesca Bassi, José Fernando Vera and Juan Antonio Marmolejo Martin	893
Sustainable tourism: a survey on the propensity towards eco-friendly accommodations Claudia Furlan and Giovanni Finocchiaro	899
<b>Bayesian methods and applications 2</b>	
A comparison of computational approaches for posterior inference in Bayesian Poisson regression Laura D'Angelo	903
Bias-reduction methods for Poisson regression models Luca Presicce, Tommaso Rigon and Emanuele Aliverti	908
Finite Mixture Model for Multiple Sample Data Alessandro Colombi, Raffaele Argiento, Federico Camerlenghi and Lucia Paci	913



On Bayesian power analysis in reliability	918
Fulvio De Santis, Stefania Gubbiotti and Francesco Mariani	
Power priors elicitation through Bayes factors	923
Roberto Macri Demartino, Leonardo Egidi and Nicola Torelli	
Predictive Bayes factors	929
Leonardo Egidi and Ioannis Ntzoufras	
<b>Clustering and classification 2</b>	
A Clusterwise Regression Method for Distributional-Valued Data	935
Antonio Balzanella, Rosanna Verde and Francisco de A.T. de Carvalho	
A novel statistical-significance based semi-parametric GLMM for clustering countries standing on their innumeracy levels	939
Alessandra Ragni, Chiara Masci, Francesca Ieva and Anna Maria Paganoni	
Introducing a novel directional distribution depth function for supervised classification	945
Edoardo Redivo and Cinzia Viroli	
Clustering alternatives in the preference-approval context	950
Alessandro Albano, José Luis Garcia-Lapresta , Mariangela Sciandra and Antonella Plaia	
Computational assessment of k-means clustering on a Structural Equation Model based index	955
Mariaelena Bottazzi Schenone, Elena Grimaccia and Maurizio Vichi	
Handling missing data in complex phenomena: an ultrametric model-based approach for clustering	961
Francesca Greselin and Giorgia Zaccaria	
<b>Economics and labour markets</b>	
A multivariate ranking analysis on the employability of young adults	967
Rosa Arboretti, Elena Barzizza, Nicolo Biasetton, Riccardo Ceccato, Monica Fedeli and Concetta Tino	
Analysis of the Gender Pay Gap in the Italian Labour Market	973
Giulia Cappelletti and Daniele Toninelli	
Evaluating the effect of home-based working employing causal Bayesian networks and potential outcomes	979
Lorenzo Giammei	
Patterns of flexible employment careers. Does measurement error matter?	985
Mauricio Garnier-Villarreal, Dimitris Pavlopoulos and Roberta Varriale	
Staying or leaving? A nonlinear framework to explore the role of employee well-being on retention	991
Ulpiani Kocollari, Fabio Demaria and Maddalena Cavicchioli	
The CAP instruments impact on GVA and employment: a multivalued treatment approach	997
Montezuma Dumangane and Marzia Freo	

