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HABILITATION THESIS

**Statistical methods used in the study of sustainable
socio-economic development**

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Bucharest,
2026

Summary

The habilitation thesis synthesizes the research programme developed after obtaining the PhD title (2015) and highlights the usefulness of statistical and econometric methods for measuring and explaining sustainable socio-economic development, starting from comparative applications across European Union Member States. The study addresses current challenges-growing complexity of policy indicators, persistent intra-EU disparities, environmental and health pressures, the transition to the circular economy, and the acceleration of digitalisation in a post-pandemic context-by proposing an integrated analytical framework based on: (i) operationalisation and measurement through composite indicators, (ii) structuring through multivariate methods, (iii) typology building through classification techniques, and (iv) investigating dependency relationships through correlation analysis and econometric models, including panel specifications where data allow.

In developing composite indicators, the thesis follows transparency and robustness principles aligned with recommendations in the specialised literature (e.g., OECD – type guidelines), through a rigorous process of indicator selection, standardisation/normalisation, missing-data treatment, internal-consistency testing, and sensitivity analyses regarding weighting. In parallel, the academic dimension of this research programme has been supported by teaching activities, including the continuous updating of course content and the integration of data-analysis software tools, supervision of bachelor's and master's theses, participation in doctoral guidance committees, and involvement in departmental initiatives for organisation and dissemination (scientific events, digital communication, editorial activity).

The thesis is structured in three parts: PART I brings together scientific achievements based on published articles and is organised into five thematic chapters; PART II presents career development plans over a 3-5 year horizon; PART III includes the list of bibliographic references used.

Part I brings together five thematic strands grounded in published results. Chapter 1 develops and validates a composite social inclusion index for the EU, built on a coherent set of socio-economic variables and aggregated using Principal Component Analysis (PCA)/factor analysis. The results highlight latent inclusion dimensions and outline cross-country rankings and patterns of convergence/divergence, useful for designing interventions aimed at reducing disparities.

Chapter 2 investigates the environment-health relationship, highlighting significant associations between air-pollution indicators and health-status indicators. Country clusters with distinct profiles

are identified, with implications for good practices and differentiated policies depending on context.

Chapter 3 analyses the European circular economy, showing that circular performance (recycling, waste management, resource productivity) correlates positively with welfare and development indicators, albeit with heterogeneous intensities across Member States, suggesting the existence of "conditional convergence clubs" and the need for policy packages tailored to economic and institutional structures.

Chapter 4 examines the globalisation–digitalisation–resilience nexus from a post-pandemic perspective, combining conceptual synthesis with empirical analysis based on internationally used composite indices (KOF Globalisation Index, FM Global Resilience Index, Network Readiness Index). The findings point to strong links between globalisation, digital-network readiness and resilience, while regression models and cluster analysis reveal typologies that are relevant for interpreting performance and vulnerability differences during shocks.

Chapter 5 models the relationship between private R&D investment and cloud-computing adoption in the private sector, emphasising the complementarity between innovation and digitalisation as drivers of competitiveness and sustainability and suggesting possible feedback mechanisms.

The thesis contributions are both methodological and applied: it proposes a replicable analytical pathway (selection-preprocessing-dimension, reduction-clustering-modelling-robustness checks), integrates comparable official statistical sources (primarily Eurostat, complemented by thematic databases and international indices), and formulates policy-relevant conclusions by highlighting intra-EU heterogeneity and differentiated interventions depending on country profiles. Methodologically, the thesis applies a common transversal framework (preprocessing–PCA/FA–clustering–econometric/panel modelling–robustness), enabling the transformation of complex indicator sets into comparable and interpretable results for public policy.

Part II outlines development directions (3-5 years), methodological and empirical extensions, and plans for projects, dissemination and internationalisation, consolidating the continuity of the research programme. Future directions include methodological extensions (dynamic panel models, sensitivity analyses to selection/weighting in composite indicators, additional validation of typologies using cohesion/separation criteria, and, where possible, causal-inference approaches) and empirical extensions (regional NUTS2 granularity for the environment–health and inclusion relationship, periodic updates of indicators for the green and digital transition). The development programme includes practice-oriented dissemination and enhanced reproducibility through open-science practices (code and preprocessed datasets, where possible).

Part III – Bibliographic references includes the main sources consulted and cited in the habilitation thesis and in the presented works, used to underpin the theoretical and methodological framework and to support result interpretation. The bibliography brings together references relevant both to teaching activities and to the further development of research directions.

In conclusion, the thesis highlights methodological and applied contributions to measuring and explaining multidimensional socio-economic phenomena in the European Union, by integrating composite indicators, multivariate methods and econometric modelling, with relevance for comparative interpretations and for designing differentiated policies.

Keywords: sustainable socio-economic development; social inclusion; composite indicators; multivariate analysis; circular economy; digitalisation; resilience.