The determinants of leaving the parental home in Italy: 2012-18 Ilaria Rocco and Gianpiero Dalla Zuanna	1003
<b>Environmental modeling</b>	
A Bayesian weather-driven spatio-temporal model for PM10 in Lombardy Michela Frigeri, Alessandra Guglielmi and Giovanni Lonati	1109
A preliminary study on shape descriptors for the characterization of microplastics ingested by fish Greta Panunzi, Tommaso Valente, Marco Matiddi and Giovanna Jona Lasinio	1015
Artificial neural network in predicting odour concentrations: a case study Veronica Distefano and Gideon Mazuruse	1021
Bayesian analysis of PM10 concentration by spatio-temporal ARIMA and STS models Michela Frigeri and Ilenia Epifani	1026
Functional ANOVA to monitor yearly Adriatic sea temperature variations Annalina Sarra, Adelia Evangelista, Tonio Di Battista and Nicola Di Deo	1032
New perspectives in the measurement of biodiversity Linda Altieri, Daniela Cocchi and Massimo Ventrucci	1038
<b>Multivariate data analysis 2</b>	
Feature Selection via anomaly detection autoencoders in radiogenomics studies  Alessia Mapelli, Michela Carlotta Massi, Nicola Rares Franco, Francesca Ieva, Catharine West, Petra Seibold, Jenny Chang-Claude and the REQUITE and RADprecise Consortia	1044
Further considerations on the Spectral Information Criterion Luca Martino	1050
How to increase the power of the test in sparse contingency tables: a simulation study Federica Nicolussi and Manuela Cazzaro	1057
Latent event history models for quasi-reaction systems Matteo Framba, Veronica Vinciotti and Ernst Wit	1063
Quantile-based graphical models for continuous and discrete variables Luca Merlo, Marco Geraci and Lea Petrella	1069
The logratio Student t distribution Gianna Monti and Gloria Mateu-Figueras	1075
<b>Statistics in Society 2</b>	
A decomposition of the changes in tourism demand in Tuscany over the 2019-2021 period Mauro Mussini	1079
Bayesian networks as a territorial gender impact assessment tool Flaminia Musella, Lorenzo Giammei, Fulvia Mecatti and Paola Vicar	1084

Can statistics be helpful in detecting electoral fraud? Massimo Attanasio, Vincenzo G. Genova and Michele Tumminello	1088
Companies' sustainability disclosure and contrast to hunger: the role of social inclusion Chiara Di Maria and Rodolfo Damiano	1093
Passing network-based performance indicator in football: evidence from UEFA Champions League 2016-2017 Riccardo Ievoli, Lucio Palazzo and Giancarlo Ragozini	1099
Topic Modeling for the travel and tourism industry: classical and innovative methods compared Fabrizio Di Mari	1105
<b>Bayesian methods and applications 3</b>	
An Importance Sampling Algorithm For Bayesian Logistic Regression with Independent Gaussian Scale Mixture Prior Paolo Onorati and Brunero Liseo	1111
Bayesian analysis of Amazon's best-selling books via finite nested mixture model Laura D'Angelo and Francesco Denti	1117
Binomial Extended Stochastic Block Model for Brain Networks Valentina Ghidini, Sirio Legramanti and Raffaele Argiento	1121
Detecting latent spatial patterns in mass spectrometry brain imaging data via Bayesian mixtures Giulia Capitoli, Simone Colombara, Alessia Cotroneo, Francesco De Caro, Riccardo Morandi, Chiara Schembri, Alfredo G. Zapiola and Francesco Denti	1127
Efficient expectation propagation for high-dimensional probit models Augusto Fasano, Niccolo Anceschi, Beatrice Franzolini and Giovanni Rebaudo	1133
Model-based clustering of non-stationary time series with common historical change times Riccardo Corradin, Luca Danese, Wasiur KhudaBukhsh and Andrea Ongaro	1139
<b>Functional Data Analysis</b>	
A functional Ground Motion Model for Italy built with a weighted analysis of reconstructed seismic curves Teresa Bortolotti, Riccardo Peli, Giovanni Lanzano, Sara Sgobba and Alessandra Menafoglio	1145
Conditional Gaussian Graphical Models for Functional Variables with Partial Separable Operators Rita Fici, Gianluca Sottile and Luigi Augugliaro	1149
Does the Inflation Factor need tuning? Simulation-based adjustment for Outlier Detection via the Functional Boxplot Annachiara Rossi, Andrea Cappozzo and Francesca Ieva	1155
Functional Graphical Models to map Brexit debate on Twitter Nicola Pronello, Emiliano del Gobbo, Lara Fontanella, Rosaria Ignaccolo, Luigi Ippoliti and Sara Fontanella	1160

Measuring Dependence in Multivariate Functional Datasets Francesca Ieva, Michael Ronzulli and Anna Maria Paganoni	1166
Robust Statistical Process Monitoring of Multivariate Functional Data Christian Capezza, Fabio Centofanti, Antonio Lepore and Biagio Palumbo	1173
The effects of mobility restrictions on public health: a functional data analysis for Italy over the years 2020 and 2021 Veronica Mazzola, Giovanni Bonaccorsi, Piercesare Secchi and Francesca Ieva	1179
<b>Machine Learning and text mining</b>	
A vocabulary-based approach for risk detection in textual annotations of contracts of public procurement Giulio Giacomo Cantone, Simone Del Sarto and Michela Gnaldi	1185
Explainable Machine Learning based on Group Equivariant Non-Expansive Operators (GENEOs). Protein pocket detection: a case study Giovanni Bocchi, Alessandra Micheletti, Patrizio Frosini, Alessandro Pedretti, Andrea R. Beccari, Filippo Lunghini, Carmine Talarico and Carmen Gratteri	1191
Hedging global currency risk with factorial machine learning models Paolo Pagnottoni and Alessandro Spelta	1197
InstanceSHAP: An instance-based estimation approach for Shapley values Golnoosh Babaei and Paolo Giudici	1203
Networks & Nature Based Solutions: an application for Milan hydric resources Alessia Forciniti and Emma Zavarrone	1209
The Roe v. Wade sentence: an analysis of tweets trough Symmetric Non-Negative Matrix Factorization Maria Gabriella Grassia, Marina Marino, Rocco Mazza and Agostino Stavolo	1215
<b>Multivariate data analysis 3</b>	
A comparison of different techniques for handling missing covariate values in propensity score methods Anna Zanovello, Alessandra R. Brazzale and Omar Paccagnella	1219
A New Penalized Estimator for Sparse Inference in Gaussian Graphical Models: An Adaptive Non-Convex Approach Daniele Cuntrera, Vito M.R. Muggeo and Luigi Augugliaro	1224
A tool for assessing weak identifiability of statistical models Antonio Di Noia, Francesco Denti and Antonietta Mira	1230
Computing Highest Density Regions with Copulae Nina Deliu and Brunero Liseo	1235
Parameter estimation via Indirect Inference for multivariate Wrapped Normal distributions Francesca Labanca and Anna Gottard	1241

Sequential marginal likelihood selection for the estimation of sparse correlation matrices	1246
Claudia Di Caterina and Davide Ferrari	
<b>Nonparametric statistical methods</b>	
A Comparison of Distribution-Free Control Charts	1252
Michele Scagliarini	
Characterizing Heterogeneity of Causal Effects in Air Pollution in Florida	1257
Dafne Zorzetto	
Comparing three robust procedures for CANDECOMP/PARAFAC estimation	1262
Valentin Todorov, Violetta Simonacci, Michele Gallo and Nikolay Trendafilov	
How active is a genetic pathway? Comparative analysis of post-hoc permutation-based methods	1268
Anna Vesely and Angela Andreella	
Non Parametric Combination methodology: a literature review on recent developments	1274
Elena Barzizza, Nicolò Biasetton and Riccardo Ceccato	
<b>Regression modeling</b>	
A Quantile Regression Model to Evaluate the Performance of the Italian Courts of Law	1280
Carlo Cusatelli, Massimiliano Giacalone and Eugenia Nissi	
A variable selection procedure based on predictive ability: a preliminary study on logistic regression	1285
Rosaria Simone and Mariarosaria Coppola	
Comparison of binary regressions with asymmetric link function for imbalanced data	1291
Michele La Rocca, Marcella Niglio and Marialuisa Restaino	
New advances in Regression Forests	1297
Mila Andreani, Lea Petrella and Nicola Salvati	
On the Optimal Non-Convexity of Penalty in Sparse Regression Models	1303
Daniele Cuntreza, Vito M.R. Muggeo and Luigi Augugliaro	
Using expectile regression with latent variables for digital assets	1309
Beatrice Foroni, Luca Merlo and Lea Petrella	
<b>4 Program</b>	<b>1315</b>

# Είλειθια comes from afar: The foreigners' contribution to fertility by Italian provinces

Eleonora Miaci<sup>a</sup>, Cristina Giudici<sup>a</sup>, Eleonora Trappolini<sup>b</sup>,  
Marina Attili<sup>c</sup>, Cinzia Castagnaro<sup>c</sup>, Antonella Guarneri<sup>c</sup>

<sup>a</sup> University of Rome, Sapienza; [eleonora.miaci@uniroma1.it](mailto:eleonora.miaci@uniroma1.it)

<sup>b</sup> University of Milano-Bicocca; [eleonora.trappolini@unimib.it](mailto:eleonora.trappolini@unimib.it)

<sup>c</sup> Italian National Institute of Statistics- ISTAT; [maattili@istat.it](mailto:maattili@istat.it)

## Abstract

The fertility differential of foreign women in Italy has decreased considerably over the years and it is expected to decrease even more over time but, despite this, the role of foreign children in slowing the decline in births remains crucial.

This study aims to further the debate on the fertility of migrants, providing an estimate of the fertility rates among foreign nationals at the provincial level over the past two decades. We intend to analyse the evolution over time and space of the contribution to fertility by foreign female citizens, investigating the determinants of their fertility behaviour and identifying differences and similarities with Italian female citizens.

**Keywords:** Migrants' Fertility, Italy, Foreign woman, Fertility, Employment level.

## 1. Introduction

Although fertility gaps within the same territory are frequent in many countries (Frejka, Sobotka 2008), there are few analyses exploring the subnational level in Europe and especially in Italy (Vitali, Billari 2017; Campisi et al. 2020).

Italy is constituted by very heterogeneous territories in terms of geographic, socioeconomic and demographic characteristics (Reynaud et al., 2020) and fertility levels differ considerably both at the level of rural or urban territories and by geographical distribution (Zambon et al. 2020).

Despite the extensive research in the field of migrant fertility examining the relationship between migration and family and reproductive dynamics (Landale 1997; Toulemon, Mazuy 2004; Cooke 2008; Milewski 2010), to our knowledge, there is no analysis to date that explores the subnational level with regard to the fertility of foreign female citizens.

The contribution of this paper is precisely to fill this gap in the literature.

We aim to estimate the age-specific and total fertility rates of foreign women in Italy, disaggregated by citizenship (for the five main citizenships), at a provincial level.

## 2. Fertility of foreign women in Italy

On 1<sup>st</sup> January 2022, more than 50% of the foreign female population resident in Italy came from Romania, Albania, Morocco, China and Ukraine. These five groups are characterised by different levels of maturity in the migration cycle. Foreign female residents are on average a younger population than the Italian female one and have contributed to slowing the decline in births, due to a significant presence at fertile age, a younger average age at childbirth and a fertility rate almost close to replacement level.

The share of foreign children in the Italian birth rate remains crucial. Due to the composition of the presence, it is not surprising that the highest number of foreign children recorded in the national registry is Romanian (14,248 born in 2020), followed by Moroccan (9,991) and Albanian (8,082). These citizenships represent about 40% of births to foreign mothers residing in Italy. As regards other citizenships, a non-negligible contribution comes from other African communities (in particular Egyptian and Tunisian nationals) and several Asian communities (in particular from India, Bangladesh, China and Pakistan).

As for Italian nationals, the fertility of foreigners shows territorial differences: the fertility rate is 2 children per woman in the North, 1.65 in the Centre and 1.86 in the South. (ISTAT, 2020)

Although the gap with the fertility rate of Italian women (1.17 in 2020) remains considerable, the reduction experienced by foreign female citizens in the last ten years has been sharper (-18% for the TFR of foreign women and -12% for the TFR of Italian women since 2010).

Numerous studies underline how the convergence of Italian and foreign women's reproductive behaviour is determined by social, political, cultural and employment conditions in the host society (Alba, Nee 1997; Carter 2000). In this context, several works stress the importance of the growing propensity of foreign women to work, mostly in the family service sectors with great variability linked to nationality and migratory background (Gabielli et al. 2007; Lübke 2015; Sobotka 2008).

## 3. Data and methods

This research is conducted as part of a curricular internship at ISTAT, carried out in the context of the EMOS (European Master in Official Statistics Workshop) programme, on "Estimating the fertility of the cohorts of women resident in Italy by citizenship in the years 2002-2020", within the framework of the doctorate in the School of Statistical Sciences, Demography curriculum, at La Sapienza University of Rome. Starting from the ISTAT births database, which contains data on all women who have had at least one child registered in the registry office since 1999, total and age-specific fertility rates were constructed for Italians and foreigners and for the five main citizenships in Italy (Romanians, Albanians, Moroccans, Chinese, Ukrainians). These indicators were then validated to provincial detail.

## 4. Preliminary results

Figure 1 displays age-specific fertility rates for the total, Italian and foreign female population at national level and by macro-areas. Foreign nationals realize their fertility behaviour earlier than Italians and with higher rates but, compared to 2010, in 2020 they experienced a greater reduction in number of births and a stronger postponement. The underlying area between the age specific rate of the total population and that of the Italian population reveals that the contribution of foreign female citizens, both in 2010 and 2020, is lower in the South than in the rest of Italy. This depends on several factors: the lower fertility rate experienced by foreign nationals in the South compared to North and Centre, their older age structure (explained by looking at the prevailing nationalities in the different macro-areas) and also on the fact that in the south, as we have already pointed, there are precisely fewer foreigners present and therefore their contribution is lower when calculating the rate of the total population.

The provincial detail of the total fertility rate (figure 2) reveals how despite a certain heterogeneity between the geographic areas, there is a clear homogeneity between the various levels of fertility of Italian provinces in the different macro-areas.

The provinces reporting a high total fertility rate for foreigners are mainly in the North, with the exception of some Sicilian provinces. The lowest rates are instead concentrated in the Centre, in some provinces of the South and in Sardinia.

Although the fertility of foreigners follows the trend of that of Italians, the data indicate a fertility differential present in almost all the provinces of the North and the Centre but limited in the South.

The five communities examined, although they have all experienced widespread fertility declines, differ in their levels of fertility in their countries of origin. In 2020 TFR ranges from 1.2 in Ukraine to 2.4 in Morocco. Except for the latter case, while remaining higher than that of Italian nationals, the TFR in the countries of origin lies below the replacement level.

One of the factors explaining the low fertility rate of foreign women in Italy is their origin mainly from low fertility countries.

Concerning Romanian migrants, we found that they have a lower fertility rate than non-migrant women, confirming previous research (Mussino, Cantalini, 2022).

One of the most original results that emerged from our study is the higher fertility of Albanian and Moroccan citizens in Italy compared to both those who remained in the country of origin (table 1) and to native Italians (figure 3). The analysis of the socio-economic characteristics, labour market integration and attitudes of these communities allowed us to hypothesise explanations for this result.

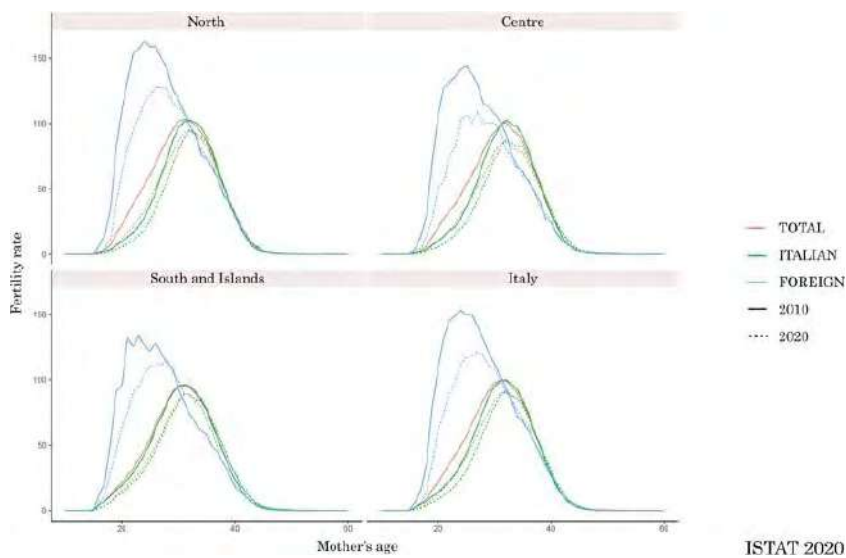


Figure 1: Age-specific fertility rates of total Italian and foreign female population for microregion

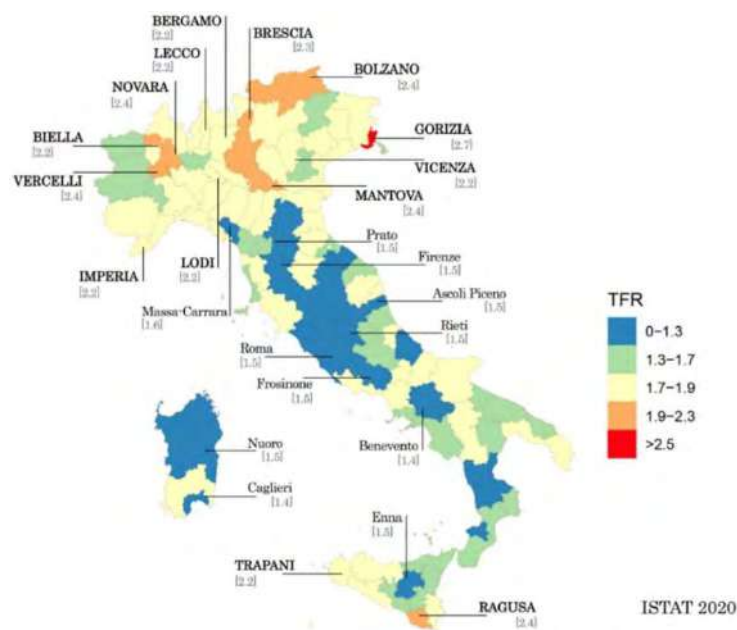


Figure 2: Total fertility rate of foreign population in Italy, 2020



Table 1: TFR of the first five citizenship in Italy and in the country of origin, 2019-2021

<i>ITALY</i>	Romania	Albania	Ukraine	China	Morocco
<b>2019</b>	1.4	2.1	1.3	1.5	3.4
<b>2020</b>	1.4	2	1.3	1.1	3
<b>2021</b>	1.5	2.1	1.2	0.9	2.9

ISTAT

<i>COUNTRY OF ORIGIN</i>	Romania	Albania	Ukraine	China	Morocco
<b>2019<sup>b</sup></b>	1.8	1.4	1.2	1.5	2.4
<b>2020<sup>c</sup></b>	1.6	1.4	1.2	1.3	2.4
<b>2021<sup>d</sup></b>	1.7	1.4	1.2	1.2	2.3

<sup>b c</sup> World Bank, <sup>d</sup> World Population Prospects

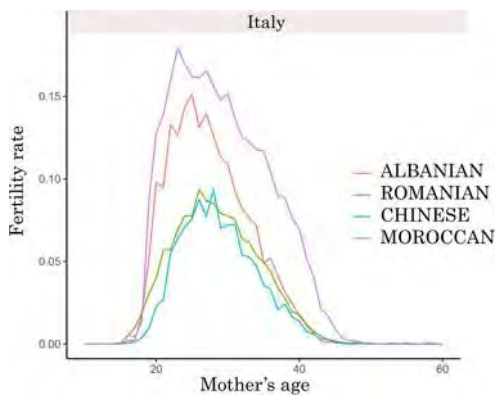


Figure 3: Age-specific fertility rate of foreign female population by citizenship in Italy, 2020

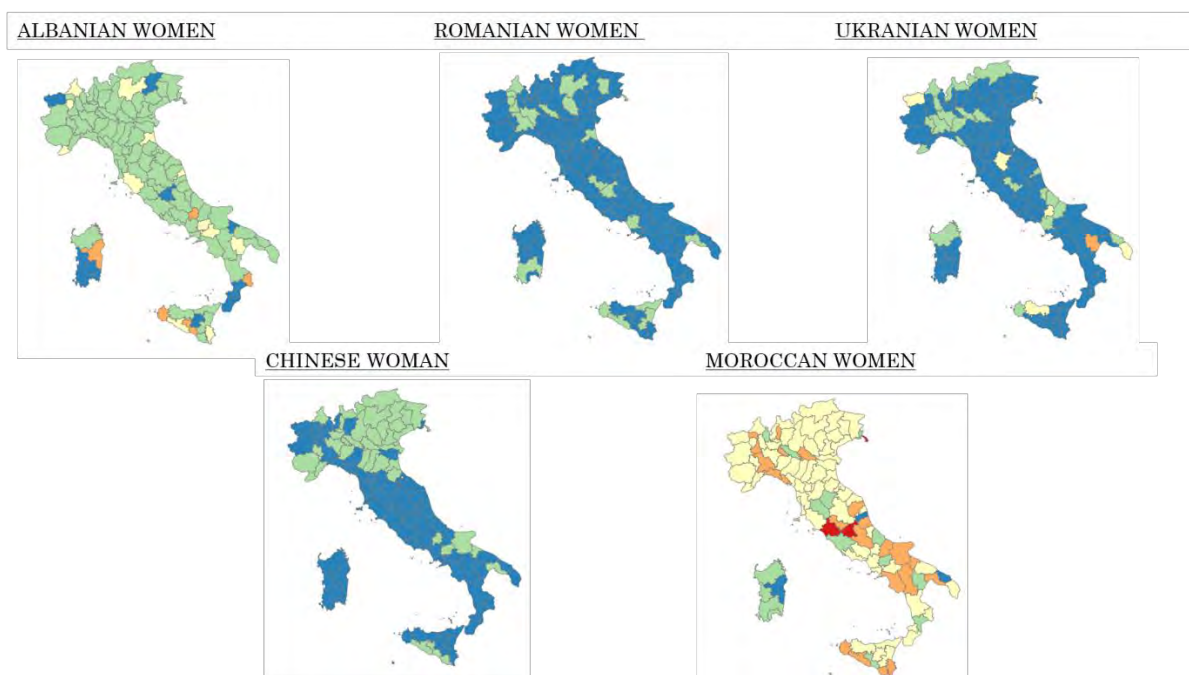


Figure 4: Total fertility rate at provincial level for the five main citizenship in Italy, 2020

## 5. Conclusion and further developments

This preliminary work introduced the relevant literature on migrants' fertility, presented a synthetic picture of the foreign presence on Italian territory and of the characteristics of the different nationalities, and illustrated a selection of the descriptive results obtained.

The paper will be implemented with linear regression models to analyse the relationship between fertility behaviour and socio-economic and contextual factors, as well as to identify differences between Italian provinces.

### References

- Istat. (2020). Censimento della popolazione e dinamica demografica 2020. Retrieved from <https://demo.istat.it/>
- Ministero del Lavoro e delle Politiche sociali. (2020). *Le comunità migranti in Italia. Rapporti 2020*.
- Adserà, A., Ana M. Ferrer. The fertility of recent immigrants to Canada. (2013).
- Algan Y., Bisin A., Manning A., Verdier, T. *Cultural integration of immigrants in Europe*. Oxford University Press, (2012).
- Alba, R., V. Nee. Rethinking Assimilation Theory for a New Era of Immigration. *International Migration Review* 31(1997):826–74.
- Alderotti, G., Mussino, E., Comolli, C. L. (2022). Natives' and migrants' employment uncertainty and childbearing during the great recession: a comparison between Italy and Sweden. *European Societies*, 1-35.
- Campisi, N., Kulu, H., Mikolaj, J., Klüsener, S., Myrskylä, M. (2020). Spatial variation in fertility across Europe: Patterns and determinants. *Population, Space and Place*, 26(4), e2308.
- Carling, J. Gender dimensions of international migration. *Global migration perspectives* 35.1 (2005): 1-26.
- Carter, M. Fertility of Mexican immigrant women in the US: A closer look. *Social science quarterly* (2000): 1073-1086.
- Colombo, A., Sciortino G. Italian immigration: The origins, nature and evolution of Italy's migratory systems. *Journal of Modern Italian Studies* 9.1 (2004): 49-70.
- Cooke, T.J. Migration in a family way. *Population, space and place* 14.4 (2008): 255-265.
- Fernández, R., Fogli A. Fertility: The role of culture and family experience. *Journal of the European economic association* 4.2-3 (2006): 552-561.
- Frejka, T., Sobotka, T. (2008). Overview Chapter 1: Fertility in Europe. *Demographic Research*, 19(3), 15-46.
- Gabrielli, G., Paterno, A., White, M. (2007). The impact of origin region and internal migration on Italian fertility. *Demographic Research*, 17, 705-740. <https://doi.org/10.4054/DemRes.2007.17.24>
- Garssen, J., Han N. Fertility of Turkish and Moroccan women in the Netherlands: Adjustment to native level within one generation. *Demographic Research* 19 (2008): 1249-1280.
- Giannantoni, P., Strozza, S. (2016). Foreigners' contribution to the evolution of fertility in Italy: A re-examination on the decade 2001-2011. *Rivista Italiana di Economia, Demografia e Statistica*, 69(3), 129-140.
- Kulu, H., González-Ferrer, A. (2014). Family dynamics among immigrants and their descendants in Europe: Current research and opportunities. *European journal of population*, 30, 411-435.
- Landale, N. S. (1997). Immigration and the family: An overview. *Immigration and the family: Research and policy on US immigrants*, 281-291.
- Lübke, C. How migration affects the timing of childbearing: The transition to a first birth among Polish women in Britain. *European Journal of Population* 31 (2015): 1-20.
- Milewski, N. (2010). Immigrant fertility in West Germany: Is there a socialization effect in transitions to second and third births? *European Journal of Population/Revue européenne de Démographie* 26 (3), 297-323
- Mussino, E., Cantalini, S. (2022). Influences of origin and destination on migrant fertility in Europe. *Population Space and Place*, <https://doi.org/10.1002/psp.2567>.
- Mussino, E., Ortensi, L. E. (2018). The same fertility ideals as in the country of origin? A study of the personal ideal family size among immigrant women in Italy. *Comparative Population Studies*, 43, 243–274. <https://doi.org/10.12765/CPoS-2019-03>.
- Reynaud, C., Miccoli, S., Benassi, F., Naccarato, A., & Salvati, L. (2020). Unravelling a demographic 'Mosaic': Spatial patterns and contextual factors of depopulation in Italian Municipalities, 1981–2011. *Ecological Indicators*, 115, 106356.
- Sobotka, T. (2008). Overview Chapter 7: The rising importance of migrants for childbearing in Europe. *Demographic research*, 19, 225-248.
- Toulemon, L., Mazuy, M. (2004). Comment prendre en compte l'âge à l'arrivée et la durée du séjour en France dans la mesure de la fécondité des immigrants (p. 34). France: INED.
- Vitali, A., Billari, F. C. (2017). Changing determinants of low fertility and diffusion: A spatial analysis for Italy. *Population, Space and Place*, 23(2), e1998.
- Zambon, I., Rontos, K., Reynaud, C., & Salvati, L. (2020). Toward an unwanted dividend? Fertility decline and the North–South divide in Italy, 1952–2018. *Quality & Quantity*, 54, 169-187.